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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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NATURE

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*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

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Chemistry as a Career.

A GREAT deal is being said and written at the present time about the teaching of science and the prospects of careers for trained specialists in its numerous branches. The serious teaching of science is no longer confined to a few schools, for it is now widely accepted that even the properly educated layman should possess some knowledge of the general principles of physics, chemistry, and biology. An indication of the educational trend may be discerned, for example, in the recent provision of magnificent laboratories at Clifton College (NATURE, June 11, 1927, p. 871), and in the curricula of the remodelled City of London School, in which "general science, including biology, will be taught on the classical side, physics-with-chemistry on the modern side, while on the science side limited specialisation in physics, chemistry, and biology will be possible" (NATURE, Dec. 24, 1927, p. 936).

Although, apart from occasional conflicts between the claims of physical and biological science, it may be comparatively easy to cater in the secondary schools for the future layman in science, the potential specialist presents a difficult problem to headmasters and parents. At what age can a boy's aptitude for a particular branch of science be judged? How is he to be enabled to demonstrate that aptitude? How far should he be allowed to specialise at school in the field concerned? To what extent can a would-be specialist in science count upon a satisfactory career? These are some of the more insistent questions which press for an answer; and we may briefly consider them in this place, particularly in so far as they affect the profession of chemistry.

The provision of answers to the first two of them

is a matter for the secondary schools ; for, given a reasonably broad basis of secondary school education in science, there should be little difficulty in diagnosing aptitude before the boy is ready to enter the university.

Coming to the third query, and focussing attention upon chemistry, we cannot escape the impression that there is a current tendency in certain secondary schools to carry specialisation very far—perhaps too far—with apt pupils. This tendency, in turn, appears to be largely a response to the increasingly difficult examination papers which determine the award of entrance scholarships from the schools to some of the universities. The lot of the master who is preparing boys for chemistry in such examinations cannot be a particularly happy one; for, besides covering the old inorganic field, he has to bear in mind that the papers may deal mainly with physical chemistry; moreover, examiners do not hesitate upon occasion to include questions in organic chemistry which might well give pause to a second-year university student in that special branch of the subject.

It is not surprising, therefore, that many of the precocious specialists who have carried the study of chemistry so far in a limited time should possess little or no knowledge of biology, and that others should be regrettably deficient in English, mathematics, and other fundamental subjects. The discovery of a particular aptitude in a pupil is always welcome, and a judicious fostering of the favoured subject is essential; nevertheless, at school, and in the earlier years at the university, a pupil should be restrained from inordinate specialisation until he has secured the necessary basis of a well-proportioned general education. There is much to be said for the adoption of a broader test of intelligence and merit than the specialised examinations which are now so often imposed upon candidates for entrance scholarships to the universities.

Any query dealing with the prospects of a satisfactory career for pupils or undergraduates who are inclined to adopt chemistry as a profession is bound to raise complex issues. First of all, how is a satisfactory career to be estimated? Even if the simple quotation of a possible salary at a given age be accepted as sufficient, the question remains exceedingly difficult to answer. Perhaps the greatest stumbling-block in a discussion of this kind lies in the fact that chemistry provides a multitude of diverse professions rather than a single homogeneous profession. As a minor result of the War, few intelligent laymen are likely at the present day to confuse the so-called 'scientific chemist' with the pharmacist, or apothecary (why, by the way, cannot this honourable old name be resuscitated?); many, indeed, might even succeed in attaching such distinguishing adjectives as 'academic,' 'research,' 'analytical,' and 'industrial,' to the term 'chemist.' However, the very title of 'chemist' is so misleading in the British Empire that the Registration Committee of the British Association of Chemists has recently replaced it by the term 'chemical practitioner.'

A preliminary indication of the scope of the profession is afforded by the fact that candidates for the fellowship of the Institute of Chemistry may qualify in any one of the following eight branches: inorganic, physical, organic, agricultural, or general chemistry; the chemistry (including microscopy) of foods and drugs, and of water; biochemistry; and chemical engineering. This, however, is only the beginning of the classification. A glance at the *Journal of the Society of Chemical Industry* is sufficient to reveal that an industrial chemist may specialise in any one of twenty-three arbitrarily selected sections, and many of these sections may be subdivided almost indefinitely. Some of the great chemical industries centre, indeed, around a single material, or a group of allied materials, such as sulphuric acid, alkalis, ceramics, metals, glass, petroleum, alcohol, cellulose, cane-sugar, fats, paints, leather, india-rubber, medicinal chemicals, dyes, explosives, etc. Add to these considerations the fact that the industrial chemist—irrespective of the particular manufacture in which he is interested—may be occupied with any combination of duties comprehended under such labels as 'research,' 'analysis,' 'control,' 'administration,' and many others, and one begins to realise the innumerable ramifications of the chemical profession.

It is thus apparent at the outset that this profession possesses as many diversities as the British Empire, and that it provides scope for all sorts and conditions of chemists. Just as a Fijian would not feel at home in Labrador, so would a chemist who has specialised in the alkali industry experience a certain sense of strangeness if required to conduct research work on the constitution of a new alkaloid. Moreover, it is quite as difficult to legislate effectively for the complex corporation of chemists as for the complex racial association of the British Empire. That is why chemists, in spite of the beneficent activities of the Institute of Chemistry, are unable to safeguard the interests of their profession in a generally acceptable manner. The Institute publishes, however, a comprehensive list of official appointments which are, or may be, held by chemists, under the title of "Official Chemical Appointments"; and it is specially con-

cerned with the creation of such posts as well as with the education and registration of professional chemists competent to fill them. Its 5300 fellows and associates represent many aspects of chemical science and practice, and they form just as unified a professional organisation as is found in similar institutions of civil and mechanical engineers or of medicine.

Specialisation is, however, the penalty that has to be paid for progress. If, therefore, a young man resolves whole-heartedly—in colloquial phrase —to 'take up chemistry,' his decisions are by no means at an end. Under modern conditions he has to specialise again—this time within the subject, and possibly in one or more of the branches recognised by the Institute of Chemistry. Eventually, he may favour academic, analytical, or industrial work. In the first contingency—in the absence of striking powers—his promotion is likely to be slow, and he may be heading for the forties before he achieves even a modest competency. If he succeeds in securing a good footing in analytical practice, or, better still, in industrial chemistry, his progress is likely to be far more rapid, particularly if he possesses adaptability and personality. In making his crucial decisions he will look for guidance to his university teachers, who should maintain the closest possible touch with the leaders in industrial chemistry.

At the present time, while opinion is practically unanimous upon the very great difficulty of finding openings in chemical industry for men of second-class attainments, and for women chemists of even the highest qualifications, there are two distinct currents of feeling regarding the prospects for trained men of undoubted first-class ability.

On one hand, there is talk of a 'glut of chemists,' as an aftermath of the War; and there is little doubt that some chemists in Great Britain have been forced to abandon their profession since 1918, owing to the difficulty of securing satisfactory appointments. Communications from disillusioned or disgruntled chemists appear at frequent intervals in the technical press. One reads of a letter offering a wage of 1*s*. 2*d*. per hour to a graduate with three years' industrial experience, in a district where an unskilled labourer receives 1*s*. 7*d*. per hour. A correspondent complains (NATURE, Mar. 19, 1927, p. 432) that a lecturer in organic chemistry is paid at the rate of a dock labourer; another refers to an advertisement in which "a chemist, bacteriologist, 'medicolegalist,' organiser, lecturer, etc., is offered the princely salary of £400 per annum."

On the other hand, it has recently been stated in an authoritative chemical publication that "chemists are not worse paid than other professional men, and . . . that in the majority of cases they are paid as much as they are worth. Those who call attention to the low salaries offered to junior chemists will find the same feature in other professions. . . . It took us several years to realise how much more valuable and how much better remunerated is the knowledge of affairs and of men than the knowledge of a science, or of law, or of history or literature. . . . The supply of the clerk, the book-man, the man educated in schools and universities exceeds the demand." That the last statement does not apply at present to the trained chemical specialist of first-class ability is evident from the categoric pronouncements of prominent leaders in the British chemical industry, to the effect that the supply of properly qualified chemists is inadequate. Here one may interpolate that the qualifications should include a sound general education, a first-class honours degree, or its equivalent, in chemistry, together with a couple of years' training in research.

Thus, Sir Alfred Mond is reported in the *Times* of Dec. 13 to have stated that

"there was a definite shortage of scientific men in this country, and that was hindering research work. In his own company the number of men of the kind they wanted was far below the number they could absorb, and they had decided to approach headmasters with a view to selecting bright boys when still at school. Those boys would be assured that, if they would go through a university and obtain first-class degrees, they would not have to look for a job, but would be found one in his organisation, with remunerative salaries, at the moment they were ready to come. The company hoped in that way to do something from the beginning to make science a career, just as the Bar or medicine was now. They wanted a much greater co-ordination between the leaders in science in the universities and those who wanted the taught material. They wanted a conference at an early date so that those who were teaching could be told the directions in which their pupils would find work of advantage both to themselves and to those by whom they were employed."

Periodical conferences of this kind would undoubtedly be of value in correlating supply and demand and in providing opportunities for discussing other problems. For example, the cost of a training which includes five or six years at a university is naturally a serious consideration to many parents, and Sir F. D. Lugard in a letter to the *Times* of Dec. 17 makes the interesting suggestion that "there are probably many boys at our public schools who have shown a marked aptitude for science, and have borne a

character for steady application to study, and would gladly agree to repay their university expenses by deductions from their subsequent salaries, if those expenses were provided in the first place by a firm which offered prospects of scientific research." It may be mentioned that a scheme of this general character was adopted some years ago with marked success by a certain enlightened and efficient chemical corporation in Australia.

Such opinions as those quoted above form a refreshing contrast to the narrow views of many of the uninformed laymen who have hitherto so often found themselves in nominal control of chemical enterprises. A good deal of the dissatisfaction to which reference has been made has probably been engendered by the unenlightened and conservative tendencies of the business man of the old school, who has been apt to regard the chemist in his factory in much the same light as the maid-of-all-work in his home. Under the new regime, the young chemist who enters a scientifically organised chemical corporation, with trained chemists in the highest administrative positions and on the board of control, will not suffer from the disadvantages which have so discouraged his predecessors. Provided that he is efficient, he will enjoy security of tenure, with, let us hope, an adequate pension provision; he will obtain the diverse experience which only a large organisation can offer; and the elastic system under which he finds himself will permit of his particular abilities being utilised to the best advantage.

To sum up this aspect of the discussion, it appears that at present, owing largely to the stimulating effect exerted upon the British chemical industry through the formation of Imperial Chemical Industries, Ltd., the prospects in this industry are decidedly promising for the new generation of properly qualified chemists. The directors of this great organisation are taking broad and patriotic views, and it is devoutly to be hoped, in the interests of Great Britain and the Empire at large, that their efforts to establish the British chemical industry upon an unassailable footing will be crowned with success. It should be the aim of the secondary schools and universities to aid in diverting into this vitally important group of key industries an adequate proportion of the best brains of the nation. That the realisation of this ideal will bring a fitting reward to the man of proved first-class ability is certain, especially if he combines with his expert knowledge of chemistry a *flair* for research, economics, administration, or business management.

J. R.

Eastern Adepts and Western Science.

The Mysterious Kundalini (the Physical Basis of the "Kundali (Hatha) Yoga" according to our Present Knowledge of Western Anatomy and Physiology). By Vasant G. Rele. With a Foreword by Sir John Woodroffe (Arthur Avalon). Pp. xi+112+viii+4 plates. (Bombay: D. B. Taraporevala, Sons and Co., 1927.) 3.8 rupees.

THE chief interest of this book, for most readers of NATURE, will consist in the description of the modification at will of certain physiological processes by a Yogi of Bombay. The Yogi demonstrated his powers before the Bombay Medical Union, and also before the students of a medical college (name of the college not given) and a few guests. On the latter occasion the author, who possesses the diplomas of F.C.P.S. and L.M. and S., and who is described by Sir John Woodroffe in his foreword as "a competent man of science," was selected, along with another doctor (unnamed), "to judge the truth of his statements," and was "told to report to the students what we actually saw and felt."

The Yogi, when told to stop his right pulse, took a deep breath and made a forcible expiration; whereupon for the first two or three seconds the pulse was very much accelerated; then came a slowing, and then a stoppage, which lasted for more than two minutes with the interposition of two or three beats at the end of the second minute. During this time his hand and fingers were "a bit shaky," and there was some twitching in his fingers; the pulse on the other side was normal, and the muscles of the arms and forearms were quite soft and pliable. The pulse on the left side, and the temporal pulse, could also be stopped at will. "When the radial pulse of one hand was stopped, the circulation in the whole arm was stopped, but when the pulsation in the temporal artery was made to stop, the carotid artery was still beating, showing thereby that the checks used by him were above the brachial artery in one case and above the carotid in another."

The heart beats, as heard by the stethoscope, could also be stopped. After the same process of deep breathing and forced expiration the heart slowed and stopped; "the duration of complete stoppage of the beat of the heart was for six seconds by the watch." When the Yogi was examined by X-rays, before the two observers and eight other medical men of repute, and told to stop the beating, his heart contracted so that its apex was about two-

thirds of an inch internal to its normal position; the apex beat was inaudible, but the rhythmic contraction of the heart was still present; the beats, recorded on a cardiograph (reproduced), were much smaller in amplitude (about two-thirds of the normal, as shown on the tracing) and less frequent (60 per minute).

This Yogi also showed "some rare feats of archery, such as splitting of hair and thread by an arrow darted at them from a distance of about 15 to 20 feet. He broke an iron chain three-eighths of an inch in thickness by a mere pull of his body; one jerk, and crack went the chain in two pieces." Physically he is described as being slender in body, legs long and thin, and calf muscles showing insufficient physical exercise.

The Yogis are adepts of the science of yoga, by which the embodied spirit, jivátma, which is a part of the universal spirit, paramátma, is made to become one with the universal spirit by certain physical and mental exercises; yoga is the "union or linking together of man with God." The necessary physical and mental exercises are arranged in eight steps; the physical exercises are concerned with posture and regulation of the respiration. The author states that all the physical practices of yoga are directed towards bringing the sympathetic under [conscious] control, and that this control is effected through the plexuses of the autonomic nervous system. Leaving aside the Yogi's feats of skill and strength, the author's explanation of the modifications of the circulation is that these are due to an acquired conscious control of the sympathetic nervous system. But "the ultimate aim of the Yogi, in the various practices, is not to acquire and manifest the various supernatural powers, which only come to him on his onward march of getting himself absorbed with the Infinite."

According to the Tantric manuals, the stimulation of the 'chakras,' which the author identifies with the sympathetic plexuses, is always through 'Kundalini'; by establishing the control of the will over Kundalini we can subjugate the whole of the autonomic nervous system. But, though numerous interpretations have been given, Kundalini has always been a mystery; the author identifies her (the feminine is apparently correct) with the vagus nerve, which has connexions with the several plexuses of the sympathetic in the thorax and abdomen, and more particularly with the right vagus. The control is obtained by practising certain 'catches' (Bandhá) and attitudes (Mudrá) during the process of Pránáyáma, the fourth of the eight steps in the training of the Yogi. The author gives a full account of the various steps, and especially of the physical exercises, by which yoga is attained, and illustrates this by a number of photographs. But though the various practices of yoga appear simple and easy of achievement on paper, they are all to be learnt at the feet of the master; "it is of paramount importance that the instructions should be received by a student from an adept."

A few words of criticism may be added. The author does not discuss the Yogi's feats of skill and strength, yet some notice must be taken of these also. If the description of the splitting of a hair, or even of a thread, by an arrow from a distance of 15 to 20 feet is to be taken literally (and if not, the value of the whole account is much depreciated), it would seem probable that either trickery on the part of the performer, or an abnormal mental condition of the spectators, must come into the reckoning. Again, we are not told who supplied the iron chain that was broken by "one jerk" of this physically poorly developed adept.

The author would presumably explain the stoppage of the radial pulse, produced at some point above the brachial (that is, by occlusion of the subclavian or axillary artery), by a localised contraction of the musculature of the vessel wall occasioned by a voluntary impulse passing along the sympathetic fibres. But it seems improbable that even the most powerful stimulation of the sympathetic—even an experimental stimulation—could cause complete occlusion of the larger arteries; it is to be remarked, too, that a graphic record of the pulse was not taken; possibly, if this had been done, pulsation might have been found to be still present, as in the case of the heart. To forestall criticism, moreover, we ought at least to have been assured that there was no possibility of anything being concealed in the axilla against which the axillary artery could be compressed, and that the subject did not possess cervical ribs which in some posture, for example, when the shoulder was depressed, could exercise compression on the subclavian. A diminution in the temporal pulse might conceivably be brought about by the compression of the external carotid from inside, by some hard body in the throat; at least, such possibilities should be definitely excluded. The effect of forced respiratory movements on the heart is well known; we seem to remember that the earlier editions of Huxley's "Lessons" stated that the heart-beats could be stopped temporarily by strong sudden inspiratory or expiratory efforts with nostrils and

mouth closed—with an added note, however, that the experiment was not free from danger.

The author's claims on behalf of the Yogi can thus not be accepted until there is evidence of the application of a more rigid criticism. The book has, however, a distinct value as describing and illustrating for western readers the physical training of the Yogi, and as an attempt at interpreting in modern terms the difficult pseudo-anatomical descriptions of the Tantric texts.

J. STEPHENSON.

British Deer.

Hunting and Stalking the Deer : the Pursuit of Red, Fallow, and Roe Deer in England and Scotland. By Lionel Edwards and Harold Frank Wallace. Pp. xi + 274 + 48 plates. (London : Longmans, Green and Co., Ltd., 1927.) 63*s*. net.

WHILE the sumptuous volume on deer-stalking and stag-hunting whereof Mr. Lionel Edwards and Mr. Frank Wallace are joint authors forms a notable addition to the literature of field sports, for the field naturalist it has a strain of melancholy, inasmuch as it records marked degeneration in the noblest of our native land fauna—*Cervus elaphus*. "It is curious," observed Mr. Walter Winans in his recent work, "Deer-breeding for Fine Heads" (London, 1913), "that Scottish stags are at the present time the worst in Europe." It would be curious, indeed, if they were not so, having regard to the conditions of climate and food supply which they have to encounter in winter. By nature and original habit the red deer is a woodland animal, only resorting to the hilltops in summer heat to escape the torment of flies and to browse on the flush of upland grass, but ever returning to the woods for shelter and food in winter. Now that man has felled the forest and claimed all the low ground for his industry and crowded habitation, the red deer are confined throughout the year to storm-swept wastes at high altitudes. The term 'deer forest' remains only to connote some of the bleakest and most treeless tracts in North Britain. The real wonder is that British red deer have not deteriorated still further from the magnificent creatures that roamed the Caledonian forest of yore, whereof the bones and antlers exhumed from peat-mosses and tidal estuaries prove to have been no whit inferior to animals of the same species now inhabiting the Carpathians, the Caucasus, and certain well-wooded English parks.

Two such antlers lie before the present writer. They are not a pair; one with seven points has part of the skull attached and measures 37 inches along the outer curve and 7¼ inches in circumference between brow and bay. The other is a cast horn, 38 inches long, with only six points remaining, the brow tine having been broken off; the bay tine is of the extraordinary length of 20¾ inches. These antlers are among very many others recovered from the alluvium in the estuary of the Cree in the work of drawing out of the clay huge oak trunks, wreckage of the Pleistocene ice.

As indicated by the title of their book, the authors treat of deer almost exclusively from the sportsman's point of view; but Chaps. xxvi. and xxvii. contain some interesting notes upon the habits of red deer, of which not the least remarkable is the readiness with which they take to the water and the distance to which they will swim, even when not pursued. They cross freely from isle to isle of the Hebrides, and an instance is recorded of a stag being captured in Kilbrannan Sound four miles at sea, "apparently swimming for Arran, which is twelve miles distant from the mainland" (p. 132).

In view of the great number of deer killed every year in Great Britain, it is strange in how little general esteem venison is held as food. Gourmets appreciate it; but in most houses it is taboo in the servants' hall. Sportsmen have come to prize a good 'head' more highly as a trophy than a fat haunch as a delicacy. Indeed, a great part of the volume under notice is occupied with a discussion of the antlers of the red stag, with long lists of detail in their dimensions and variety.

"The chief reason," writes Mr. Wallace, "why the horns of the *Cervidæ* present so many features of interest lies in their never-ending variety. Place twenty of the finest heads of any other species of game alongside one another, and whether they be kudu, sable, ibex, or the great sheep, you will notice very little difference. . . . No two heads of red or roe deer . . . are alike even to a casual eye, and so to the study of their horns attaches a peculiar interest" (p. 95).

The authors make no reference to what is, after all, the most remarkable feature in the antlers of deer, namely, that alone among Ungulates the Cervidæ grow solid horns and cast them annually. The giraffe and rhinoceros also carry solid horns, but a single pair of these, like the hollow horns of oxen, goats, and antelopes, serve them throughout life for offence, defence, and ornament; whereas the far heavier armature of a red stag has to be fashioned afresh, with considerable pain and irritation, each summer, only to be

cast off in the following spring. The consequent waste of material in a herd of deer is considerable, especially among reindeer, whereof both sexes carry palmate antlers. Among the remains referred to above as recovered from the estuary of the Cree is a pair of red stag's antlers weighing exactly 18 lb.

Purpose in the waste of such fine armature baffles conjecture, but there is no doubt about the purpose for which it was grown.

"Deer, as is well known, are great fighters, and when with the hinds a stag leads a pretty strenuous life. . . . I doubt if a big beast with a large number of hinds gets any sleep at all for days, one might almost say weeks, on end. Watchful rivals are for ever hanging on the flanks of his harem ready to dash in and cut out a stray hind or two if their master's alertness is relaxed for a moment. Towards the end of October, worn to skin and bone, with bloodshot eyes, completely exhausted, he can no longer display his former activity, and smaller beasts may evade his weakened fury."

The volume is well and profusely illustrated, the coloured plates by Mr. Lionel Edwards being very beautiful. HERBERT MAXWELL.

Quanta.

Handbuch der Physik. Herausgegeben von H. Geiger und K. Scheel. Band 23: Quanten. Redigiert von H. Geiger. Pp. ix + 782. (Berlin: Julius Springer, 1926.) 57 gold marks.

IT is little more than a generation ago since Planck first formulated his quantum theory to explain the observed distribution of intensity of black-body radiation in its dependence on frequency and temperature, and so introduced the discontinuity idea into the description of natural processes. Meanwhile, the new theory has thrown out its feelers into practically every branch of physics, and developed with such amazing rapidity that it appears both fitting and natural that a special volume of the "Handbuch der Physik" should be devoted to it. Even so, not all the applications of the quantum theory are embodied in the present volume. Subjects such as the statistical applications of the theory, its relation to chemistry and to molecular structure, and certain aspects of the theory of band spectra have been relegated to their appropriate volumes. Furthermore, the epoch-making developments of quantum mechanics by Heisenberg, Born, Jordan, Dirac, L. de Broglie, Schrödinger, and others, are not included, but will doubtless receive their due share of attention in later volumes of the 'Handbuch.'

The editor has been particularly fortunate in his choice of contributors, all of whom are in the forefront of the branches on which they write. In its production, too, the book is of exemplary clearness; the paper is good, the diagrams clear, and the photographic reproductions bring out even the finer detail. Copious references to the literature occur at the foot of almost every page, an index is included, and nothing of importance appears to have been overlooked.

Chap. i. is more than the word chapter conveys. In a space of somewhat less than three hundred pages, W. Pauli, Jr., gives a complete statement of the quantum theory, which is masterful in its brevity. The underlying ideas are presented with remarkable clearness, and the experimental developments of the subject are everywhere kept in view. We can perhaps pay no higher tribute to the chapter than to state that it reaches the same high order of excellence as the author's well-known article on relativity in the "Encyclopædia of the Mathematical Sciences," which, at the instigation of Prof. Sommerfeld, was reprinted in separate book form. In three sections Dr. Pauli deals successively with the general principles of the quantum theory, the theory of the spectrum of atoms with a single electron, and with the spectra of atoms with more than one electron. Even in its more difficult parts the theoretical treatment is remarkably lucid, and we venture to express the hope that this article by Dr. Pauli may also be printed separately in book form and made available in English. A slight misprint occurs on p. 173 (footnote) in the spelling of Guthrie! Spectral notation is badly in need of standardisation, and is a constant source of confusion even to specialists. In this chapter Dr. Pauli has done his best to preserve clearness in this respect, for he devotes p. 278 to a statement of the term and quantum number notations as used by Sommerfeld, Landé, and by himself. His own notation has been arrived at after consultation with Sommerfeld and Hund, and it is to be hoped that co-operation will soon be exercised and uniformity attained through the medium of an international convention.

One of the most remarkable and striking features of atomic physics is the accuracy with which the various fundamental constants are known. The second chapter, comprising a theoretical and an experimental section, is concerned with the evaluation of Planck's constant h, and gives a critical and very valuable summary of the results. R. Ladenburg concludes that the best value of h in the present state of knowledge is $(6 \cdot 55 \pm 0 \cdot 01) \times 10^{-27}$ erg sec.

The absorption and scattering of X-rays is dealt with by W. Bothe in Chap. iii., and it need scarcely be said that the subject is ably and authoritatively presented, for the author himself has contributed in no mean measure to the work done in this field. Both theory and experiment are treated, and many useful numerical data are included. The older work is proportionately discussed, and more recent work (directional distribution of photoelectrons, Compton effect, etc.) is described in a clear and well-balanced manner. A brief appendix on the energy measurement of the rays is not only of theoretical interest, but also of importance in radiological practice.

H. Kulenkampff gives in Chap. iv. a full account of the continuous X-ray spectrum, the laws of its excitation, the energy distribution in the spectrum, as well as polarisation effects and the azimuthal distribution of intensity. The chapter contains much useful information, both experimental and theoretical, and is a valuable critical survey of the subject.

The fifth chapter owes its origin indirectly to the War, when the author, P. Pringsheim, spent the period of his unfortunate internment in Australia in the collection of material for his well-known book on "Fluorescence and Phosphorescence," in which he gratefully acknowledges the help afforded him by Profs. Lyle, Pollock, and Wellisch in procuring the necessary literature. The chapter is entitled "The Excitation of Emission by Radiation," and deals fully with resonance radiation, the disturbance of resonance radiation by collisions, the fluorescence and phosphorescence of organic compounds, the fluorescence of inorganic molecules, and crystal phosphors. This new and up-to-date treatment of a rapidly developing subject is most welcome, and Prof. Pringsheim has performed his task admirably.

Photochemistry is one of those border-line sciences which cannot be regarded as the prerogative of physicists. Too detailed an account of it is thus scarcely called for even in a handbook of physics. On the whole, we feel that W. Noddack has been judicious in the selection of his material, and the essential facts are presented clearly and well arranged in the forty pages of Chap. vi. In one or two instances, however, he has erred on the side of brevity, especially in the section on the effects of corpuscular rays. The latest reference to the action of α-particles in promoting chemical reaction is of pre-War date, whereas much valuable work has been done during the last few years, notably by S. C. Lind.

Our knowledge of atomic structure has made vast strides since the classical experiments of Franck and Hertz, and much of the progress made has resulted from the application of their method of retarding potentials in work on the "Excitation of Quantum Jumps by Impact." This is the title of Chap. vii., excellently written by J. Franck and P. Jordan, and it is one of the most valuable in the book, both in its clear statement of theory and in its presentation of experimental method. The authors deal with slow electrons, critical potentials and energy levels, the probability of excitation and ionisation, and kindred topics. The treatment is not only critical, but also delightfully lucid and complete. It is based on the authors' well-known book on the same subject.

Our Bookshelf.

Mikroskopische Physiographie der Mineralien und Gesteine: ein Hilfsbuch bei mikroskopischen Gesteinsstudien. Begründet von H. Rosenbusch. Band 1: *Die petrographisch wichtigen Mineralien und die Methoden ihrer Untersuchung.* Fünfte, neu bearbeitete Auflage von E. A. Wülfing und O. Mügge. Zweite Hälfte: Spezieller Teil. Fünfte, erweiterte Auflage von Prof. Dr. O. Mügge. Pp. xv + 555 - 814 + Tafeln 21 - 35 + 17 Tabellen. (Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung, 1927.) 33 gold marks.

THIS is the concluding instalment of the second half of the first volume of the classical work of Rosenbusch, which is a necessary part of the equipment of every student of petrology. It forms part of the fifth edition, the first after the death of the master. The fact that Prof. Mügge is responsible for it is a sufficient guarantee that the standard of the work has been maintained and that it has been brought thoroughly up-to-date.

The 'special' half of the volume deals with the physical, above all the optical, characters of the different rock-forming minerals by which they can be recognised. As much space as ever is devoted to the determination of the position of soda lime felspars in the continuous series from albite to anorthite. The use of the theodolite stage for the purpose had been already very clearly explained in the first or 'general' part.

An elaborate table for reference in identifying the different minerals presents some novel features. There is a separate category for minerals soluble in water. The biaxial minerals are not classed according to their crystallographic systems but according to their chemical nature. Whether this arrangement will help to facilitate the recognition of minerals remains to be tested by experience. The crystallographic system is indicated by Roman numerals, and it is rather disturbing at first to find that IV. means an orthorhombic mineral and not a tetragonal one, and VI. triclinic, not hexagonal.

The beautiful reproductions of mineral photographs remain one of the most attractive features of the book, and their number has been considerably increased. J. W. E.

(1) *Laboratory Manual in General Microbiology.* Prepared by the Laboratory of Bacteriology and Hygiene, Michigan State College. Third edition. Pp. xxvi + 472. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1926.) 17*s.* 6*d.* net.

(2) *Les Microbes.* Par Prof. P. G. Charpentier. Avec un atlas de photomicrographies de P. Jeantet. (Bibliothèque générale illustrée, tome 5.) Pp. 77 + 59 planches. (Paris: F. Rieder et Cie, 1927.) 16·50 francs.

(3) *Dictionary of Bacteriological Equivalents: French-English, German-English, Italian-English, Spanish-English.* By William Partridge. Pp. xi + 140. (London: Baillière, Tindall and Cox, 1927.) 10*s.* 6*d.* net.

(1) DESIGNED as a guide to students and teachers of general microbiology, this volume deals with general morphological and cultural methods, the physiology of micro-organisms and applied microbiology. The last named is subdivided to include air, water and sewage, soil, dairy and plant sections. Animal diseases and immunity, and an appendix dealing with special media, stains, etc., are added. Each part is arranged in a series of exercises with instructions, questions, and a list of references.

It is possible that this volume might prove of value in outlining a course for students in general microbiology, since much useful material is included. The new classification of the Society of American Bacteriologists is not used in the book.

(2) Prof. Charpentier, in his small volume, aims at conveying to the lay mind some knowledge of microbes both useful and harmful to man. Well-known examples are used and described in an easily readable and interesting manner. A large number of photomicrographs are given at the end.

(3) As the author states, this little book of 140 pages is intended to serve as a supplement to the general dictionary. All the foreign words included have, for the most part, been taken from the bacteriological literature of the country concerned. In all, about 7800 words are dealt with, of which 2400 are French, 2600 German, 1200 Italian, and 1600 Spanish. Many of the words are not found in ordinary dictionaries.

The Elements of Telephone Transmission. By H. H. Harrison. Pp. vii + 147. (London: Longmans, Green and Co., Ltd., 1927.) 5*s.* net.

SINCE Heaviside developed the theory of the transmission of electric and magnetic waves in long distance telephone circuits, vast improvements have taken place in the technique of the construction of telephone lines. As Heaviside assumed that his readers were thoroughly familiar with mathematical theory, he omitted many essential steps in his proofs, and this makes it no easy matter to follow his reasoning. The ordinary telephone engineer who uses Heaviside's somewhat complicated formulæ would probably be unable to prove them. In general, also, the engineer has little grasp of the physical processes which operate on a long telephone circuit. Most of the books on the subject are of a very advanced character. We therefore welcome an addition to the scanty literature which is suitable for the elementary student.

The reader will find this book a good introduction to the standard text-books on the subject. It is divided into four chapters, the first being a purely mathematical introduction dealing mainly with the elementary calculus. Engineers seem to think that there is some special virtue inherent in writing j for $\sqrt{-1}$ and calling it an operator. We prefer to use the Greek letter iota, ι, for $\sqrt{-1}$ and D for an operator. We know that this has been the custom at Cambridge for many years.

The United States of America: Studies in Physical, Regional, Industrial, and Human Geography. By Prof. A. P. Brigham. Pp. x + 308. (London: University of London Press, Ltd., 1927.) 8*s.* 6*d.* net.

PROF. A. P. BRIGHAM is already well known as an authority on various geographical aspects of the United States, and those who were stimulated by his lectures in London and Oxford in 1924 will be glad to know that they in turn have stimulated the lecturer to prepare this well-proportioned and illuminating book.

Besides the students of the later secondary and the earlier university years for whom the work is specifically intended as a text, there must be a wide circle of readers who have wished for a trustworthy account—not too long, and not too technical—of the United States and its varied inhabitants as they are to-day. They need look no further: for here they will find a panoramic survey of all the leading facts; a summary which is masterly in its balance, and in its freedom from the cramped terseness of many small works on large subjects; and an outlook which is sane and unprejudiced. The author has attempted to write for both sides of the Atlantic. In Great Britain his book will be welcomed as making a notable contribution to the literature of a subject which deserves to be far better understood than it is. The book is beautifully illustrated, and is produced at a price that does credit to the enterprise of the publishers.

A Course of Volumetric Work for Day and Evening Students of Pure and Applied Chemistry. By E. Clark. Pp. vi + 146. (London: Sir Isaac Pitman and Sons, Ltd., 1927.) 4*s.* 6*d.* net.

THE subjects dealt with are standard solutions, acidimetry and alkalimetry, silver nitrate, permanganate, iodine, and dichromate, and a few unclassified estimations. The principles of the methods are well explained and careful directions are given for performing the experiments and calculations. The book is suitable for use in evening classes and also for university students of intermediate standard. In both cases the work of the teacher will be simplified by the careful explanations given. All the points which offer difficulties have been dealt with and the book may be recommended as distinctly better than most existing works of its size and scope.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Flame and Combustion.

PROF. H. S. TAYLOR, in a letter to NATURE of May 21, directed attention to work going on in his laboratory and continued in Sweden by Dr. Bäckström (*Medd. K. Nobel Inst.*, 6, 15, and 16, 1927). Dr. Bäckström has found that the photochemical oxidation of benzaldehyde in the liquid state is a chain reaction, and since the effect of inhibitors is the same for the photochemical as for the thermal reaction, the latter is almost certainly a chain reaction (*J.A.C.S.*, **49**, 1460; 1927). In our work on the combustion of hydrocarbons below their igniting temperatures, the effect of inhibitors (such as phenol or aniline) on the gaseous oxidation appears to be similar to their effect on the oxidation of benzaldehyde in the liquid state. Therefore, probably, the mechanism of oxidation is the same.

We are led, therefore, to the following general view of gaseous combustion. Reaction will commence when a sufficiently energetic molecule of fuel combines momentarily with an energetic oxygen molecule. A temporary peroxide in a high energy state is thereby formed. Among the several possible changes which may result, starting with a hydrocarbon, a breakdown into an aldehyde and a water molecule is quite a likely one. These molecules would possess not only the initial energy of activation but also the reaction energy, and on their next encounter with other fuel molecules (or oxygen molecules) could communicate sufficient energy to enable combination to occur and so start a reaction chain. Such a mechanism would explain why the initial stages of combustion are so much influenced by concentration. For example, a small quantity of acetaldehyde added to pentane makes little difference to the igniting temperature of the pentane, although the aldehyde alone ignites at a lower temperature. The reaction chains facilitating the oxidation of the aldehyde alone, cannot be started to the same extent in the mixture, as the collisions with the hydrocarbon molecules communicate insufficient energy to activate the latter.

The main significance of a reaction chain mechanism as regards ignition, is that a comparatively rare occurrence becomes a frequent occurrence locally; centres of high energy are thus established which, if diffusion is prevented, become centres of ignition. It is clear that some of the molecules may become deactivated by loss of energy as radiation; (chemiluminescence with pentane is visible 200° below the igniting temperature). Photochemical oxidation, however, is probably insignificant compared with the thermal reaction, and we have found illumination makes no appreciable difference to the igniting temperature, though it has been observed to affect the rate of reaction at considerably lower temperatures (Bennett, *Trans. Farad. Soc.*, **23**, 295; 1927). The upper limit for excitation of molecules would be given by the ionisation of the molecule, though often dissociation occurs before ionisation. Where dissociation does not take place and as the reaction proceeds more and more rapidly and the temperature rises, the chances of reaching higher energy states become greater and there is every probability that some ionisation occurs. In my view this is one of the later stages of combustion and not the essential primary step; the combination of a fuel molecule with an oxygen molecule is the essential initial process. Combustion naturally will be most intense in the regions of high ionisation, because there the most highly active particles are to be found. In the flame itself ionisation, for the same reasons, is intense.

Prof. Taylor mentioned the effect of the organic radicals with which the metal in an antiknock compound is associated. Our experiments showed that this effect was secondary (*Jour. Petrm. Techn.*, **13**, 244; 1927). These radicals would certainly influence to some extent the oxidation processes which are going on in the locality of the 'antiknock' molecule. Thus, ether added to petrol tends to prevent the inhibitory effect of lead tetraethyl by forming with it a fairly stable oxidation product, but I found no such effect to occur with nickel carbonyl and ether-petrol mixtures; nickel probably does not form a similar compound. The effect of an 'antiknock' is mainly that of an inhibitor of oxidation and it does not assist combustion as some have suggested, though its result may be to obtain the kind of combustion required.

The 'autocatalysis' in the initial stages of combustion to which I have referred is a 'joy to the antiknock soul,' because it provides a mechanism which can be readily slowed down by the breaking of the reaction chains. This, together with the point established in the papers cited that the antiknock acts in a high state of oxidation which can be taken to a lower state and then regenerated, seems to account satisfactorily for many of the facts.

I am afraid that the above remarks are not in terms to be appreciated by Prof. Armstrong. I should like to achieve his approval by interspersing a few 'hydrones,' but so few people appreciate their charms that I can scarcely be blamed for failing to invoke them, having not that power over words which Prof. Armstrong enjoys and with which he enlivens us.

ALFRED EGERTON.
Clarendon Laboratory, Oxford.

Artificially-induced Metamorphosis in Echinoderms.

IN 1922 (*Biol. Bulletin*, **43**, p. 210) I propounded a theory as to the mechanism of metamorphosis in sea-urchins based upon the study of dedifferentiation in the larvæ. The Echinoid pluteus responds very readily to various unfavourable conditions by dedifferentiation. Starvation, lack of oxygen, overcrowding, and poisoning with very dilute potassium cyanide or salts of heavy metals, causes the arms to shrink and eventually to be resorbed, and the body to round up and contract; at the same time the gut may dedifferentiate considerably.

I assumed that in normal development the weight of the growing Echinus rudiment would eventually carry the larva down from the optimum conditions of food and aeration near the surface, to the bottom. The conditions here, being unfavourable for the larval tissues, would cause them to begin dedifferentiation. The Echinus rudiment, not being similarly susceptible (largely, it was suggested, owing to its cells and organs not presenting so much relative surface), would then be able more successfully to compete for food materials with the larval tissues. The balance, once tilted, would swing right over in its favour, and the larval organs, once dedifferentiation had begun, would speedily be altogether resorbed.

During the last two summers, thanks to the courtesy of Prof. E. W. MacBride, who annually raises numbers of Echinus plutei to metamorphosis, I was able to put this hypothesis to experimental test.

A number of late larvæ were selected from the plunger-jars where they were being reared, and divided into five classes according to the size of their Echinus rudiment (the most advanced specimens, with incipient resorption of the tips of their arms, were rejected). A number of representatives of each class were then replaced in the plunger-jars; another similar set were placed in sea-water, changed frequently, in small vessels; and a third set were exposed to the agency chosen to induce dedifferentiation.

The most successful agency was found to be very dilute mercuric chloride, from one two-millionth to one three-millionth molar. With such solutions, the results were perfectly definite. In less than twenty-four hours, above 90 per cent. of surviving specimens (more than 70 per cent. of total number) of larvæ with moderate to large Echinus rudiments, but with no trace of arm-resorption, had completely metamorphosed or were in the middle of metamorphosis; while only 6 per cent. of the two sets of controls had done so. None of the experimental animals remained fully larval (*i.e.* without any visible alteration such as arm-resorption, etc.); while nearly 70 per cent. of the controls did so. The majority of the control specimens in the plunger-jar had not metamorphosed after ten days.

One of the artificially metamorphosed Echini lived for eight days in spite of the absence of proper food. The fact that many died in one to two days may be compared with the high mortality in artificial (thyroid-induced) metamorphosis in amphibian larvæ. Doubtless, attention to precise strength of solution and length of exposure would (again as in Amphibia) much reduce the mortality.

Further, just as high doses of thyroid given to very small tadpoles give disharmonic results in metamorphosis (resorption of tail and gill system before proper limb size can be attained), so here larval dedifferentiation in stages when the Echinus rudiment was small (about half its final larval diameter) produced disharmonic metamorphosis, the result being a mere spherical lump with no or very slight indications of tube-feet, etc.

The fact that metamorphosis can be precociously caused by inducing larval dedifferentiation is presumptive evidence that larval dedifferentiation is the primary cause of metamorphosis in Nature. At any rate, the criticism (Pérez, *Année Biol.*, **4** (pt. 2), p. 16; 1923) that since dedifferentiation is a pathological phenomenon, it therefore can have nothing to do with a normal process like metamorphosis, is shown to be without foundation. So far as I am aware, this is the first case of experimentally-altered time of metamorphosis in any group of marine invertebrates, the recorded cases being confined to Amphibia, Tunicates, and Insects.

J. S. HUXLEY.

King's College, London,
Nov. 15.

Golgi Bodies in Plant Cells.

THE interesting letter of Prof. Bose, in NATURE of Dec. 3, on the Golgi apparatus of plant cells, may serve us as reason for discussing shortly the present position of our knowledge of this branch of cytology. The last ten years' work has enabled animal cytologists to show that the classic Golgi apparatus of nerve cells is a highly specialised structure, and that the true primitive Golgi body is in the form of a chromophile (osmiophile, argentophile) cortex and a chromophobe medulla, the whole usually granular in nature, except when the various elements form a close mass around the centrosome, in a juxta-nuclear position. In oogenesis these granules usually multiply rapidly and their centres become vacuolated and occupied by fatty materials forming the vitellus of the egg. In gland secretion the same phenomenon often happens. In spermatogenesis, in all animals investigated, the Golgi bodies secrete a bead which becomes attached to the nucleus to form the acrôsome.

Now in plant cells, Guilliermond and his school have homologised the well-known plant canalicular system, with the net-like Golgi apparatus of nerve cells. The two structures superficially resemble each other. Moreover, as Guilliermond (and now Prof. Bose) has shown, this canalicular system in plants sometimes has the power of reducing silver, and osmic acid, as has the Golgi apparatus of nerve and other animal cells.

Recently Parat has extended the vacuolar conception of the plant 'Golgi apparatus' to animal cells, and has claimed that the vacuoles in eggs, first described, I believe, by Dr. Ludford and myself, and more recently investigated, among others, by Dr. Rodgers Brambell and Miss Shana King, and the vacuoles in gland and other cells (Ludford, Nassonow, Bowen), are the true Golgi apparatus, and homologous with the plant canalicular system. The Russian (Nassonow), the American (Bowen), and the Belgian (Duesberg), and the leading English workers, all seem to regard the cortex of the animal vacuole as the homologue of the nerve cell Golgi apparatus. The vacuole is usually regarded either as the derivative (English school) or the associate of the true Golgi cortex (osmiophile, argentophile). To the non-cytologist this can be explained by thinking of the intracellular granule as an orange. British workers regard the skin as the homologue of the nerve cell Golgi apparatus, its contents as the derivative of the cortex. Parat and Guilliermond would regard the inside as the true Golgi apparatus, and the cortex—and here they fall—as a modified mitochondrial structure!

Amidst all these discussions, Dr. Charles Walker provides curious relief, by waking up nearly thirty years after Golgi discovered this intra-cellular organella, and claiming that this structure, which can be seen *intra vitam*, is merely an artefact. Be it noted that Dr. Walker (*Proc. Roy. Soc.*, 101, 1927) does not quote the botanist, Löwschin, who previously 'showed,' about twelve years ago, that one could manufacture mitochondria *which even divided*, by mixtures of different lecithin, albumen, and salt solutions.

Löwschin's papers are rarely quoted nowadays, and deserved better treatment from Dr. Walker. Curiously enough, Parat, exponent of the vacuolar Golgi apparatus, quotes the paper of Moore and Walker on mammalian spermatogenesis as evidence for the veracity of his theory! It was really Moore and Walker who discovered the "Golgi apparatus" in animal spermatogenesis!

Now Prof. Bose, following Guilliermond and his school, has demonstrated the canalicular system in mushroom cells. Like Guilliermond, he calls these canaliculi the Golgi apparatus. For years the work of Guilliermond's school has proved an embarrassment to the zoological cytologist. We could not but believe that bodies, so universal in animal cells (as universal as the nucleus itself), would not have real prototypes in the plant cells. Parat's rocket-like flash across the cytological sky also proved a temporary embarrassment, and has put several promising men on the wrong track.

Now, however, the recent paper by Bowen comes as a relief from the confusion of French cytology. Bowen (*Biol, Bull.*, **53**, 1927) claims that there are *three* categories of cell inclusions in plant cells, *besides the*

canaliculi: Structures resembling the invertebrate Golgi bodies; secondly, the well-known plastids; and thirdly, the mitochondria. Bowen gets the canaliculi, too. Moreover, and this is crucial, Bowen shows that in mosses his supposed Golgi bodies form the acrosome of the sperm *as in animals*.

Now, in view of Bowen's work, I feel that Prof. Bose's claim that the mushroom cell canaliculi are Golgi bodies, must be rejected. I believe that until Prof. Bose and other such workers follow these bodies through the life cycle of the plants they are studying, and demonstrate what they do in gametogenesis and in the general cell life of the plant, that such work as published by Prof. Bose is a waste of time. If Prof. Bose expects other cytologists to accept the view that what reduces silver and osmium in the cell must be Golgi bodies, he is much mistaken.

J. BRONTË GATENBY.

Trinity College, Dublin,
Dec. 5.

The Density necessary to produce the Nebulium Spectrum.

THE chief lines of the nebular spectrum have been identified by I. S. Bowen with forbidden transitions in the atoms of singly ionised nitrogen and singly and doubly ionised oxygen (NATURE, **120**, 473; Oct. 1, 1927). The life of an atom in the metastable state is very long compared to that of the other excited states, and the transfer to another state is accomplished by collisions of the second kind. Bowen argues that in the nebulæ, the density being extremely low and hence a long interval of time between impacts, the atoms in metastable states would return to normal states spontaneously with the emission of radiation. From spectroscopic data he has computed the frequency and frequency differences for N II, O II, and O III, and finds agreements with the chief nebular lines. A. Fowler has since computed the frequency differences, using data not available to Bowen, and finds even better agreement with the nebular lines (NATURE, **120**, 582, 617; 1927).

It remains to be seen whether a nebular spectrum can be produced when the density of a mixture of oxygen and nitrogen becomes small enough. The production of densities in the laboratory comparable with those in the nebulæ seems to be impossible with the present technique, and it is necessary to look to celestial phenomena in which the predominating physical change is that of decreasing density. The novæ offer just such an example, for in these objects there is apparently the expulsion of a shell of gas, and at some time in the life of this shell there originates from it the characteristic lines of the nebular spectrum.

To obtain the density of the shell of gas when it reaches the nebular stage it is necessary to know the original density and radius of the shell, which is probably the atmosphere of the star, the velocity of the shell, and the interval from outburst to the nebular stage. These data are available only in the case of Nova Aquilæ 3, which had a spectrum of type A and an absolute magnitude of $+2\cdot7$ before outburst. This indicates that the star belonged to the main sequence and, hence, one may make a good estimate of its radius and of the density of its atmosphere, about 6×10^5 km. and 10^{-9} grams per c.c., respectively. The velocity corresponding to a displacement of half of the width of the emission lines is taken as the rate of expansion of the shell. For Nova Aquilæ 3 this is about 1700 km./sec. (Hubble and Duncan, *Astroph. Jour.*, **66**, 59; 1927.) The N_1, N_2 lines were recognised in the spectrum of the nova about nineteen days after the outburst. Assuming that the shell was moving out with a constant thickness, the density at the time of the appearance of the nebular spectrum is about 10^{-17} grams per c.c. This density compares well with the mean densities of from 10^{-18} to 10^{-20} grams per c.c. obtained for the nebulæ.

For other novæ the densities in the shells at the time of nebular stage can be obtained in terms of the original densities and radii of the shells. The results for nine novæ are as follows:

Nova.	Density.
Nova Aurigæ	$3\cdot2\times10^{-20}\,\rho_0 r_0^2$ grams/c.c.
Nova Geminorum 1	7·7
Nova Persei 2	2·2
Nova Lacertæ	2·3
Nova Geminorum 2	8·5
Nova Aquilæ 3	12·7
Nova Cygni 3	5·5
Nova Ophiuchi	2·4
Nova Pictoris	1·3

ρ_0 = original density, r_0 = original radius.

It is rather surprising that there should be such little variation in the coefficients of $\rho_0 r_0^2$. The constancy would seem to indicate that the novæ originate from stars of similar physical conditions and that there is a limiting density above which the conditions are unfavourable for the production of the nebular spectrum.

Until more is known of the pre-nova history, the objects will have to be treated statistically. Assuming that the original stars belong to the main sequence, and again using the density 10^{-9} grams per c.c. and the radius 6×10^5 km., the mean density at which the nebular spectrum appears is $1\cdot8\times10^{-17}$ grams per c.c.

C. T. ELVEY.

Dearborn Observatory,
Evanston, Illinois,
Nov. 30.

Amendments to the International Rules of Zoological Nomenclature.

UPON unanimous recommendation by the International Commission on Zoological Nomenclature, the International Zoological Congress, which met at Budapest, Hungary, Sept. 4-9, 1927, adopted a very important amendment to Article 25 (Law of Priority), which makes this Article, as amended, read as follows (*italicised type represents the amendments*; Roman type represents the old wording):

Article 25.—The valid name of a genus or species can be only that name under which it was first designated on the condition:

(*a*) That (*prior to January 1, 1931*) this name was published and accompanied by an indication, or a definition, or a description; and

(*b*) That the author has applied the principles of binary nomenclature.

(*c*) *But no generic name nor specific name published after December 31, 1930, shall have any status of availability (hence also of validity) under the Rules, unless and until it is published either*

(1) *With a summary of characters (seu diagnosis; seu definition; seu condensed description) which differentiate or distinguish the genus or the species from other genera or species;*

(2) *Or with a definite bibliographic reference to such summary of characters (seu diagnosis; seu definition; seu condensed description). And further,*

(3) *In the case of a generic name, with the definite unambiguous designation of the type species (seu genotype; seu autogenotype; seu orthotype).*

The purpose of this amendment is to inhibit two

of the most important factors which heretofore have produced confusion in scientific names. The date, Jan. 1, 1931, was selected (instead of making the amendment immediately effective) in order to give authors ample opportunity to accommodate themselves to the new rule.

The Commission unanimously adopted the following resolution:

(*a*) It is requested that an author who publishes a name as new shall definitely state that it is new, that this be stated in only one (*i.e.* in the first) publication, and that the date of publication be not added to the name in its first publication.

(*b*) It is requested that an author who *quotes* a generic name, or a specific name, or a subspecific name, shall add at least once the author and year of publication of the quoted name or a full bibliographic reference.

The foregoing resolution was adopted in order to inhibit the confusion which has frequently resulted from the fact that authors have occasionally published a given name as 'new' in two to five or more different articles of different dates—up to five years in exceptional cases.

The three propositions submitted by Dr. Franz Poche, of Vienna, failed to receive the necessary number of votes in Commission to permit of their being recommended to the Congress. Out of a possible 18 votes for each proposition, Poche's proposition I. received 9 votes, II. received 6 votes, and III. received 7 votes.

Zoological, medical, and veterinary journals throughout the world are requested to give to the foregoing the widest possible publicity in order to avoid confusion and misunderstanding.

C. W. STILES,
Secretary to Commission.
United States Public Health Service,
Washington, D.C.

Salivary Secretions of Blood-sucking Insects in Relation to Blood Coagulation.

MOST blood-sucking insects at the time of biting inject into their host an irritant which causes a skin reaction, generally a wheal, more or less conspicuous and itching in relation to the habituation of the host to the particular parasite. Although these injections are of such great importance in the transmission of disease, their purpose has in no case been properly elucidated hitherto. Macloskie forty years ago suggested that the salivary secretion of mosquitoes prevents the blood from clotting on the way to the stomach, but the work of Nuttall and Shipley (1903), and of Schaudinn (1904), threw doubt on this theory. Cornwall and Patton (1914) proved the presence of an anticoagulin in the salivary glands of several blood-sucking insects and ticks, and also showed that a neutralising coagulant enzyme sometimes existed in the stomach.

Dr. H. M. O. Lester, of this Tsetse Investigation, has found that the tsetse-flies, Glossina, have both an anticoagulin in the salivary secretion and a coagulin in the mesenteron, and, after studying the behaviour of these enzymes *in vitro*, has come to the conclusion that their influence on the coagulation of blood is similar to that of antikinase and kinase respectively. The anticoagulin thus differs from the anticoagulant enzyme of the leech, Hirudin, which is said to be an anti-thrombin.

We have proved that Macloskie's theory, if applied to the tsetse-fly, is correct. The entire salivary glands of *G. tachinoides* may be removed by a very simple operation without killing the fly and often without causing appreciable shock. Flies from which the glands are thus removed draw blood normally for a time, causing no wheal on the most susceptible skin, and may survive for long. There is never any regeneration of the glands. One fly lived for 58 days, taking 26 meals of human blood and producing 4 healthy larvæ, while others survived to 14 days. Sooner or later the flies choke, or sometimes get convulsions, and can no longer draw blood. It is then found that the lumen of the proboscis and the œsophagus are occluded by clot, and generally the capacious crop is also full of firmly clotted blood. In the case of the tsetse-fly, therefore, the injection of salivary secretion into the host is not a necessary preliminary to feeding but rather in the nature of an accident, because the secretion mixes with the indrawn blood at the very tip of the proboscis, so that a certain amount inevitably escapes into the tissues of the host.

The amount of secretion mixed with the blood is enough to delay the coagulation of mammalian blood for 2-3 hours at least, but the coagulin of the mesenteron is so powerful that in a matter of seconds it has neutralised the anticoagulin and formed a small clot at the posterior end of the meal. The main function of this clot appears to be that it puts a brake on to the fluid meal and holds it in the proper region of the gut while digestion begins. LL. LLOYD.

The Tsetse Investigation,
Azare, via Bauchi,
Nigeria, N.P.,
Nov. 16.

The Thermal State of the Earth's Crust.

THE product of the rate of increase of temperature with depth in the earth's crust into the thermal conductivity of the surface rocks gives the rate of loss of heat from the interior. When allowance is made for the residual effects of the original heat, this gives a most important datum concerning the rate of generation of heat below, and hence, if the radioactivity of the rocks is known, to an estimate of the thickness of the radioactive layer. Hitherto it has been good enough, in discussions of this problem, to adopt mean values of the temperature gradient, the conductivity, and the radioactivity. It has now, however, become worth while to allow for variation of conductivity with depth, and to attend more to details in the vertical distribution of radioactive matter. When this is done as well as is at present possible, the agreement of the results with those obtained from the study of near earthquakes is practically perfect (*Gerlands Beiträge z. Geophysik*, **18**, 1-29; 1927).

The next step towards understanding the earth's thermal state is to find out why the observed temperature gradient varies from place to place; the mean for North America, for example, is substantially less than for Europe. This may be attributed to a different thickness of the radioactive layers, or to different percentages of radioactive matter in them. But these questions cannot be effectively discussed without an additional datum that has not yet attracted the attention of observers, namely, the conductivity of the uppermost layer (usually sedimentary). The actual temperature gradients are measured in this layer, and we cannot find the rate of conduction of heat to the surface without a knowledge of its conductivity. Conductivities of sedimentary rocks are given in some of the standard physical tables, but these refer to dried specimens, and the effective conductivity of the same rocks *in situ* is probably considerably higher on account of the part played in transferring heat by water in the interstices. Further, there is no known reason why it should not vary from place to place.

If any experimenter is willing to collect samples of the rocks from the principal borings and mines where temperature gradients have been measured, being careful to retain any moisture they may contain, and to determine their conductivities, he will achieve a great service to geophysics.

HAROLD JEFFREYS.

St. John's College, Cambridge.

The Aston Dark Space.

SIR J. J. THOMSON'S comment in the November *Philosophical Magazine* upon the similarity between the non-luminous layers which cover cold surfaces in a high-frequency electrodeless discharge, and the intensely dark region within the cathode dark space and immediately adjacent to the cathode of a Geissler discharge, discovered by Dr. F. W. Aston in 1907, points to a fresh way for finding the respective contributions of positive ions and electrons to the current in the latter case. Both have the appearance of the positive ion sheaths which have recently become important through their application by Langmuir to the theory of exploring electrodes. Since there is good evidence that the fall of potential across the Aston dark space is the ionisation potential of the gas, the current density of positive ions can be calculated by inserting in Langmuir's equation for a plane collector the appropriate observed thickness of the layer, and when compared with the total current density, this will give the required information, without, of course, affording any idea as to exactly how the electrons are produced at the metal surface.

Unfortunately, the Aston dark space can be seen in only a few gases, and the experimental data by which any theory of its origin can be tested are meagre. Langmuir's analysis does, however, explain why its thickness is independent of pressure, if the effect of collisions made by the positive ions in traversing the sheath can be neglected, and also why its thickness is approximately inversely proportional to the square root of the current density, on the assumption that the relative contributions of the two types of carriers do not depend on the total current. Somewhat similar ideas seem to have been first proposed by Prof. Güntherschulze in 1925, to explain why it does not appear in heavy gases, where it should theoretically be too thin to be seen. As regards numerical agreement, we do not feel justified in saying more at present than that the quantities involved are of the right order of magnitude, but we feel that the conception of a space-charge sheath on the cathode, separating it from the main cathode dark space, does at least partly remove the somewhat arbitrary distinction between this electrode and any other type of collector which had to be made previously.

K. G. EMELEUS.
N. M. CARMICHAEL.

Queen's University of Belfast,
Dec. 3.

Use of the Term 'Self-Adaptation' in Biology.

THE letter from Mr. A. G. Lowndes, published in NATURE of Dec. 24, raises a question of great and increasing importance. We all know that the old controversy between materialism and vitalism has entered on a new phase, and a decision is once more in the balance. It is, therefore, premature to clear our biological language of all terms savouring of vitalism, more especially as materialism has definitely failed to account for certain well-defined phenomena of development. The modern tendency is distinctly against ignoring mental phenomena, and making a sharp line of demarcation between humanity and the rest of the world of life. Biologists with a philosophic training prefer to explain unknown things in terms of the known, and nobody can deny that mental processes are much more amenable to cognition than any material processes whatever. We know what we mean by the term 'self-adaptation,' and we have no reason to exclude the animal world, or even the vegetable kingdom, from the working of a process familiar to our own experience.

Materialistic biology has had its day, and has done useful work in clearing the ground of mystical conceptions. Paracelsus, the first materialist, proclaimed man to be a chemical compound. In doing so, he killed at one blow all the demons and spirits which had encumbered the art of medicine. There is no necessity now to hug obsolete bio-chemical theories for fear that if we yield an inch to the vitalists the hosts of pandemonium will be let loose upon us. We can, therefore, give due regard to the psychological factor which, on any philosophically sound view, must be co-extensive with life.

E. E. FOURNIER D'ALBE.

47 Brentway,
Finchley,
London, N.3.

Imperial Agricultural Research.

ONE may hope it will not be assumed by readers of the editorial in NATURE of Oct. 15 (p. 539) that anything approaching complete failure has attended the efforts of the trustees of the Science and Industry Endowment Fund to attract post-graduate students to the biological services of the Commonwealth Government. It is true that no candidate of sufficient standing came forward for the first scholarship offered in mycology. Possibly the trustees made a mistake in insisting on first-class final honours and definite proof of capacity for research, though it will be a pity if it is found necessary to lower the standard. There are, however, quite a number of graduates at present in training abroad in other branches of work, including three in entomology, two in food preservation, two in forest products, and one (recently appointed) in plant pathology. In addition, three are gaining experience in fuel research. So far no studentships in genetics have been offered.

A. C. D. RIVETT.

Commonwealth Council for Scientific
and Industrial Research,
314 Albert Street, East Melbourne,
Nov. 23.

'Greasy' Burettes.

BURETTES employed in volumetric analysis to contain standard acid usually present, after short use, a greasy appearance, and considerable inaccuracy in measurement may result from the adherence of small drops of the solution to the surface of the glass above the liquid.

The necessity for frequent cleansing with a brush may be obviated by the addition of a minute trace of saponin to the standard acid, and, provided that the amount added be very small, and the solution not unduly shaken, there need be no inconvenience due to frothing.

A burette containing decinormal hydrochloric acid, thus treated, has been in use for several weeks, without any necessity for cleansing, and the device is no doubt capable of more general application to other solutions.

W. LOWSON.

Chemistry Department,
The University, Leeds.

New Data on Alcohol and Duration of Life.[1]

By Prof. RAYMOND PEARL and AGNES LATIMER BACON.

IN "Alcohol and Longevity" (New York: Knopf, 1926) Pearl presented life tables embracing some 5248 persons, living and dead, from the working-class population of Baltimore, divided into groups according to the extent and regularity of their alcohol consumption during life. The life tables demonstrate that, so far as could be judged by the sample of lives: "the moderate drinking of alcoholic beverages did not shorten life. On the contrary, moderate steady drinkers exhibited somewhat lower rates of mortality and greater expectation of life than did abstainers. This superiority is not great in the male moderate drinker, and may not be significant statistically. But it certainly gives no support to the almost universal belief that alcohol always shortens life, even in moderate quantities."

The purpose of the present paper is to report briefly some additional evidence bearing upon these results, which has been gained from a new and entirely independent set of data. For some time past we have been engaged in the study of the autopsy records of the Johns Hopkins Hospital. The first 7500 of the autopsy protocols have been abstracted and the information they contain has been transferred to cards for statistical study. The general statistical characteristics of this material, and the incidence of cancer in it, have already been reported by us.[2] Besides the strictly pathological records from the autopsy protocols there was also set down on each working card certain information derived from the clinical history of the patient filed in the archives of the Johns Hopkins Hospital. Among other items there was transferred to the card whatever information existed in the clinical history regarding the use of alcoholic beverages by the patient. Omitting the cases in which there was no information in the history regarding alcohol habits (of which there were 3906), and those in which the statements made on the point were so lacking in precision as to make it impossible to conclude more than that the person had at some time in life used some alcohol as a beverage (of which there were 42), we have the number of cases shown in Table I. of persons twenty years or more of age at the time of death, in which the information recorded is believed to be critically accurate.

TABLE I.

Group.	Abstainers.	Moderate Drinkers.	Heavy Drinkers.
Male white . .	239	713	418
Male coloured[3] .	85	435	340
Female white .	119	66	10
Female coloured[3]	75	95	23
Total . .	518	1309	791

There are thus 2618 persons for whom we have definite records as to alcohol consumption, on one hand, and age at death on the other hand. These persons are derived from all classes of society. They include rich and poor, labourers and loafers. As a group they are far less homogeneous than the group studied in "Alcohol and Longevity." One thing that they have in common, however, is that they died in the Johns Hopkins Hospital and were there 'autopsied.' The statements which they made as to their alcohol habits were given to the hospital physician under whose care they were, as a part of their medical history. It was information given in some sense 'under the fear of death.' They were persons who had come into the hospital because they were ill and hoped to be cured, or at least benefited by medical or surgical treatment. In such circumstances they were likely to tell the truth as they knew it regarding their alcoholic habits. Anyone who is ill and hopes to be made better, will try to be as exact as possible about a habit which both he and the physician believe may have a significant bearing upon his present state, the method of treatment to be adopted, and the prognosis. Indeed his eager desire to put the physician in possession of all the facts which may possibly have a bearing upon his case often leads to a garrulity over details which sorely tries the patience of the clinician.

The rubrics 'abstainer,' 'moderate drinker,' and 'heavy drinker,' have precisely the same meaning here as the same terms did in "Alcohol and Longevity" (see pp. 72, 73 of that book for the definitions of these terms used in classifying the material in that study and in this one).

Table II. gives the distributions of the ages at death (and autopsy) of the 2618 persons included in Table I.

As we have already pointed out in the papers cited above, a hospital population is always a selected one, and the 'autopsied' proportion represents a still further selection. But we know of no reason to suppose that any of the selective factors operating under these premises are such as, *per se*, to affect differentially the distribution of ages at death of those persons in an 'autopsied' hospital population who have been previously abstainers, as distinguished from those who have been moderate drinkers, or of these in turn from those who have been heavy drinkers.

In Table III. are given the simple biometric constants for the age distribution of Table II., the centring points used being those previously given by Miner.[4]

From the data here presented the following points are to be noted:

1. As compared with a general population, the part of an 'autopsied' population here discussed is,

[1] Papers from the Statistical Department of the Johns Hopkins Hospital (No. 10), and from the Institute for Biological Research of the Johns Hopkins University.

[2] Pearl, R., and Bacon, A. L., Biometrical Studies in Pathology. IV. Statistical Characteristics of a Population Composed of Necropsied Persons, *Arch. of Path. and Lab. Med.*, vol. 1. pp. 329-347, 1926. V. The Racial and Age Incidence of Cancer and other Malignant Tumors; *Ibid.* vol. 3, pp. 963-992, 1927.

[3] Meaning persons of pure negro blood, or mixed negro and white in any proportion.

[4] Miner, J. R., "The Centering Points of Distributions by Age at Death," *Amer. Jour. Hyg.*, vol. 5, pp. 102-105, 1925.

as a whole, inferior in mean duration of life. This has been shown in an earlier paper (*loc. cit.*) to be true of the Johns Hopkins Hospital autopsies as a whole. In this respect, and also in the respect that the mean age at death of the females is lower, generally speaking, than that of the males (instead

TABLE II.

Group.	Age at Death.							
	20-29.	30-39.	40-49.	50-59.	60-69.	70-79.	80-89.	90-99.
Male whites :								
Abstainers . .	39	35	45	50	35	31	4	..
Moderate drinkers	84	117	151	184	117	54	6	..
Heavy drinkers .	38	95	105	102	66	11	1	..
Male coloured :								
Abstainers . .	31	12	17	13	9	2	1	..
Moderate drinkers	112	100	92	76	39	14	2	..
Heavy drinkers .	55	76	91	75	33	9	..	1
Female white :								
Abstainers . .	16	26	31	24	18	4	..	..
Moderate drinkers	7	18	13	14	12	1	..	1
Heavy drinkers .	1	4	2	3	..	..	..	..
Female coloured :								
Abstainers . .	17	17	19	15	5	1	1	..
Moderate drinkers	22	24	27	15	4	3	..	..
Heavy drinkers .	6	8	4	3	2	..	..	..

of higher as in the general population), the part of the autopsy material here dealt with appears to be a fair sample of the total 'autopsied' population from which it is drawn. In other words, the cases for which information is available as to alcoholic habits

TABLE III.

Group.	Mean Age at Death (Years).	Standard Deviation (Years).	Coefficient of Variation.	Difference in Mean Ages at Death (Years).
Male white :				
Abstainers	50·05 ± 0·72	16·43 ± 0·51	32·83 ± 1·12	Abstainer—moderate = 0·34 ± 0·80
Moderate drinkers . . .	49·71 ± 0·36	14·44 ± 0·26	29·04 ± 0·56	Abstainer—heavy = 2·41 ± 0·83
Heavy drinkers . . .	47·64 ± 0·42	12·70 ± 0·30	26·66 ± 0·66	Moderate—heavy = 2·07 ± 0·55
Male coloured :				
Abstainers	41·30 ± 1·12	15·34 ± 0·79	37·14 ± 2·17	Heavy—abstainer = 3·54 ± 1·22
Moderate drinkers . . .	42·45 ± 0·46	14·18 ± 0·32	33·40 ± 0·84	Heavy—moderate = 2·39 ± 0·66
Heavy drinkers . . .	44·84 ± 0·48	13·10 ± 0·34	29·21 ± 0·82	Moderate—abstainer = 1·15 ± 1·21
Female white :				
Abstainers	46·40 ± 0·83	13·35 ± 0·58	28·77 ± 1·36	Moderate—abstainer = 0·92 ± 1·44
Moderate drinkers . . .	47·32 ± 1·18	14·17 ± 0·83	29·95 ± 1·91	Moderate—heavy = 5·10 ± 2·75
Heavy drinkers . . .	42·22 ± 2·48	9·73 ± 1·47	23·05 ± 3·65	Abstainer—heavy = 4·18 ± 2·62
Female coloured :				
Abstainers	42·67 ± 1·04	13·38 ± 0·74	31·35 ± 1·89	Abstainer—moderate = 1·26 ± 1·36
Moderate drinkers . . .	41·41 ± 0·87	12·54 ± 0·61	30·28 ± 1·61	Abstainer—heavy = 3·12 ± 2·11
Heavy drinkers . . .	39·55 ± 1·84	12·17 ± 1·21	30·78 ± 3·34	Moderate—heavy = 1·86 ± 2·04

appear not to be sensibly differentiated in other respects from the rest of the 'autopsied' group.

2. The coloured persons in this experience have lower mean ages at death than the corresponding groups of white persons Again the result is in agreement with the autopsy experience as a whole, as previously reported, and with general population figures. The negro seems always to be a poorer life risk than the white, under American urban conditions.

3. There is no significant difference between abstainers and moderate drinkers, in respect of mean age at death, in any of the four groups. In two groups (male white and female coloured) the mean for the abstainers is slightly higher than that for the moderate drinkers, while in the other groups the opposite condition appears. With the exception of the male coloured group, the mean age at death of the heavy drinkers is lower than that for either abstainers or moderate drinkers.

4. What the present material shows, in short, is that in the first 34 years of operation of the Johns Hopkins Hospital, all of those patients in its experience over twenty years who came to autopsy and were known to have been moderate drinkers (as defined in "Alcohol and Longevity") died at approximately the same average age as did all of those patients over twenty years of age who came to autopsy and were known to have been total abstainers. Thus material from a totally different source, collected by entirely different persons with no possible thought of its use in the present connexion, representing a different portion of the general population, and of a high degree of critical accuracy, essentially confirms the main conclusion of the former study, embodied in "Alcohol and Longevity." *This autopsy material gives no evidence that moderate drinking shortens life.*

We intend to make detailed studies of the pathology of the different organ systems of the body in this material, classified according to drinking habits.

The Glozel Investigations.

THE report of the International Commission on Glozel appointed by the Institut d'Anthropologie, appeared on Dec. 23 as a special supplement of the *Revue Anthropologique*. It describes the investigations carried out by the Commission on the ground and the results of an examination of the objects previously found.

The Commission's verdict is unanimous, and it is unfavourable. The objects examined at Glozel cannot be regarded as ancient. M. Peyrony appends a report, in which he recants his former opinion in favour of their genuine character. The criticisms of previous visitors are fully corroborated. The Commission directs attention to the unsystematic character of the digging, to which Mr. Crawford has already referred, the haphazard excavations giving the ground the appearance of having been shelled. Dr. Morlet stated that this was due to the fact that visitors had been allowed to excavate where they pleased as a pledge of good faith, and also that the antiquities were apt to occur in veritable nests.

Two trenches were dug by the Commission, one on the east and one on the west. Nine objects in all were found, including a 'brick' with alphabetiform signs, a ceramic 'idol,' which crumbled to pieces when touched, and a stone ring. Precautions were taken to prevent tampering when the Commission was not on the ground; but it is significant that loose earth usually preluded a find. Dr. Morlet stated that this was generally the case.

The Commission came to the conclusion that the objects had been 'introduced' to the point at which they were found, and at no ancient date. It was clearly evident that a clod of earth had been taken out and replaced after the 'brick' had been inserted in the place in which it was found. Of the objects previously found, mostly from the oval pit first discovered, some may be genuine, others may be ancient, but if so there is nothing to show when they were introduced. The remainder exhibit anomalies which would be difficult to explain if they were really genuine.

It was scarcely to be expected that the champions of Glozel would take the report of the Commission lying down. Immediately on the publication of the report, says the Paris correspondent of the *Times*, in the issue of Dec. 27, MM. Salomon Reinach, Loth, and Esperandieu published a manifesto in which they compared the Commission to the Inquisition and the verdict to the condemnation of Galileo. Dr. Morlet, notwithstanding the fact that his personal sincerity and integrity had been fully endorsed by the report, has also lost no time in counter-attacking. He criticises the composition and procedure of the Commission, but his reply speedily resolves itself into an attack on MM. Begouen and Capitan, and an accusation against two other members, in one case of tampering with the ground, in the other of scratching with a penknife a stone on which a reindeer was drawn. Of this, which is in the right Glozelian manner, perhaps the less said at the present stage the better.

Although it is improbable that we have heard the last of Glozel, the resources of a laboratory, and especially an analysis of the material which is said to be evidence of cremation, from which the Commission was precluded, would no doubt deal it a final blow, but one which in the opinion of most field archæologists is unnecessary.

In *Discovery* for January, M. Salomon Reinach expounds his reasons for accepting the Glozel finds as genuine. Excepting M. Reinach's own letters in the *Times*, we believe this is the first occasion on which one of the French protagonists in the controversy has had an opportunity in England of supporting the genuineness of the discovery. On the general question, M. Reinach relies on the number of the objects found, and is of the opinion that the manufacture of these three thousand antiquities is beyond the energy and powers of any forger. The inscriptions, he maintains, present certain features, such as the absence of the letter B, which would be beyond the knowledge of any but a specialist. In his view, previous discoveries, including those of Lartet, Christy, and Piette, as well as the inscriptions from Aivao in Portugal, all lead up to those at Glozel, which should not, therefore, have come as a surprise. Apparently, the survival of the reindeer in the obscure period between the palæolithic and the neolithic is to be accepted as a fact, and its representation here not regarded as evidence against the genuine character of the discovery.

In the meantime, however, M. Dussaud, curator of the Louvre Museum, in repeating his charges against the Fradins of 'faking' the finds, argues that their number and character does not preclude the possibility of forgery. He points out that Lequeux, who is now in prison for fraud in connexion with finds from Spiennes and Morocco, produced very nearly as many. Nor was the knowledge required beyond the reach of young Fradin, for books had been lent him by M. Clément. Of the first three bricks handed to Dr. Morlet, two had been treated in the furnace which existed on the site; but this was afterwards recognised by M. Franchet, an expert in ceramics, as dating from the sixteenth century. M. Camille Jullian remains unshaken in his view that the finds are genuine, but the stock in trade of a Gallo-Roman magician. He has proceeded further with the translation of the tablets and explains the Phœnician characters as an example of the practice of using Hebrew and other foreign characters in magical formulæ.

The absence of the mouth in the human faces represented at Glozel has led P. Hippolyte-Boussac of the Institut d'Egypte to ask why this feature should frequently be absent in primitive

carvings, drawings, and other representations of the human form. In *La Nature* for Dec. 15, he points out that although, according to certain views, the numerous figurines found in or near burials stood for a tutelary goddess of the tomb, and the absence of the mouth may be emblematic of the silence of death, it does not explain why that rather than any other feature should be left out. He reviews a number of examples, and in particular pictures by the aborigines of Australia in which it is omitted. These he seeks to connect with an animistic train of thought such as that which placed a Wingless Victory before the Propylæum at Athens—wingless in order that she might not leave the city. By analogy the sepulchral and other figures are represented without a mouth to prevent them from talking. Obviously, P. Boussac's suggestion has no bearing on the genuine character of the Glozel figures, and wisely he refrains from committing himself on the point.

The Development Commission.[1]

THE report recently issued by the Development Commissioners for the year ended Mar. 31, 1927, is mainly a series of summaries of work in progress at the centres of agricultural research assisted from the Development Fund, and as such is a convenient source of reference. The part relating to fisheries is much shorter, but indicates the activity in sea and other investigations. Another useful reference is the list of publications for 1926–27 : (*a*) relating to researches carried out at agricultural research institutes aided from the Development Fund, (*b*) published by advisory officers, (*c*) relating to researches carried out at fisheries laboratories aided from the Development Fund. These reports indicate that the Development Commission is expected to supervise a field that includes animals, plants, soils, economics, on to the welfare of the countryside, and even provision of harbours and the widening of roads.

The Development Fund now contributes a little more than £400,000, mainly to agricultural research. That this sum, large though it be, is inadequate for its aims is evident from a perusal of the report. Fortunately, in a period of national stringency, other sources have come into being to meet the increasing demands of research. The original Development Fund required in that year an addition of £200,000, voted by Parliament, £60,000 more than the previous year. Supplementary to this is a Special Fund provided by the Corn Production Acts (Repeal) Act, 1921, by which the original fund is doubled. This was limited to a five-year period and has now ceased, and new arrangements are outlined. More recently two other sources of contributions have come into being, the Empire Marketing Board for research into problems connected with production and marketing in Great Britain and overseas, and the International Education Board established by Mr. John D. Rockefeller, Jr., in 1923.

These new sources for grants are evidently handling large sums, and their relation to the Development Fund is discussed at some length. A case given in the report, the development of the Animal Breeding Research Department at Edinburgh, illustrates the position : the Development Fund contribution was £16,000, the International Education Board gave £30,000, the Empire Marketing Board £10,000, and a generous donor £10,000. The same applies to other large research institutes, so that great post-War developments have been possible. At the same time, the whole structure seems needlessly complex, and it looks as if a large amount of energy were expended on administration and finance rather than on actual research.

The recent progress of animal research is a feature of the period of the report. The large equipment necessary has been provided from the various sources indicated. The scope of the work may be seen by the reports from some of the larger centres ; at Cambridge, animal nutrition and animal pathology ; at the Rowett Institute, Aberdeen, composition of pastures and the influence of iodine ; at Edinburgh, animal breeding and animal diseases. On the plant side, the grants cover many investigations on nutrition, breeding, and pathology. A recent development is the study of fruit, its culture and preservation, as conducted at Long Ashton, East Malling, and other research institutes, largely assisted by the Empire Marketing Board.

The scheme for advisory officers, provided for by the Development Fund for fifteen years, is reviewed at some length (pp. 89-109). The grants to eighteen centres total about £60,000, not including special grants for equipment, etc. It is now suggested that as the centres become better staffed with county organisers, the function of the advisory officer might be better described by the term local research officer. Why not use the simple word ' adviser,' which suggests advice, and allow ' officer ' to lapse, since it suggests something in the way of inspection or detection ?

The grants under the heading of fisheries and harbours are only a small part of the State contributions, but they have encouraged a number of special investigations, including those on haddock, herring, and various shell-fish.

A number of smaller grants have been made for the encouragement of rural industries, as a contribution to the larger movement for development of the countryside. A review of the position points out that, with motor transport and broadcasting, village life is not so isolated as formerly ; hence the need for revision of schemes. Much of the present work must be experimental, but there is need for concentration so as to bring the efforts under the control of some more centralised organisation than at present.

[1] Development Commission. Seventeenth Report of the Development Commissioners for the year ended Mar. 31, 1927. (London: H.M. Stationery Office, 1927.) 3s. net.

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New Results on Cosmic Rays.[1]

By Prof. R. A. MILLIKAN and Dr. G. H. CAMERON.

THE cosmic radiation is defined as that small portion of the 'penetrating radiation' which is of cosmic origin. The main purpose of this paper is to present a preliminary report upon some very recent work which throws new light upon the properties of these extraordinary rays, and shows that still harder ones exist than had heretofore been found, rays capable of penetrating 190 feet of water, or about 16·7 feet (5 metres) of lead, before being completely absorbed.

Since doubts have been expressed so late as last summer by some of the foremost of living physicists as to whether or not there are any rays which have as yet been definitely proved to be of cosmic origin, and since up to this moment different observers of undoubted credentials, such as Swann,[2] Hoffmann,[3] Kolhörster, and ourselves differ in some cases as much as eight- or tenfold in our estimates of the intensity of the cosmic radiation if it exists, our first task will be to present very briefly the nature of the evidence up to the time of these experiments, and then to see how the new results supplement this evidence.

This procedure will have the further advantage of presenting a very beautiful illustration of the slow, step-by-step process by which most advances in science are made, each experimenter building on the past, but pushing on, if he is fortunate, a little beyond where his predecessors had gone, until presently the world finds itself in the full glory of a new conception of Nature without having been conscious of any particular instant at which the dawn came. Since the days of Greek mythology, very few discoveries have sprung full-grown out of the brain of anyone.

EARLY WORK ON COSMIC RAYS.

A starting point in the study of the very 'penetrating radiations' near the earth's surface was made in 1903 when these rays were brought to light and named by McLennan,[4] Rutherford,[5] and their collaborators, who found that the rates of discharge of electroscopes could be very markedly reduced by surrounding them with successive screens of lead several centimetres thick, thus showing that rays existed in the atmosphere capable of penetrating such thick screens, and therefore appropriately named the 'penetrating radiations.'

The next important step was taken by the Swiss physicist Gockel,[6] who in 1910 first took an enclosed electroscope in a balloon to a height of 4500 metres and found, contrary to expectation, that the radiation was higher at this altitude than at the surface, a fact which at once suggested that all of it, at least, was not of terrestrial origin, but that a part of it came into the earth's atmosphere from above, an idea which had been put forward by O. W. Richardson [7] so early as 1906.

During the next four years, Hess [8] in Austria and then Kolhörster [9] in Germany made other flights like Gockel's, checked his results and rendered them more *quantitative*, Kolhörster taking balloon readings up to 9000 metres, and finding the discharge rate decreasing slightly up to about 1000 metres and then increasing, until at 9000 metres it was some seven times as great as at the surface—more accurately, 80 ions more than at the surface, since it was this difference which he reported rather than the readings themselves.

The War put a stop for a while to further advances, but in the fall of 1921 and the spring of 1922, Millikan and Bowen [10] took the next important step by building and sending up recording electroscopes

[1] Substance of an evening discourse, with additions, delivered by Prof. Millikan at Leeds, on Sept. 2, during the meeting of the British Association.

[2] Swann, *Phys. Rev.* (**29**, 372; 1927), finds the ionisation due to such rays on the summit of Pike's Peak to be 0·75 per c.c. per sec. per atmosphere, while we found them in the same place to be close to 5 ions.

[3] Hoffmann, *Ann. der Physik* (**82**, 413; 1927), finds the ionisation at sea-level 0·29 per c.c. per sec. on the assumption, taken from Kolhörster's 1926 findings (*Zeit. f. Physik*, **36**, 147; 1926), that the absorption coefficient is invariant and of value $\mu H_2O = 22 \times 10^{-4}$ cm.$^{-1}$. We, on the other hand (*Phys. Rev.*, **28**, 851; 1926), found the absorption coefficient definitely variable (the rays therefore inhomogeneous), and the ionisation at sea-level 1·4 ions.

[4] McLennan and Burton, *Phys. Rev.*, **16**, 184; 1903.

[5] Rutherford and Cooke, *Phys. Rev.*, **16**, 183; 1903.

[6] Gockel, *Phys. Zeit.*, **11**, 280; 1910.

[7] Richardson, NATURE, **73**, 607; **74**, 55; 1906.

[8] Hess, *Phys. Zeit.*, **12**, 998; 1911; and **13**, 1084; 1912.

[9] Kolhörster, *Phys. Zeit.*, **14**, 1153; 1913; and *Verh. d. Deut. Phys. Ges.*, July 30, 1914.

[10] Millikan and Bowen, *Phys. Rev.*, **22**, 198; 1923; and **27**, 353; 1926.

in sounding balloons to a height of nearly 10 miles—15,500 metres—more than nine-tenths of the way to the top of our atmosphere, measured by the fraction of the air left below. These flights checked the results of the European observers in indicating an increasing discharge rate up to that height, though the new observed rate was very much less than had been computed from the afore-mentioned observations up to 9000 metres; thus showing that the 'penetrating rays,' *if they came from above*, were actually more penetrating than had been supposed up to that time. Since if the rays come in from above, the ionisation inside airtight electroscopes must increase exponentially, that is, geometrically with the distance of rise toward the top of the atmosphere, these very high flights were, and are now, especially significant. They place very certain and very definite upper limits upon the absorption coefficients of the rays entering the atmosphere, if there are in fact such rays.

The fact, however, that the total discharge of the electroscopes in these flights was but about one-fourth what it should have been from the absorption coefficients, computed on the cosmic ray hypothesis from the data of Hess and of Kolhörster, suggested some other cause for the phenomenon. For up to this time the increasing rate of discharge with altitude was the sole phenomenon upon which the hypothesis of rays of cosmic origin rested. But other alternatives were possible, and had indeed been suggested; such, for example, as radioactive particles of unknown origin spread through the upper regions of the atmosphere. Such an alternative could be tested definitely by making *direct measurements* of the coefficients of absorption of the penetrating rays rather than attempting to compute these coefficients as had heretofore been done, on the assumption that the rays entered the atmosphere from above. For if the rays were of radioactive origin, they would not be expected to be appreciably harder than those of the known radioactive substances such as thorium D or radium C.

The next step was taken during summer of 1923, when Kolhörster [11] in Europe and Millikan and Otis [12] in America independently made the first direct absorption measurements with materials other than the atmosphere itself—the former in Alpine glaciers and in shallow bodies of water at sea-level, the latter in thick lead screens carried to the top of Pike's Peak—for the sake of throwing new light on the possible origin of the penetrating rays.

[11] Kolhörster, *Sitz. Ber. d. Preuss. Akad.*, 34, 366, Dec. 20, 1923.
[12] *Phys. Rev.*, 23, 778; April 1924. Also 26, 851; 1926.

Kolhörster reported as a result of his glacier experiments an absorption coefficient of 0·25 per metre of water, or about half that previously found, namely, 0·55, thus eliminating the discrepancy between the findings from his balloon flights and our sounding balloon experiments. He states in the paper describing this work that his experiments prove definitely the existence of gamma rays of about one-tenth the absorption coefficient of the hardest known gamma rays (4·1 per metre of water),[13] but speaks with reserve about their origin. He says, after discussing various alternatives, that "one inclines more and more of late to the view that the penetrating rays are a phenomenon the origin of which is to be sought in the cosmos." [14]

Millikan and Otis, on the other hand, concluded from their new Pike's Peak absorption data that if any of the penetrating rays which they found on the Peak were of cosmic origin they had to be more penetrating, or less strong, than corresponded even with the reduced values now found by Kolhörster, namely, 2 ions at sea-level, absorption coefficient 0·25 per metre of water. The mean coefficient of the radiation which they found on Pike's Peak was but slightly less than that of thorium D, and a large part of it was certainly of local origin. They brought to light in these experiments no new evidence for the existence of rays of cosmic origin. Indeed, up to 1925, there appears from the literature to have been no feeling of certainty in any quarter that the existence of rays of cosmic origin had been proved. The increase in ionisation in closed vessels up to nearly 10 miles was an undoubted fact, and Kolhörster's glacier experiments were favourable to the cosmic ray interpretation; but the possibilities of the radioactive contamination of a glacier are not small, nor do its irregular shape and proximity to land masses adapt it well to trustworthy absorption-coefficient measurements. Further, Hoffmann [15] in Germany, with an extraordinarily fine technique, had in 1925 pronounced against the existence of rays of cosmic origin. Also in America, Swann [16] was convinced that the work of himself and his collaborators with the ionisation in vessels at pressures up to 75 atmospheres was incompatible with the cosmic ray interpretation of the penetrating radiation.

[13] Radioactivity, *Bull. Nat. Res. Council*, Kovarik and McKeehan, p. 114, 1925.
[14] "Neuerdings neigt man immer mehr der Ansicht zu, die Höhenstrahlung als eine Erscheinung aufzufassen, deren Ursprung im Kosmos zu suchen ist." Again: "Da für die erstere Auffassung der Höhenstrahlung als einer aus den höheren Atmosphärenschichten stammenden bisher keinerlei direkte Andeutung gefunden wurde, so sprechen die augenblicklichen Verhältnisse mehr zugunsten einer kosmischen Erklärung."
[15] Hoffmann, *Phys. Zeit.*, 26, 40, 669; 1925.
[16] Downey, *Phys. Rev.*, 20, 186; 1922. Fruth, *Phys. Rev.*, 22, 109; 1923.

Observations in Mountain Lakes.

In 1925, however, Millikan and Cameron got unambiguous evidence from their own point of view of a penetrating radiation which had to be of cosmic origin. It was indeed weaker and more penetrating than had corresponded to preceding estimates, having an ionising power at sea-level of but 1·4 ions per c.c. per sec., an absorption coefficient which became as small as 0·18 per metre of water, and a definite spectral distribution, the longest wave-lengths found having a value, computed from A. H. Compton's formula, $\lambda = 0{\cdot}00063$ A, the shortest 0·00038 A. This last is but one-thirtieth the wave-length of the very hardest gamma rays.

These experiments consisted in sinking sealed electroscopes in deep, high-altitude, snow-fed lakes, and thus finding, to take a particular case, that the ionisation in Muir Lake (altitude 11,800 ft. or 3590 m.) decreased steadily with depth from 13·3 ions per c.c. per sec. at the surface to 3·6 ions at 60 ft. (18 m.) below the surface, below which point there was no further measurable decrease with instruments of such sensibility as were being used. *This was the first time the zero of an electroscope—the reading with all external radiations completely cut out—had been definitely determined, and the results accordingly began to show that it was possible to make with certainty determinations of the absolute amount of the penetrating radiation.*

Up to the point to which we have thus far described the experiment, it proved merely either the existence at the surface of the lake of a penetrating radiation so hard as to be able to penetrate 60 ft. (18 m.) of water before becoming completely absorbed, or else a very strange distribution of radioactivity in the water of the lake.

Next, by taking similar readings in another deep, snow-fed lake, 300 miles farther south and having an altitude 6700 ft. (2060 m.) lower, *we found a similar curve, but with each reading displaced just six feet upward.* But six feet of water was exactly the equivalent in absorbing power, where the mass absorption law holds, of the layer of atmosphere lying between the altitudes 11,800 ft. (3590 m.) and 5100 ft. (1530 m.).

This experiment, supplemented by later similar findings in other lakes, therefore proved definitely three things:

First, that the effects in Muir Lake had not been due to any radioactivity which happened to be distributed in the water in a particular way.

Second, that the source of the rays was not at all in the layer of atmosphere between the two altitudes, for this layer acted in every particular like an absorbing blanket, having precisely the absorption that it should have *if the rays came in wholly from above.*

Third, that in different localities 300 miles apart, north and south, the rays were *exactly* alike at the same altitudes.

These facts, combined with the further observation made both before and at this time, that within the limits of our observational error the rays came in equally from all directions of the sky, and supplemented finally by the facts that the observed absorption coefficient and total cosmic ray ionisation at the altitude of Muir Lake predict satisfactorily the results obtained in the 15·5 km. balloon flight, *all this constitutes pretty unambiguous evidence that the high altitude rays do not originate in our atmosphere, very certainly not in the lower nine-tenths of it, and justifies the designation 'cosmic rays,'* the most descriptive and the most appropriate name yet suggested for that portion of the penetrating rays which come in from above. We shall discuss just how unambiguous the evidence is at this moment after having presented our new results.

These represent two groups of experiments, one carried out in Bolivia in the High Andes at altitudes up to 15,400 ft. (4620 m.) in the fall of 1926, and the other in Arrowhead Lake and Gem Lake, California, in the summer of 1927.

Penetrating Radiation in the High Andes.

The experiments in the High Andes had four prime objectives as follows: (1) To see whether in lakes in the southern hemisphere the altitude-ionisation curve would coincide with that found in lakes in the northern hemisphere. This curve was particularly sensitive in the very high altitude lakes obtainable in the High Andes, and the spectral distribution found in 1925 could be more accurately tested. If the northern hemisphere and the southern hemisphere curves coincided, it would go a long way toward eliminating the possibility that the rays are generated by the incidence of high-speed beta rays on the very outer layers of our atmosphere—about the only hypothesis which could put the source of these rays in the last tenth of the air about the earth. For such beta rays would be expected to be influenced by the earth's magnetic field so as to generate stronger radiation over the poles than over the equator. In Lat. 17° S. we should be completely screened from such pole effects, particularly if we could get into suitable high altitude pockets in the mountains.

(2) To obtain further crucial tests of the C. T. R. Wilson hypothesis that these rays may be due to the integration of the effects of the impact in the earth's atmosphere of electrons endowed with many millions of volts of energy acquired in thunderstorms. Lakes in suitable pockets in the High Andes would be completely screened from such effects. Also, a comparison of the rays found in thunderstorm areas with those found in large regions like California which are comparatively free from thunderstorms might furnish check observations upon this point. (3) By determining, as outlined above, the zero readings of new electroscopes to obtain new checks on our value of the ionisation due to the cosmic rays at sea-level, a quantity upon which as yet there have been wide divergences between the results of different experimenters. (4) To get into suitable pockets or valleys in very high mountains where the rays are three or four times as intense as at sea-level, and there to make more trustworthy tests on directional effects in cosmic rays—in particular to see whether the Milky Way is more or less effective than other portions of the sky in sending these rays into the earth.

On all these four points we obtained, despite unfortunate accidents with two of the electroscopes, satisfactory and definite information.

As to (1), we obtained on the surface of Lake Titicaca (alt. 12,540 ft. or 3822 m.) readings which corresponded very nicely with similar ones taken at Muir Lake, California. Also in Lake Miguilla, near Caracoles, Bolivia (alt. 15,000 ft. or 4500 m.), we obtained readings which fell satisfactorily on the extrapolated Muir Lake curve. If, then, there are any geographical differences in the altitude-ionisation curve, they are beyond the limits of our present observational technique.

As to (2), Lake Miguilla is a small lake surrounded on all sides by mountains several thousand feet high. It would be completely shielded from rays having their origins in thunderstorms anywhere on the earth. Further, off the coast of Central America we took a long series of readings in the wireless room on shipboard on a night on which a brilliant display of lightning was going on along the coast, and we compared the results with readings taken on the California coast, which is almost entirely free from thunderstorms, without bringing to light the slightest difference. The C. T. R. Wilson hypothesis is therefore quite definitely eliminated.

FIG. 1.—Lake Miguilla, Bolivia. Altitude, 15,000 ft. (4500 m.) about 2000 ft. long, 700 ft. wide, and 175 ft. deep.

As to (3), we took the zeros of two of our electroscopes by sinking them to sufficient depths and then made an elaborate series of sea-level observations on the ship all the way from Mollendo, Peru, to Los Angeles. *We found no variation in sea-level reading with geographical position*, and but slight differences between the ionisations in different

instruments, though they had volumes nearly in the ratio 1 to 2 and different sorts of walls. The mean value of the sea-level ionisation thus directly observed was but a few tenths of an ion above the mean of the sea-level cosmic ray ionisations given by the two curves of our preceding report. These curve-values were 1·4 for electroscope No. 1, and 1·6 for electroscope No. 3—mean value 1·5, which is thus checked approximately, though not yet accurately (see below), since the ionisation due to the radioactive matter in the air above the ocean must be very small. The main uncertainty in this present value 1·5 for the sea-level ionisation lies in the determination of the capacities of the electroscopes, and in uncertainties in the effect of electroscope walls. Upon the latter effect we shall make a later report.

As to (4), we took two long series of observations, each lasting three days, at an altitude of 15,400 ft. (4620 m.) in a deep valley from which the Milky Way was in sight for a period of 5 or 6 hours and then practically out of sight for another 6 hours. The value of the cosmic rays which entered our electroscopes in this valley was 3·6. *We could detect no difference at all in the value of the readings when the Milky Way was overhead and when it was out of sight.* Our error in the mean values of these readings could scarcely be more than 0·1 ion. Even if we double this estimate so as to have a wide factor of safety, we may conclude at least that the Milky Way exerts no influence upon the cosmic rays which it is yet within the power of the instruments used to detect, and that this should mean that the rays coming from the direction of the Milky Way are not 6 per cent. greater or less than are those coming from the portion of the heavens at right angles to the Milky Way. This is in agreement with our preceding less discriminating measurements, and also with recent very careful work at sea-level by Hoffmann and Steinke,[17] who can find there no directional effect in cosmic rays at all; but it is at variance with results reported by Büttner [18] and by Kolhörster.[19]

This present work was, however, done under quite as favourable conditions as have ever been used. It is very important to obtain unambiguous evidence upon this point. No entirely trustworthy conclusions about the origin of the rays can be drawn until it is settled. As yet, the case for a favoured region from which the rays come does not seem to have been established, but more sensitive tests can be made and will be made in the near future.

[17] Steinke, *Zeit. f. Phys.*, 42, 570; 1927.
[18] Büttner, *Zeit. f. Geophys.*, 2, 190; 1926.
[19] Kolhörster, *Naturwissenschaften*, 14, 936; 1926.

Observations in Californian Mountain Lakes.

The object of the new group of experiments at Arrowhead and Gem Lakes, begun early in 1927, was to use an increased electroscope sensibility and an increased accuracy in the determination of the electroscope constants, for the sake of introducing greater precision into cosmic ray determinations and placing the whole subject upon a more strictly quantitative basis.

As already indicated, different observers are still wide apart on the absolute value of the ionisation, though a considerable group of us now find it to be between one and two ions at sea-level. This, however, can scarcely be called quantitative agreement. But this could scarcely be expected, since no observers except ourselves have thus far been able to determine the zeros of their instruments; so that all values of ionisations except ours must be regarded as estimates rather than measurements. Our own values suffer from rather large uncertainties, possibly 10 per cent., though probably less, in the determination of the capacities of our electroscopes.

As to mean absorption coefficients, Kolhörster and ourselves are now in reasonable agreement, but no one except ourselves had until very recently brought to light the inhomogeneity of the rays, though the latest results by Hoffmann and Steinke lead them to support provisionally our findings and to suggest that in the mixture of cosmic rays some may exist even harder than the hardest brought to light by us. These we found to have an absorption coefficient equal to 0·18 per metre of water, which corresponds, if computed by Compton's equations, to a wave-length 0·00038 A, or an equivalent generating potential of 32,600,000 volts. Hoffmann,[20] in order to explain his latest sea-level readings, assumes components of hardness corresponding to a wave-length, computed in the same way, of 0·00029 A, or an equivalent generating potential of 41,000,000 volts.

We began in the fall of 1926 to build new electroscopes of greater sensibility to the cosmic rays in the hope of determining the intensities of these rays more precisely and studying their *spectral distribution* more discriminatingly; in particular, we wished to test for the presence of still harder rays than could be brought to light by the sensibility of our preceding instruments; for there were theoretical reasons for suspecting that still harder rays might exist. These electroscopes will be

[20] Hoffmann. *Ann. der Phys.*, 82, 417; 1927.

described in detail in more technical papers. Suffice it to say here that we can now measure the capacities of our electroscopes to a few parts in a thousand (0·791 electrostatic unit is the capacity of the instrument with which the following results have been obtained), and that we are now using eight times the sensibility to cosmic rays that we have heretofore employed; so that at sea-level we have in our electroscope 11 cosmic ray ions to play with instead of 1·4, and at Muir Lake about 40 instead of 5.

In carrying out experiments with this electroscope in Gem Lake last summer, the ionisation at the surface of the lake was 33·6 per c.c. per sec., and it decreased with depth of immersion, *regularly and very smoothly, to a zero value of* 2·6. *But this*

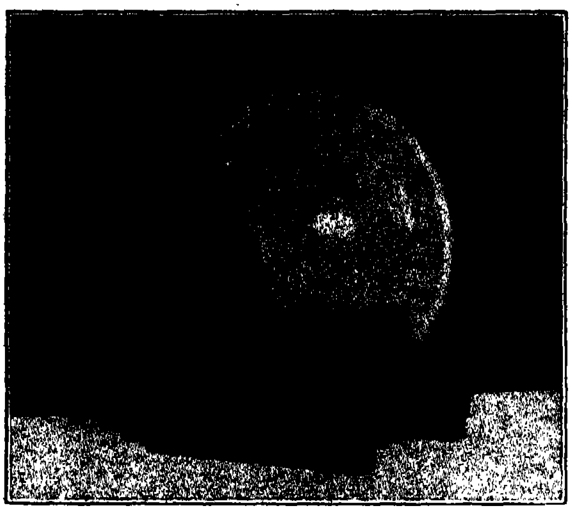

FIG. 2.—The type of electroscope sunk to depths of 164 ft. before its readings became constant at 2·6 ions/c.c./sec. Readings at surface, 33·6 ions/c.c./sec.

asymptotic value of the ionisation–depth curve was only reached at a depth of 164 *feet* (50 m.) instead of at about 54 feet (16·2 m.) as in our preceding 1925 Arrowhead experiments. This does not represent a discrepancy between the two sets of results. It means only that the ionisation ordinates of the curve have now been multiplied eightfold by the increased sensibility. In spite of this, the series of ionisation–depth readings taken with the new electroscope falls much more smoothly upon the curve, that is, shows less scattering, than was the case before; so that by improvements in technique the actual sensibility has been multiplied considerably more than eightfold. It is this increased sensibility and precision of measurement alone which is responsible for the fact that at depths between 54 ft. and 164 ft. ionisation is now clearly shown which was before masked by observational uncertainties.

Taking into account the absorption of the atmosphere above Gem Lake, which is the equivalent of 7·45 metres of water, *the new experiments reveal rays so penetrating as to pass through* 57 *metres* (190 *ft.*) *of water, or* 5 *m.* (16·7 *ft.*) *of lead before being completely absorbed.*

The new curve can be analysed for spectral distribution much more reliably than has been heretofore the case; but it is very satisfying that, analysed by the method before used, the portion in the neighbourhood of the elevation of Arrowhead yields precisely the same coefficient as did the former curve in the same region, namely, 0·23 per metre of water, while *the lowest part of the curve yields the coefficients* 0·1 *per metre of water, so that we have here brought to light rays nearly twice as penetrating as those heretofore found by us.* Computed as before, the shortest wave-length is now 0·00021 A, the equivalent generating potential of which is 59,000,000 volts, very considerably higher than the estimates made by Hoffmann.

Our total curve now extends from an absorption coefficient of $\mu = 0{\cdot}25$ per metre of water to $\mu = 0{\cdot}1$, or in equivalent wave-lengths computed as heretofore, 0·00053 A to 0·00021 A, *a range of between one and two octaves.* If the computations are made by Dirac's formula,[21] which is probably more trustworthy than Compton's, the relative values do not change, but the absolute frequencies or energies are increased about 30 per cent.

The cosmic ray sea-level ionisation in this electroscope, reduced to atmospheric pressure, is the same that we published before for electroscope No. 1, namely, close to 1·4 ions per c.c. per sec., and the error here should be, for this electroscope, less than 1 per cent.

The Source of Cosmic Rays.

What can now be said with reference to the possible source of these extraordinary rays? Their penetrating power alone—or frequency, computed by whatever formula—obviously requires that they correspond to changes of some sort taking place within the nucleus itself, since no extra nuclear charges can possibly be associated with anything like such energies. The simplest hypothesis is that to which we directed attention in our 1925 paper, namely, that these rays are produced by direct encounters between the nuclei of atoms and high-speed electrons. It is true that the mere potential energy of separation of the electron from the nucleus is not enough in the case of the light atoms, without a larger disappearance

[21] Dirac, Proc. Roy. Soc., 109, 206; 1925.

of mass than there is as yet reason to suppose takes place. Our most energetic rays heretofore found corresponded, it will be remembered, very closely to the energy change—loss of mass—accompanying the union of four atoms of hydrogen into one atom of helium, but the new measurements give rays of practically double this energy, but still only about one-fifteenth of that to be expected from the complete transformation into radiation of the energy of separation of the positive and negative electrons; so that *there is as yet no direct experimental ground for supposing that this last sort of annihilation of mass occurs.*

If, however, there are processes widely distributed throughout the universe by which electrons become endowed with many millions of volts of energy—C. T. R. Wilson calls upon thunderstorms on the earth as one such process—then there is no difficulty in calling upon the encounters between such electrons and the nuclei of atoms, however light, to act as sources of the observed rays. We shall not here attempt to list possible causes for such high-speed electrons, but if we postulate their existence the cosmic rays follow at once. For from the best of spectroscopic evidence the astronomer now populates interstellar space with not less than one atom per cubic inch. Furthermore, from the ionised state of the calcium atoms which are found in interstellar space, Eddington [22] estimates that the temperature of space, defined by the mean kinetic energy of agitation of the atoms and electrons therein found, is about 15000° C., *i.e.* higher than the surface temperature of the sun or of that of most of the stars.

Again, no radiations of the sort here considered, if generated in the interiors of stars, could possibly get out, since they follow the mass absorption law, and according to the foregoing experiments are all absorbed in a thickness of 190 ft. of water. This thickness might be multiplied many, many fold before getting through the merest outer skin of a star. The mass equivalent of this thickness will be reached by going out in any direction to a distance of 10^9 light-years, on the assumption that space is studded with one atom per cubic inch. These considerations, if correct, indicate that the directions of the sun or the stars are not likely to differentiate themselves from other directions as sources of these rays, and all observers are agreed that the sun at least does not so differentiate itself.

If, however, high-speed electrons are postulated as a source of these rays, why not let these high-speed electrons be the rays themselves? Why assume short ether waves at all? The answer is that we know experimentally that through the photo-electric process the same energy can be interchanged without loss between ether waves and electrons. Also, according to Ellis's results, these quantum laws are followed quite as well in nuclear as in extra nuclear changes. The degradation of the energy into heat, however, takes place primarily when the energy is in the electronic carrier. In other words, the absorption coefficient of beta rays is a hundred or more times greater than that of ether waves of the same energy; so that electrons set into motion by the Compton process or otherwise, very rapidly degrade the energy when it gets into them in any locality; but its transport through space in the concentrated form (which corresponds to high penetrating power) must take place when it is in the form of ether waves.

It is therefore quite futile to postulate as the source of the observed rays the bombardment of the air in the outer tenth of our atmosphere by high-speed electrons of the same maximum energy. If such high-speed electrons could enter the top of our atmosphere in sufficient quantity, they would indeed produce just such rays as we observe; but the difficulty is *that they would have been doing so all through space*, and it would be the ether waves with their high penetrating power rather than the high-speed electrons with their relatively low penetrating power which would reach our atmosphere in quantity. It would be only in case the high-speed electrons were in the main generated relatively near us, as in the sun or nearer stars, and had not yet had space, before reaching the earth, to have their energy dissipated into heat or transformed into the more penetrating rays, that this argument would be invalid.

But *this last case is precisely the one that has been eliminated by our failure to find that the sun has any appreciable influence upon this radiation.* For if the direction of the sun stood out above other directions in the heavens as one in which high-speed beta rays were superabundant, it would, of necessity, also be a direction in which the cosmic rays were generated in abnormal abundance. It seems quite impossible then, on this theory of their origin, to limit the source of the rays to the upper tenth of our atmosphere or to any astronomically near-by regions.

Cosmic Origin.

Again, the foregoing considerations as to the distance from the earth at which the rays originate

[22] Eddington, "Stars and Atoms," p. 69 (Oxford Press, 1927).

apply with ever greater force to any hypothesis involving either spontaneous or induced nuclear changes not associated with electron impacts; for matter in the upper tenth of our atmosphere must upon any such hypothesis be endowed with properties entirely unlike any which matter just a little closer to us or more remote from us possesses.

Now while matter in remote regions of the universe may well be assumed to be endowed with properties which do not manifest themselves on earth, it would be a violation of the principle of minimum hypothesis to assume that a thin ring of matter just beyond us has properties which matter neither more remote nor more near possesses. We can see no possible way, then, of assigning to the rays any other than a cosmic origin; and if the Milky Way does not differentiate itself from other parts of the sky as a source of the rays—and our experiments thus far have failed to find any such differentiation—then *the rays must come, in the main, from beyond the Milky Way, i.e.* either from the spiral nebulæ, if these are uniformly distributed throughout the heavens, or else from 'the cloud in space.'

From the results of our 1927 experiments, we are now for the first time able to compute with a fair degree of confidence the total energy per sq. cm. per sec. that flows into the top of the earth's atmosphere in the form of the cosmic rays. It comes out $3{\cdot}1 \times 10^{-4}$ ergs cm.$^{-2}$ sec.$^{-1}$, or just one-tenth the total energy coming into the earth's atmosphere in the form of star light and heat.

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Obituary.

PROF. MILTON WHITNEY.

BY the death on Nov. 11, at the age of sixty-seven years, of Milton Whitney, soil science loses one of its most striking and original personalities. His work extended over nearly forty years, and throughout the whole period he was noted for the freshness of his outlook and the novelty of his deas. He first came into prominence in 1892, when, as professor of geology and soil physics at the Maryland Agricultural College and physicist to the Experiment Station, he published an interesting paper, "Some Physical Properties of Soils in Relation to Moisture and Crop Distribution," in which he examined a number of soils of known productiveness and showed that their agricultural properties are closely related to the texture of the soil as revealed by mechanical analysis. The physical properties of the soil, especially the texture, regulate its temperature, moisture content, and air supply, or, as he called it, with the love of analogy which characterised all his writings, the 'climate' of the soil, and he argued that the significance of these physical properties in determining the distribution and yield of crops must therefore be of the same order as that of climate in the ordinary sense of the word. In short, these physical factors are the predominant factors in soil fertility. He thus broke completely away from the idea currently accepted at that time that fertility is mainly a matter of chemical composition of the soil. The American workers were prepared for this insistence on the physical properties, as W. H. King had already at Madison been carrying on important physical studies, and there were no active soil investigators in Great Britain to controvert the position even if they had wished to do so.

This and other papers marked out Whitney as a man of ideas, and when the United States Department of Agriculture set up its Soil Bureau in 1894, Whitney was put in charge. Among his early studies here was one on the tobacco soils of the United States, showing the close connexion between the quality of the crop and the texture of the soil. High quality or 'wrapper' tobacco was produced on soil containing much sand and little clay, while low quality or 'filler' tobacco was grown on heavier soils containing more clay and silt. Other crops showed similar relationships with soil composition, and Whitney regarded his thesis as so well established that, in the great soil survey of the United States then being organised, he used mechanical analysis as the basis of classification. The scheme has, in point of fact, been altered, but it served a very useful purpose.

Before long it appeared that mechanical analysis alone would not suffice to explain all the phenomena of fertility. For example, in the survey of Florida, two widely different soils, the good 'pinelands' and the barren 'hammock soils,' had the same mechanical analysis, yet obviously could not be classed together. Whitney tried electrical methods of soil moisture determination in the soil *in situ*, but without much result: he was led, however, to recognise the importance of the soil solution in the nutrition of the plant and, in conjunction with Cameron, brought out a paper in 1903 on the chemistry of the soil in relation to crop production, in which the principles of physical chemistry were for the first time applied to the soil.

The subject was so novel that most investigators were not prepared for it, and some of the deductions were so startling that they gave rise to a vigorous controversy—the first there had been in soil science for many years. The centre of it was Whitney and Cameron's statement that the soil solution, which is the proper food of plants, is of the same order of composition and concentration in all soils, and therefore all soils, fertile and infertile, are equally well supplied with plant food: fertilisers do not feed the plant, but act in some other way. The controlling factor in soil fertility was in some cases physical, but in some at least it was the presence of toxic substances in the soil. This led to the study of the organic substances in the soil by Schreiner and Shorey, and the isolation of dihydroxystearic acid and other poisonous substances from certain infertile soils.

The controversy is now over, and it is known that the soil solution does vary in composition and in concentration in different soils and in different seasons in the same soil. But the great value of Whitney's work remains unchallenged: he widened the range of the subject and enriched it with ideas and analogies which, if not themselves entirely sound, nevertheless make the investigator stop and think.

E. J. RUSSELL.

MR. W. C. F. NEWTON.

THE death of Mr. W. C. F. Newton, on Dec. 22, at the age of thirty-two years, takes away a young worker of rare quality in a field that has been but sparsely cultivated in Great Britain—cytology and its bearing upon genetics. Newton was a student at the Birkbeck College, but his course was interrupted by war service (he received the Mons medal) and he did not take his degree until 1921. With a scholarship from the Department of Scientific and Industrial Research, he continued to work at the Birkbeck under Dame Helen Gwynne-Vaughan, and began to investigate the chromosomes of Galtonia, a paper on which appeared in the *Annals of Botany* for 1924.

In 1922, Bateson, who had long been on the look-out for a cytologist, invited Newton to join the staff of the John Innes Horticultural Institution, and there he continued to work. Much time was not given to him, for he had to undergo a severe operation in the summer of 1926, and was in hospital while he corrected the proofs of his paper (*Jour. Linn. Soc.*, 1927) on the chromosomes of Tulipa and allied genera. This paper contains some incidental mention of the improvements in technique he had introduced, methods of fixing and staining which are now in general use, though, as

they had been freely communicated in talk, it is forgotten that they originated with Newton. Newton came back to the laboratory in 1927, and resumed his work on tetraploid hybrids, among them *Digitalis ambigua* × *purpurea* (produced by B. H. Buxton) and *Primula kewensis*. Around the latter hybrid many misconceptions had arisen, which by the perfection of his technique he succeeded in removing, finally reconciling its peculiar cytological and genetical behaviour.

Newton had not finished with Tulipa, a genus abounding with problems, providing the sort of material most apt for his thesis, that cytological relationships provide the real key to systematics. But the study of tulips has lost within a short space both Dykes, who had given years to the collection and morphological examination of the species, and now Newton, who was seeing his way to bring order out of the confusion. He was also occupied with colour inheritance in poppies and an interesting sex problem in Silene, until in the late autumn the recurrence of his malady laid him aside. But he never lost either his interest or his courage, and within a few days of his death, in a state of pitiful weakness, he would still discuss his problems and suggest the lines on which further work was needed.

Such was the man, a true *passionné* (pour faire quelquechose de grand il faut être passionné), soft-voiced and gentle, almost austere in manner until his humour broke out, but rigorous for himself and carrying his high laboratory standards into the other walks of life and learning. Death has dealt hardly with the men whom Bateson gathered round him at one time or another, and Newton bade fair to carry on in a quite different fashion that inspiration and stimulus which had so characterised his chief.

A. D. H.

MR. HENRY EDMUNDS.

HENRY EDMUNDS, who died at Hove on Nov. 18, at the age of seventy-four years, was one of the pioneers of electric lighting. He was born at Halifax in 1853. At the age of twenty-four he introduced electric lighting by Jablochkoff candles into America. He then returned to introduce the Farmer-Wallace system of electric lighting into England. The Brush Electric Lighting Co. appointed him its first engineer, and so early as 1879 he did much to popularise the Brush system of lighting in Great Britain.

In conjunction with Sir Joseph Swan, Edmunds installed incandescent lamps in H.M.S. *Inflexible* and the Atlantic liners *City of Richmond* and *Servia* in 1881, and in 1885 he became a partner in the firm of Messrs. W. T. Glover and Co., of Manchester, the cable manufacturers. He was a personal friend of Mr. T. A. Edison, and brought the first phonograph to England. An account of this invention was published in the *Times* in January 1887. He was also associated with the late Mr. Augustus Stroh in the manufacture of phonographs. Amongst electrical engineers, however, he is best known by his connexion with the cable manufacturing industry. He founded the Cable Manufacturers' Association, which is an early and successful example of co-operative working.

Edmunds was also one of the earliest of the pioneers of cycling and motoring in England. In 1898 he brought from Paris a De Dion motor tricycle and trailer, which at the time excited great public interest. It is also interesting to recall that he introduced Mr. C. S. Rolls to Mr. Royce, a meeting which led to the formation of the Rolls Royce Company. He had a very interesting personality and will be missed by many friends.

HERR JULIUS BAUMANN, deputy-director of the Verein für chemische und metallurgische Produktion in Aussig-Karlsbad and extra-ordinary professor of technical chemistry at the University of Innsbruck, died on Aug. 17. Born in Hungary in 1859, Baumann studied for a time at Prague, but soon relinquished the idea of an academic career and devoted his energies to chemical industry, in which he became recognised as one of the leading personalities in Austria.

PROF. PAUL GROTH, of the University of Munich, the well-known crystallographer and author of "Die physikalische Krystallographie," died recently at the age of eighty-five years. His discovery in 1870 of morphotropy, or change in crystalline form due to the replacement of hydrogen by other atoms or groups, was largely responsible for stimulating investigations into the structure of atoms.

WE regret to announce the following deaths:

Surgeon Rear-Admiral Sir Percy Bassett-Smith, K.C.B., C.M.G., a past president of the Royal Society of Tropical Medicine and Hygiene, on Dec. 29, aged sixty-six years.

Mr. R. B. Buckley, C.S.I., formerly chief engineer to the Government of Bengal and author of "Irrigation in India," on Dec. 19, aged eighty years.

Mr. W. H. Dines, F.R.S., distinguished for his work on the physics of the upper air, on Dec. 24, aged seventy-two years.

Mr. S. W. Fairchild, of the firm of Fairchild Brothers and Foster, manufacturing pharmaceutical chemists, who founded the Fairchild scholarships and prizes for pharmaceutical students in Great Britain and Ireland and in the United States, on Nov. 13, aged seventy-five years.

Prof. Georg Fendler, until recently chemical director of the new research institute for foodstuffs in Berlin, on Sept. 11, aged fifty-four years.

Mr. H. A. Grueber, late keeper of the Department of Coins and Medals at the British Museum and for many years honorary secretary of the Royal Numismatic Society, on Nov. 21, aged eighty-one years.

Mr. J. B. Hill, until 1922 geological adviser to the Ministry of Health and formerly of the Geological Survey of Great Britain, on Dec. 18, aged sixty-five years.

Dr. William R. Orndorff, professor of organic and physiological chemistry at Cornell University, on Nov. 1, aged sixty-five years.

Prof. Hugo Strache, director of the Institute for fuel technology at the Technische Hochschule in Vienna and a leading authority on gaseous fuels, on Nov. 4, aged sixty-two years.

News and Views.

ONE of the most interesting features of the Leeds meeting of the British Association was undoubtedly the evening discourse by Prof. R. A. Millikan on "Cosmic Rays," which we are privileged to publish, with additions, as a special supplement to this issue. The fact that an electroscope would gradually lose its charge even when surrounded by considerable thicknesses of metal had been known for many years, and a good deal of experimental work was done in the early days of the subject, without any very positive results, to discover the origin of this 'spontaneous' ionisation. The difficulty is, of course, that radioactive materials are very widely disseminated in minute quantities, and the possible presence of such material in the electroscope walls, and in the plates used to screen the instrument, was a continual source of uncertainty and confusion. The first advance in the subject was secured when Gockel made balloon ascents with an enclosed electroscope in 1910, and found that the rate of discharge became appreciably greater as the altitude increased, thus suggesting that part of the effect, at any rate, was due to penetrating radiation coming through the atmosphere from extraterrestrial sources. These results were confirmed and extended by Millikan and Bowen, among others, in 1921. In his more recent experiments, Millikan, who has pursued the subject with all his well-known vigour and skill, has been using, as his absorbing material, the water of snow-fed lakes in the high mountains of California and Bolivia, material which he finds to be exceptionally free from radioactive contamination.

BY sinking electroscopes into the depths of these mountain lakes, Millikan is able to measure not only the absorbability of the radiation in water, but also the actual fraction of the whole effect which is due to radiation from extra-terrestrial sources. This amounts to 1·4 ions per c.c. per second at sea-level. From the nature of the absorption curves he is able to analyse, more or less satisfactorily, the extra-terrestrial or cosmic radiation, and from the absorption coefficients, assuming that the ordinary relation between wave-length and absorption holds in this part of the spectrum, to deduce the wave-lengths of the cosmic rays. According to Millikan's latest results, the most penetrating of the cosmic rays has a wave-length of only 0·00021 A, a wave-length far shorter than the shortest of the γ-radiations from any known radioactive material, and corresponding to a generating potential of nearly sixty million volts. By working at different times of day and in two hemispheres, Millikan has shown that the radiation is not due to the impact of high-speed electrons on the outer layers of the atmosphere; neither does it come from any particular direction in space. Its intensity is the same no matter to what portion of the heavens the electroscope is exposed. It is not in the stars that we must look for its origin; its birthplace is either in the great nebulæ, or in that very rarefied matter which pervades all space. Even so, its existence seems to postulate phenomena unknown terrestrially. The excitation voltage demanded, sixty million, is not only far greater than anything possible in the extranuclear system of the atom: it is also far greater than the voltages we are accustomed to associate with the nucleus itself, which are generally of the order of two or three million volts.

MILLIKAN points out that the most penetrating of the rays which he has so far detected has only about one-fifteenth of the energy to be expected from the mutual annihilation of an electron and a proton, and thinks that *as yet* the cosmic rays do not provide direct evidence of the transformation of matter into radiation in outer space. On the other hand, much of the radiation is of the quality which might be expected from the conversion into radiation of the mass which is lost when four hydrogen atoms condense to form an atom of helium. These results are full of interest, and it seems as if here again we have a subject where a careful watch on Nature's laboratories in the heavens might enable us to supplement the obvious deficiencies of our own.

THE list of New Year honours includes the names of the following men of science and others associated with scientific work:—*Baronet*: Major-General Sir Richard Havelock Charles, Sergeant Surgeon to H.M. the King, a past president of the Royal Society of Tropical Medicine and Hygiene. *K.C.V.O.*: Sir Frank Baines, until lately Director of Works, H.M. Office of Works. *Knights*: Prof. Jahangir Cooverjee Coyajee, professor of political economy and philosophy in the Presidency College at Calcutta; Mr. F. G. Hallett, Secretary of the Joint Examining Board, Royal College of Physicians of London and Royal College of Surgeons of England; Brigadier-General H. B. Hartley, fellow and tutor of Balliol College, Oxford, and member of the Chemical Warfare Committee; Dr. E. H. Pascoe, Director of the Geological Survey of India; Principal C. Grant Robertson, Vice-Chancellor and Principal of the University of Birmingham; Dr. T. E. Stanton, Superintendent of the Engineering Department, National Physical Laboratory; Mr. A. E. Aspinall, secretary of the Imperial College of Tropical Agriculture, Trinidad. *C.M.G.*: Major R. G. Archibald, Director of the Wellcome Tropical Research Laboratories, Khartum; Mr. O. T. Faulkner, Director of Agriculture, Nigeria.

SIR DAWSON WILLIAMS is retiring this month from the editorship of the *British Medical Journal*, after completing his thirtieth year in that office and seventeen years previously in the editorial department of the journal. He is being succeeded by Dr. N. G. Horner, who has been assistant editor for the past eleven years and previously served on the staff of the *Lancet* in a similar capacity. The *British Medical Journal* was first issued as the weekly organ of the Association in 1857, and it has continuously grown in importance with the Association, which is now in its ninety-sixth year and has a membership of nearly 34,000. The Association was established for the

promotion of the medical and allied sciences and the maintenance of the honour and interests of the medical profession. Its organisation and its journal show what can be done to foster fellowship and promote progress among members of a profession widely scattered and with diverse interests. Sir Dawson Williams had to steer his bark through some troubled seas caused by the introduction of the National Insurance scheme and the War, and the success with which he did so is represented in the high character of the contents of the journal and the continued progress of the Association. He goes into retirement with most cordial good wishes of all who know his work and influence.

AN important step towards developing an efficient organisation for the scientific study of the difficulties besetting primary industries has been taken by the Commonwealth Council for Scientific and Industrial Research. It has been decided to establish a strong entomological section which, as was announced in our issue of Nov. 26 last, will be under the control of Dr. R. J. Tillyard, at present Assistant-Director of the Cawthron Institute, New Zealand. Dr. Tillyard will commence his new duties at the beginning of March. It is proposed to erect central laboratories and insectaries at Canberra and sub-stations in various parts of the continent. Provision will be made not only for a permanent supporting staff, but also for post-graduate students who may desire to specialise in entomological research work under Dr. Tillyard's guidance.

IT is estimated that insect pests cost Australia as much as £10,000,000 in a bad year, the blow-fly alone, in its ravages on sheep, accounting for £4,000,000. Attention will largely be concentrated upon the problem of blow-fly control by means of parasites, but at the same time active work will be carried on to secure control of buffalo fly (Lyperosia), lucerne flea (Smynthurus), thrips, and underground grass grub (Oncopera). Noxious weeds also cost Australia large sums annually. The success which is attending the attempt to eradicate prickly pear by means of Dactylopius, Cactoblastis, and other insects, encourages the hope that St. John's Wort, Skeleton weed, Paterson's curse, and other widely spread plants, may be brought under control. The necessity for hastening prickly pear eradication is being recognised, since there are numerous native insects which may parasitise the beneficial ones, particularly the valuable Cactoblastis, and reduce their efficiency. St. John's Wort covers nearly a quarter of a million acres of splendid land in the north-west of Victoria and is rapidly spreading into the fertile areas of Gippsland. A sub-station to deal with it will be established shortly. It is hoped that close association with the Imperial Bureau of Entomology, with Rothamsted, and also with the Cawthron Institute, will be maintained in all this work.

THE amount of energy that is duplicated, and, in so far as duplication is unnecessary, therefore wasted, in the preparation of annual analytic indexes to biological literature, has long been the subject of protest, suggestion, and not very effective remedial experiment. It is interesting, and some may find it hopeful, to learn that the International Institute of Intellectual Co-operation, which is working under the League of Nations, is making a fresh attempt to introduce order and co-ordination. A meeting of editors of the chief biological bibliographies was convened at the Institute in Paris last April, and passed several resolutions which have recently been approved by the assembly of the League of Nations. The chief recommendations are these: That editors of journals publishing original work in biology should supply, through a central organisation, enough copies of each paper for distribution to the bibliographic bodies concerned. That an author's abstract, averaging from three to five per cent. of the original paper, should be published with each paper. For purposes of distribution or exchange of scientific contributions, the bibliographic publications must be classed, and the following groups are suggested: General biology; zoology; systematic zoology; botany; systematic botany; genetics; physiology; anatomy and embryology; microbiology and parasitology.

THE scheme was sketched out when only one number of *Biological Abstracts* had appeared, and its importance could not be estimated. This may entail modifications, but meanwhile the Institute of Intellectual Co-operation desires to have the views of biologists, and in particular of the editors of bibliographic journals. Suggestions, which will be welcomed, should be addressed to the Director of the Institute, 2 Rue de Montpensier (Palais-Royal), Paris, I. The most valuable proposal, if it can be carried out, is the distribution of papers to the relevant bodies. The difficulty of seeing the literature is the greatest obstacle to all bibliography. The compulsion of authors to furnish abstracts will, if enforced, be splendid—for the authors. Many authors cannot produce abstracts of their own papers, and often succeed in giving marvellously little information. But *Biological Abstracts*, if it continues, will give us more than we need in this direction, at least for readers of English. That points to two difficulties. It is sometimes suggested that every scientific worker should be able to read English, French, German, Italian, and Spanish; but how many can? *Rivistas*, *Revues*, and *Berichte* will still be called for. Then the bulk is so enormous that special subjects will in self-defence organise their own bibliographies; though perhaps they would do better to produce analytic indexes such as the *Zoological Record*. Again, many periodicals would collapse did they not give reviews and abstracts of recent publications. The question of bibliography is part of the larger question of scientific publication, and those who discuss it must take human nature largely into account.

WITH great enthusiasm and assiduity Mr. W. Rodier continues to urge the adoption of his method of exterminating rats, rabbits, and other polygamous pests. In a recent circular he cites the success which has attended the method, now widely adopted for the

increase of wild stock, of killing males and sparing all females, and suggests that the reverse process, killing females and sparing males, will have the opposite result of reducing the stock. It is obvious that the slaughter of females must reduce progeny, but it cannot be assumed that the sparing of the males will hasten the process under ordinary conditions. Nor is it evident that where pests have increased in spite of the killing of both sexes, the sparing of the males would have transformed the increase into a decrease. The Rodier method can be successful only where the numbers of females are so reduced relatively to the males that male competition interferes with successful breeding. This is likely to take place only in delimited areas where the immigration of females from outside and the emigration of males can be prevented, and where, moreover, intensive trapping has reduced the sex proportions to the requisite critical point of interference. These conditions are not easily attained.

THE Central Cotton Committee of Russia has published a volume in Russian on "Locusts and Grasshoppers," by B. P. Uvarov (Library of Cotton Industry, vol. 8, Moscow, 1927; pp. 305). The book presents a comprehensive account of the morphology, anatomy, physiology, development, and behaviour of locusts and grasshoppers in general; further, ecology, natural enemies, and causes of periodic mass appearances and of migrations of the insects in question are discussed in detail. Description and critical discussion of technique and organisation for the control of locusts and grasshoppers conclude the general part of the book, and succeeding chapters are devoted to a discussion of all the more important Russian species, with particular reference to their ecology and bionomics. A list of more than 300 references to literature, in ten different languages, is appended. We understand that an enlarged English edition of the book is to be published shortly in Great Britain.

MARCONI short wave-beam services are now in operation to Rio de Janeiro and Buenos Aires. Brazil and the Argentine are thus in direct communication with London. The beam service operates both to and from Rio, but at present Buenos Aires has no beam aerials and so it has only a one-way service. In the near future, however, the two-way beam service will be completed. The success of the beam services is now assured. The Australian Prime Minister has said that they have attracted 45 per cent. of the Pacific Cable Co.'s traffic from Australia alone, as well as what they have taken from other cable routes. During the week ending Dec. 3, the total number of words carried over the four British Empire circuits was at the rate of considerably more than 40 million words a year. The beam services with New York, Rio, and Buenos Aires are expected to be equally great. The beam transmitting stations for the North and South American services are situated at Dorchester and are operated by 'remote control' by the signalling keys in London. The receiving station is at Somerton, about thirty miles from Dorchester. These services are normally worked at about 150 words per minute, but much higher speeds can be attained. The only limit to the speed appears to be that introduced by the recording apparatus. It is possible to vary the width of the beam. In this way the Rio stations can handle traffic from Paris and Berlin as well as London. Receiving aerials are now being built near Paris, but they have not yet been begun in Germany. When the final arrangements are completed there will be seven Marconi beam services operated from Dorchester and Somerton: two to the United States, two to South America, two to Japan and the Far East, and one to Egypt.

THE Society for Experimental Biology held its London meeting at the Imperial College of Science on Dec. 21–22. The very full programme of papers and demonstrations included a symposium on certain aspects of tissue culture, in which Dr. G. P. Wright, Mrs. B. Holmes, Dr. H. B. Fell, and Dr. Canti took part. In connexion with this, microscopic demonstrations were given by Miss S. F. Cox on the effects of X-rays of different wave-lengths on mitosis in tissue cultures, by Dr. Fell on the development of the isolated otocyst of the chick embryo, by Mr. F. G. Spear on the effects of low temperature upon mitosis *in vitro*, and by Miss D. H. Strangeways on monocytes and fibroblasts in tissue culture. Profs. MacBride and Huxley discussed problems in connexion with the metamorphosis of echinoderm larvæ and dedifferentiation under certain conditions; Capt. Diver gave an unusual study of the variation in webs of the spider *Epeira diadema* and another species. Dr. C. M. Yonge described the mechanism of feeding and digestion in Septibranchs, including deep-sea forms, and Dr. G. C. Robson discussed the variation of the radula in the Octopus and in Peristerna. Mr. E. A. Spaul described further experiments on the comparative quantitative effects of thyroid and pituitary in producing metamorphosis in Amphibians. Mr. J. T. Cunningham described experiments on the effects of ligature of the vas deferens and the vasa efferentia in mammals. Miss M. A. Tazelaar gave an account of experiments with eggs of the frog and the hen, in which the two poles or the two sides of the young embryo were subjected to different temperatures. Mr. R. Snow described the transmission of inhibition to bud growth through dead stretches of stem, while papers were presented by Dr. A. Walton and Mr. J. A. Hammond on the mechanism of impregnation and spermatozoan movement in the rabbit and the experimental production of small litters. The meetings concluded with the exhibition in the Imperial Institute cinema of a remarkable film showing the growth, division, and other activities of living cells in a tissue culture from the periosteum of the chick embryo, by Dr. Canti. The behaviour of cells in a culture of Jensen's rat sarcoma was also shown, as well as the effects of irradiation on the living cells. The next meeting of the Society will probably be held at Oxford in April.

IN consequence of the increased activity in oil-field investigation in Australia, and following the appointment of Dr. W. G. Woolnough as Commonwealth geological adviser, the services of Mr. Frederick Chapman, of the National Museum, have been lent to the Commonwealth for a year as Government palæontologist.

PROF. E. W. BROWN, professor of mathematics in Yale University, New Haven, has been elected an

associate of the Royal Academy of Belgium, and M. Armand Renier, director of the geological services of Belgium, and Prof. Lucien Hauman, professor of botany in the University of Brussels, have been elected *correspondants* of the Academy.

THE Ministry of Health has issued a memorandum (Memo. 122 A/T.) showing under various heads the cost per patient per week at certain residential institutions for the treatment of tuberculosis during the year ended Mar. 31, 1927. A mass of information has been collected, analysed, and tabulated which should be of the greatest value to authorities and other bodies who administer tuberculosis sanatoria.

IN preparation for the meeting of the International Commission on Illumination in America in September next, the technical committees of the Commission met at Bellagio, Lake Como, in September 1927, to discuss forty-six papers which had been prepared. The problems of eliminating glare in industrial lighting, motor headlights, street lighting, and signal glasses received much attention. Copies of a brief report of the meetings can be obtained from the Secretary of the Commission at the National Physical Laboratory, Teddington.

THE annual report for 1926–27 and *Proceedings* of the first session of the Merseyside Aquarium Society has been received. This Society was formed in Sept. 1926 with the object of helping those interested in aquatic life. Several good lectures have been given and excursions organised, the president being Dr. James Johnstone, professor of oceanography in the University of Liverpool. We note that "negotiations are at present being conducted by a sub-committee with a view to space being reserved in the course of development of the Wallasey sea front for a Public Aquarium, and in the event of these being successful the Committee trust that they will have the hearty support of members in the always arduous task of collecting funds for the establishment and equipment of the Institution."

MESSRS. Wheldon and Wesley, Ltd., 2 Arthur Street, W.C.2, have just sent out Catalogue, New Series, No. 20, of recent purchases by them of books on zoology, botany, and the physical and mathematical sciences. Upwards of a thousand books and serials are listed.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: An executive secretary to the Library Association—The Hon. Secretary, Library Association, Public Library, Buckingham Palace Road, S.W.1. (Jan. 12). An established analytical chemist in the scientific research and experimental department of the Admiralty at the Royal Naval Cordite Factory, Holton Heath —The Secretary to the Admiralty (C.E. Branch), Whitehall, S.W.1 (Jan. 16). A mycologist in the agricultural department of the Government of Burma —The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (Jan. 21). Two chemists in the agricultural department of Nigeria, primarily for work on vegetable oils and nuts, *e.g.* palm nuts, ground nuts, shea nuts, etc.— The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, S.W.1 (Jan. 31). A pathologist (morbid anatomy and hæmatology only) at the Royal Prince Alfred Hospital, Sydney, Australia—Hospital Agents, c/o J. W. Vickers and Co., Ltd., 24 Austin Friars, E.C.2 (Feb. 1). A professor of public health at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, South Kensington, S.W.7 (Feb. 16). A reader in chemistry at Bedford College for Women— The Academic Registrar, University of London, South Kensington, S.W.7 (Feb. 17). Civilian education officers in the Educational Service of the Royal Air Force—The Secretary, Air Ministry, Adastral House, Kingsway, W.C.2. A live stock officer for the department of agriculture, Kenya Colony — The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, S.W.1.

Our Astronomical Column.

COMETS.—Skjellerup's comet passed perihelion on Dec. 18 and is now rapidly receding from sun and earth; as it remains close to the sun in the sky, its further observation will be very difficult.

Encke's comet should be visible with moderate instruments in January and February. The following ephemeris for 0^h is from the *B.A.A. Handbook*:

	R.A.	Decl.	log r.	log Δ.
Jan. 10.	22^h 46·4^m	N. 3° 51′	9·987	0·023
18.	22 51·2	3 45	9·920	9·997
26.	22 54·7	3 16	9·837	9·958
Feb. 3.	22 52·6	N. 1 38	9·731	9·903
11.	22 34·6	S. 3 16	9·605	9·836

Perihelion is on Feb. 19·7. After Feb. 11 the comet is too near the sun for observation. On its emergence it will be visible only to southern observers.

RECENT DISPLAY OF THE AURORA BOREALIS.—Judging from the character of the Greenwich magnetograph traces, reports given in the press of the appearance of the aurora borealis on Dec. 26 and 27 are without foundation. Mr. C. Leaf, observing at Cambridge, states, however, that on Dec. 28 "a short-lived but well-marked display was observed here to-night. At 19^h 30^m G.M.T. the sky was clear, but at 20^h 00^m a bright oblong glow was visible low down in the north. Its colour was pale primrose and dark sky was visible below it, except at its western end, where a pale white band reached down to the horizon in the north-west. By 20^h 05^m the glow in the north had entirely vanished, and only a few faint and fluctuating bands in the north-west lasted till 20^h 15^m, after which time the sky was entirely clear."

Mr. Leaf's observations are confirmed in an interesting manner by the Greenwich declination traces. On the evening of Dec. 28, after several undisturbed days, a sharp wave occurred in declination, commencing at 19^h 55^m, reaching a maximum displacement of 21′ eastwards by 20^h 12^m, returning nearly to normal by 21^h 30^m with slight agitation continuing until 4^h on Dec. 29. At the time of the aurora, a stream of spots was about 20° west of the sun's central meridian. These spots reached a considerable but brief maximum on Dec. 28. The coincidence between the occurrence of aurora, magnetic disturbance, and sunspots is noted, but a connexion between these solar and terrestrial phenomena is not necessarily implied in this instance.

Research Items.

AN ANCESTRAL FIGURE FROM NEW IRELAND.—In *Man* for December, Mr. H. J. Braunholtz illustrates a carved wooden figure from New Ireland recently acquired by the British Museum, which belongs to a class of object sufficiently familiar from museum specimens, but of which the meaning and use are still to some extent obscure. The interest of the present specimen lies in the fact that between its legs is an object which clearly represents a friction gong, the *livika* peculiar to New Ireland. This makes the figure unique, although other representations of musicians are known, *e.g.* one playing the pan pipes in the British Museum, and two playing the conch shell and the pan pipes respectively illustrated by Kramer, who describes them as rain-makers. These funerary carvings are only found in the central and northern districts of New Ireland, their region of highest artistic development being the Hamba district, where they have been classified as 'historical' and mythical, the former representing actually known ancestors. One example quoted is that of a famous shark catcher, who was represented with his shark-catching implements. It would therefore be reasonable to regard the present figure as that of a famous *livika* player, though since the *livika* represents a hornbill, it might here represent a totem or might even be a moon-god, of which the hornbill is a symbol. The *livika,* which is manufactured only in a few inland villages, is played at ancestral ceremonies, its sound representing the voice of the spirits. Like the bullroarer, it is then intended to frighten away the women.

CEREMONIAL RUNNERS OF THE FOX INDIANS.—"Contributions to Fox Ethnology," by Mr. Truman Michelson (*Bull. 85*, Bureau of American Ethnology), contains, among other matters, a native text with translation which gives an account of the ceremonial runners of the Fox Indians. The ceremonial runners who, according to this account, ceased to exist about sixty years ago, were three in number, one being drawn from each of three of the four important Fox gentes, the Bear, the War Chiefs, and the Eagle Gens. The member of the Bear Gens was the leader. These runners were blessed by the spirits,—the wind, the deer, and the humming bird. Their functions were carrying messages, especially the news of deaths, and summoning councils; but in addition they exercised a kind of supervision at ceremonial dances, in the councils in case of a division of opinion they gave the decision, and they were rain-makers, or weather controllers. In case of excessive cold they rolled in the snow. To become a ceremonial runner necessitated a severe fast, at the end of which the entrant was blessed by the spirits mentioned above. A detailed account of the instruction given by each of the three spirits is given, in which it is enjoined upon the runner that he shall do his duty cheerfully, shall keep his body clean by frequent bathing, and shall speak no ill of anyone, or mock women. While performing his duty he was to eat no meat but that of the turtle-dove and quail (though at other times ordinary food might be taken), and carry nothing red when sent on an errand to announce a death. His moccasins were to be of buffalo hide, and his offerings to the spirits of tobacco only. Each runner had to make a wooden bowl and spoon, he had to live on the south side of the camp or settlement, and had for his rug the hide of a spotted deer, which it was one of his first duties to obtain for himself by killing the deer. The runners did not marry, and might not be seen by women after childbirth or when otherwise ceremonially unclean, as, for example, during menstruation.

TOXIC EFFECTS OF ROAD TAR EXTRACTS ON TROUT.—In a recent paper, Mr. A. C. Gardiner deals with "The Effect of Aqueous Extracts of Tar on Developing Trout Ova and on Alevins" (*Fishery Investigations*, Series 1, vol. 3, No. 2, 1927. London: H.M. Stationery Office, 1927). The extracts used contained 1·6 parts per 100,000 of 'acid' substances (phenols, etc.), and 0·25 to 1 part of basic substances (pyridine, etc.). It was found in general that susceptibility rapidly increased with age. The fertilisation reaction was unaffected in the tar extracts; and an hour's immersion in these extracts had little or no effect on the subsequent development of freshly fertilised eggs or on embryos 30 days old. Alevins 2 to 3 days after hatching likewise were not harmed by 20 hours' immersion in tar extracts, though they were restless and apparently irritated by the solution. However, from this stage onwards the fry became more and more sensitive, until when 84 days old, none was able to withstand 2 hours' immersion; yearling trout losing equilibrium in 3½ minutes. There is thus a remarkable increase in sensitivity to tar products as the adult stage is approached, the fertilisation process and the young larvæ being unaffected. These conclusions accord with previous work, and it is pointed out that the lethal action of the phenols on the adult trout is probably due to its action on the gills in preventing normal respiration. No explanation is at present suggested for the relative immunity of the alevins. One might perhaps suggest that the critical factor was the ratio of the amount of respiration through the gills to that through the skin. If the gills were unable to function, the adult would be unable to maintain its normal respiration, and death would occur from suffocation. On the other hand, in the larva, derangement of the gills would probably still allow sufficient respiration to occur through the skin; the large ratio of surface to volume of tissue allowing considerable gaseous exchange. The probability of this explanation is enhanced by the fact that sensitivity to tar extracts increases with great rapidity after about the eightieth day. This would be about the time of scale formation, a process which would rapidly reduce the permeability of the skin to dissolved gases.

TOBACCO AMBLYOPIA.—In the recently published issue of the *Annals of Eugenics*, Miss Elderton has made an elaborate statistical investigation of the data collected by Mr. Usher relating to the incidence of tobacco amblyopia, and has arrived at the interesting conclusion, comforting to many laboratory workers, that excessive smoking in itself cannot be proved to cause tobacco amblyopia. The evidence suggests that if there be a tendency to the development of this visual defect, heavier smoking may hasten the time of onset.

NORTH AMERICAN TERRESTRIAL ISOPODS.—H. Lomander (*Proc. U.S. Nat. Mus.*, vol. 72, art. 17, 1927) has examined the North American Trichoniscidæ in the collections of the U.S. National Museum. He finds three species which are also more or less widespread in Europe—*Trichoniscus pusillus*, *T. pygmæus*, and *Haplophthalmus danicus*, and two non-European species—*T. papillicornis* and *Brackenridgia cavernarum*. It is reasonably certain that *T. pygmæus* and *H. danicus*, which in Europe are generally found in hot-houses and gardens, have been transported to North America from Europe with garden produce, etc. *T. pusillus*, which occurs over the whole of

central and northern Europe and is the most common of the terrestrial isopods in the Scandinavian countries, may also be indigenous in the eastern parts of North America. *T. papillicornis*, hitherto found only in the extreme northern portion of the Pacific—Bering Island and Cook Inlet—has, on close examination, been found not to be a Trichoniscus. It belongs to the family Scyphacidæ and is nearly allied to certain species of terrestrial isopods which have been hitherto found only in the Antarctic. This species is made the type of a new genus, Detonella.

AIR BLADDER OF FISHES.—Miss F. M. Ballantyne *Trans. R. Soc. Edin.*, vol. 55, pp. 371-394; 1927), in an important paper, reviews the present state of knowledge of the evolutionary history of the air bladder of fishes, and extends it by observations on this organ in a number of the more primitive types of living fishes such as Amia, Lepidosteus, Acipenser, Gymnarchus, Ceratodus, and Callichthys. As a result of her work, the author supports the view of Sagemehl, as extended and supplemented by Graham Kerr, that the air bladder of the modern fish is derived from bilaterally symmetrical ventrally placed paired lungs. The author traces the following series of evolutionary stages. First there is the gradual reduction of the left and the enlargement of the right lung, as seen in the young of Polypterus and the adult of Ceratodus. The next stage is illustrated by Amia with its pulmonoid air bladder, which has the normal pulmonary nerve and blood supply, but opens dorsally into the alimentary canal. Lepidosteus has a pulmonoid air bladder with pulmonary nerves but blood coming from the aorta. Acipenser shows a condition in which the reduction of the respiratory function is complete and the air bladder is a simple membranous sac with its blood supply from the dorsal aorta. In Salmo the hydrostatic function has developed further and the air bladder has now red-glands in its anterior walls, but it is still a simple sac opening dorsally into the alimentary canal. The stages from the simple air bladder of Salmo to the complex organ present in the Physoclistic fishes have been worked out by Tracy.

FRESHWATER FOSSIL MOLLUSCA FROM THE ARGENTINE.—From the Pehuenchian beds of the Rio Negro, by some considered as of Eocene and by others as of Senonian age, a small collection of fresh-water mollusca is described by M. Doello-Jurado (*Bol. Acad. Nac. Cien. Cordoba*, vol. 30). The present is stated to be a preliminary notice and deals with only nine species belonging to the genera Corbicula, Diplodon, Physa, Viviparus, and Melania. Judging from the photographic figures, which are very clear, the specimens were by no means in a good state of preservation. It should be noted that they were found in association with Dinosaurian remains.

THE AGE OF THE OCEANS.—In an article entitled "The Problem of Geological Time," in *Scientia* for December, Prof. A. Holmes offers some criticisms of the calculation of the age of the oceans based on their sodium content. This argument, depending on statistical measurements in various parts of the world of the sodium in the ocean and the annual increment by rivers, and corrected by taking into account certain other factors, gave about ninety million years. This figure is far below the estimate based on radioactive minerals. Prof. Holmes believes that the discrepancy lies in a false estimate of the annual sodium increment. The above calculation of J. Joly assumes that 1·9 per cent. of all material added annually to the ocean is sodium, which means, since 10 per cent. of that material is derived from the gases of the atmosphere, that 2·1 per cent. of eroded material is sodium. But the sodium percentage of rocks has been calculated to be 2·85 per cent. for igneous and 0·81 per cent. for sedimentary rocks, giving an average of only 1·32 per cent. Prof. Holmes believes that the analyses of river waters for sodium invariably give too high results, and he thinks that this is because much of the salt in rivers comes from sediments and ground waters and is not new sodium added to the oceans by erosion of the rocks. He denies that the sodium method can give any serious contribution to the problem of the age of the oceans.

WATER SUPPLY OF THE NILE.—In continuation of the study of the regime of the Nile, the Egyptian Ministry of Public Works sent an expedition to the Lake Plateau in 1926. Under the title of "The Lake Plateau Basin of the Nile," Dr. H. E. Hurst has published an account of his work on that expedition (Cairo: Government Press, 1927). The discharge of the Victoria Nile was measured with difficulty, but appears to be about 760 cubic metres per second. The only important inflow to Lake Victoria is the Kagera River, which proves to have a considerably lower discharge than was previously supposed. It was thought to vary between 140 and 1500 cubic metres per second, but Dr. Hurst puts the average flow at not more than 250 cubic metres, and reduces the Kagera's contribution to the lake by about twenty-five per cent. Many more measurements are required throughout the year before the contribution of this area to the water supply of the Nile can be stated with certainty, but so far as can be judged at present, it is not large.

THE PETROLOGY OF THE PACIFIC.—A long paper which summarises all existing knowledge of the mineral and chemical constitution of the volcanic islands of the Central Pacific has just been published by Prof. A. Lacroix (*Mém. de l'Acad. des Sciences*, Paris, **59**, 1927). A great many new analyses are presented, and a careful comparison is made with the rocks of the Hawaiian Islands and those of the islands off the South American coast. Throughout the region studied basaltic rocks (including the *andésites* β of Lacroix) with trachytic and ultrabasic differentiates are the dominant types. No granites, crystalline schists, or ancient sediments have been recorded in any form. Three main series are distinguished according to the marked or virtual presence or absence of nepheline and its equivalents. In a few localities dacites and rhyolites are present, but the typical 'andesites' of the circum-Pacific facies (*e.g.* hypersthene-andesites and *andésites* α of Lacroix) are wholly absent. Prof. Lacroix is characteristically cautious in drawing conclusions about the nature and structure of the sub-Pacific crust, and as to the meaning of the regional variations, he remarks: "Il faut reconnaître que les causes du phénomène nous échappent pour l'instant."

GRAVITY SURVEY BY SUBMARINE.—Investigations in gravity observations during the voyage of a Dutch submarine from Holland to Java via the Panama Canal in 1926 were the subject of a paper read by Dr. V. Meinesz on Dec. 12 to the Royal Geographical Society. The apparatus, consisting of three practically isochronous pendulums, was described in detail. It proved satisfactory and the influence of the ship's movements were effectively eliminated. Only provisional figures can be given, but Dr. Meinesz believes that the error arising from the ship's movement is only 0·0008 cm. in g. There are, however, other sources of probable error, including a very small error due to the uncertainty of the chronometer rate, and

others which are very difficult to determine, caused by the velocity of the ship and the speed of currents. Only preliminary results are available, until the computation of the observations by the United States Coast and Geodetic Survey are completed. One of the most interesting discoveries is the occurrence of positive anomalies in both Atlantic and Pacific Oceans. After isostatic reduction, the mean of 17 purely oceanic stations in the Atlantic gave an anomaly of $+0.025$ cm. and the mean of 14 similar stations in the Pacific $+0.020$ cm. These anomalies do not correspond to a pure longitude term and are greater than those that might be expected because of the deviation between the geoid and the spheroid caused by a corresponding distribution of mass. Several other preliminary results were also discussed in the lecture, which is to be published in the *Geographical Journal* (*v.* also NATURE, Dec. 17, p. 898).

THE HALL EFFECT IN IRON CRYSTALS.—The July issue of the *Proceedings of the Cambridge Philosophical Society* contains a paper by Dr. W. L. Webster on the Hall effect in single crystals of iron. The plates used were cut parallel to one or other of the faces of the crystal, were about 1·3 cm. long, 0·7 cm. broad, and 0·016 cm. thick, and were tested in magnetic fields up to 22,000 gauss. The Hall effect was balanced by means of a potentiometer. Up to 21,000 gauss the effect is proportional to the field and after that remains constant. Its value is identical for the specimens used and for pure iron, and there appears to be no connexion between the effect and the change of resistance of iron crystals in a magnetic field.

HARDNESS AND TEMPERATURE.—The results of Mr. E. G. Herbert's investigation of the effect of temperature on the hardness of metals, were communicated to the Institution of Mechanical Engineers at the meeting on Dec. 2. The hardness is tested by a pendulum hardness tester provided with a spherical faced diamond of 0·5 mm. radius, which rests on a short block of the material to be tested of 13 mm. square section kept at the desired temperature by an electric furnace. Where the specimen is of steel, it is heated to a temperature between 900° and 1300° C., quenched in water or oil, and tested either immediately or after a further heating to 400°-700° C. and slow cooling. High speed steel after the first heating and quenching has a hardness which decreases slowly with rise of the temperature of the test to 600° C. and more rapidly at higher temperatures. The further heat treatment decreases the hardness at low temperatures but raises it at high temperatures, so that it is nearly constant up to 600° C. As the materials cut by the tool steel are hardened by the operation, tests of this hardening have been made and it is found to be closely related to the ductility of the material.

MODIFICATIONS OF CANE SUGAR.—In the *Chemiker-Zeitung* of Nov. 12, Prof. von Lippmann gives a brief account of some investigations which were begun in Japan by Dr. Helderman and are being continued at Utrecht by Prof. Ernst Cohen, on the existence of modifications of cane sugar. In the special number of the *Zeitschrift für phys. Chemie* dedicated to Prof. Cohen, Helderman describes two distinct modifications, precipitated by methyl and ethyl alcohol respectively from aqueous solutions, of which the latter is the more stable at ordinary temperatures. Since the specific gravities and heats of solution show considerable differences, it is obvious that all physical constants of cane sugar will have to be re-investigated.

CONSTITUTION OF COLLOIDAL PLATINUM.—In the *Journal of the Chemical Society* for October, S. W. Pennycuick gives an account of an investigation of the constitution of colloidal platinum. Platinum sols do not require the addition of stabilisers, and so it was possible to prepare sols by sparking pure platinum electrodes in pure conductivity water, great care being taken to exclude all impurities, including carbon dioxide. The conductivity of such a sol at 25° increased over a period of several days, and approaching a limiting value. This equilibrium could be quickly reached by boiling for a few minutes. After any temperature change, however, there was a lag in the equilibrium as indicated by conductivity measurements. Sols with conductivities of more than 40 gemmhos at 25° were prepared. Pennycuick supports Pauli's theory, according to which some of the platinum is oxidised on disintegration, and in contact with water acts as an electrolyte, probably H_4PtO_4. This acid gives rise to the formation of complex anions which are in equilibrium with free hydrogen ions. Experiments on the titration of platinum sols with alkalis confirm the presence of free hydrogen ions, and it suggested that in addition to these, there is a surface layer of hydrogen ions on the complex anion. A change of temperature causes a measurably slow rearrangement of the equilibrium. The titration curves show that the sols are not strictly comparable with either strong or weak acids.

DEVIATION OF WIRELESS WAVES AT A COASTAL BOUNDARY.—Major J. P. G. Worlledge, writing from the United Service Club, Pall Mall, London, S.W.1, refers to the reflection of wireless waves suggested by Dr. A. H. Davis and Dr. R. L. Smith-Rose in a communication by the latter to NATURE of Sept. 19, 1925, p. 498. In the course of some experiments carried out at a direction-finding station during the period January to October 1927, Major Worlledge has obtained evidence of the reflection of wireless waves at a coast line. During the calibration of the direction-finding station it was noted that the bearings on certain stations, using more than one wave-length, showed abnormal variations accompanied by sudden shifts of as much as four or five degrees on wave-lengths in the neighbourhood of 1000 metres. As a result of systematic observation, it was found that the change in bearing was related in a harmonic manner to the frequency of the waves received. The period of this harmonic relation was found to be consistent with the explanation that the change in bearings was due to the reflection of waves from the landward side of the neighbouring coastline. In such circumstances two waves would be received, the direct and reflected waves, and the error in apparent bearing would depend upon the path difference of these waves in terms of the wave-length employed. The maximum deviations of bearings are observed when the wave-length is such that the direct and reflected waves arrive in the same phase, while at intermediate wave-lengths, blurred minima are observed on the direction-finder as a result of the difference in phase of the two waves. In most practical cases the matter is complicated by the fact that reflection may take place from more than one point on the coast-line, and Major Worlledge has arrived at the above explanation only by subjecting a large number of observations to periodogram analysis and comparing the results with accurate maps of the neighbourhood. The theory of the subject has been developed concurrently with the experiments and has given satisfactory agreement.

The Overthrusts of the Trans-Alai and Alai Chains.

By Prof. D. J. MUSHKETOV, Director of the Comité Géologique of the U.S.S.R.

THE great plains which run south-eastward from the Sea of Aral contract to the basin of Ferghana, which lies between the great crescentic curve of the Thian Shan to the north, and a series of chains which abut against the Pamir and the mountainous northern projection of Western India. It was shown by J. V. Mushketov, by surveys between the years 1874 and 1880 (described in his "Turkestan," 1886), that in the Alai Mountains the Palæozoic rocks were overturned in many places, and rocks that are not normally in contact had been brought together over wide areas. These facts were not followed up at that time nor by the systematic survey of Turkestan, which began in 1909. That survey showed that in addition to the Palæozoic rocks being overturned northward the Alai chain is traversed by large fault lines with surfaces sloping southward, and that its Kainozoic and Cretaceous deposits show in many places a paradoxical dip under the Palæozoic, and that exotic cap-shaped masses of the Palæozoic rest on younger rocks.

The geological survey of the Ura-Tuba region, that is, of the northern slope of the Turkestan chain between the valleys of Liaïliak and Zaamin Rivers, which I began in 1925, added much to the information regarding the eastern Ferghana: and the study of the numerous northerly curving Palæozoic band-shaped horsts prove the predominance of pressure from the south during the Kainozoic orogenetic processes. These preliminary observations were verified and completed in 1926 by my collaborator, A. P. Markowski, and later in 1927 by myself from the clear sections along the Liaïliak River.

The fundamental element of the tectonic structure in this area appears to be an inclination towards the north of long band-shaped Palæozoic blocks which trend west and east and are uplifted at the southern end and plunge downward at the northern end.

The formation of some oblong depressions (Rhabat, Bujun, and others) and many morphological peculiarities of the region appear to result from the mechanism which produced this widespread basin structure.

The second series of interesting observations were made during the past summer (1927) in the second part of my journey across the intersection of the Trans-Alai chain, along the Altyn-Dara River, and along the northern slope of the chain from the summit Khtai-Saz to Mt. Kaufmann, 26,000 ft. high.

The western part of the Trans-Alai chain is more complicated and interesting than the eastern part, and fully confirms the already known discordance between the structure of the eastern, or rather the middle part—the Kyzylart, and that of the Peter the Great Mountains.

These observations lead me to the following conception of the structure of the northern slope of this part of the Trans-Alai chain. It is a large isosyncline (about 3 km. wide) which is highly overturned to the north, and is lying almost horizontal; it consists largely of Lower Mesozoic red flaggy sandstones, which rest discordantly upon a base that consists of Upper Silurian limestones and that rises slightly above the floor of the valley. The core of this syncline is highly crumpled and includes 16 to 20 steep fan-shaped folds of Upper Cretaceous and Eocene marls and clays; they are raised by this folding to a height of 18,000 ft. in Mt. Khtai-Saz and other peaks. The southern limb of the syncline is truncated by the overriding from the south of the Lower Cretaceous red series, which, in their turn are overridden by the Palæozoic beds containing effusive rocks that form the southern slope of the Trans-Alai chain.

Probably, moreover, the whole mass of the Trans-Alai chain, together with its Palæozoic base, was overthrust on to the Alai chain, thus occasioning the southward slope of the Alai chain while a large longitudinal displacement began the formation of the Alai valley. The morphological evidence of this fact, announced in 1903 by the American geologist Pumpelly, is now supported by direct geological proof, by the inclination and disappearance under the Alai valley of the Cretaceous and Kainozoic series of its northern bank (Daraut, Gaz, Sake-Yar). There, of special interest, is the sharp turn of the syncline from an east to west into a meridional strike, accompanied by an overturn to the north; for this change in direction is a supplementary proof of the influence of the southern or Pamir (Alpine) pressure. This change in direction takes place east of the meridian of Mt. Kaufmann, in accordance with the beginning of the curvature of the whole Alai chain into the 'Ferghana flexure.'

Observations on the southern limb of the flexure, between the Alai valley—along the Taldyk River, the southern Yagatch-art and the valleys of Katta-Karakol, Ak-bosagha and Archat—prove the occurrence (along an extent of about 100 km., from the mouth of the Kara-Kavak River, and extending up the southern slope of the Alai to its crest, and farther, beyond Yagatch-art, down the northern slope of the chain) of a large overthrust sheet of the massive Lower and Middle Devonian limestones. This sheet has been followed from south to north, and these limestones are in an absolutely abnormal position, as they lie above the Kainozoic and Cretaceous series and are in apparent accordance with them.

The width of the overriding and the thickness of the masses intersected by it diminish from west to east, in such a manner that on the west the younger series are generally squeezed out and are absent; and then gradually along the overridden band appear younger and younger series, first Cretaceous and finally Tertiary. Thus, to the east of Ak-bosagha, the Devonian deposits lie beneath red sandstones and conglomerates that are very high in the Kainozoic. The surface of the overriding sheet dips distinctly 35° S.E.

The observations of the past season complete the previous data and entirely confirm the conclusions which I have expressed at different times, particularly as to the 'Pamir orogenesis,' and also my preliminary diagrammatic section from the Pamirs through the Alai up to Ferghana (Izvestia Comité Géologique, 1926, No. 1).

The important observations of the recent Pamir expedition of the Comité Géologique of the U.S.S.R. under the leadership of Prof. D. V. Nalivkin are entirely in agreement with those previously mentioned. Prof. Nalivkin has conclusively proved the arch-shaped bending to the north of all the tectonic elements of the Pamir described by myself in 1917; and that the structure consists exclusively of Mesozoic and Tertiary series with Palæozoic rocks overriding them to the west of Kyzylarchat; he has discovered marine Jurassic deposits at the base of a Mesozoic complex along the Markansu valley, and has shown the analogy of the Jurassic formations of the Pamir with those of Western Bukhara; he has also proved the presence of Mesozoic rocks in the region of Mus-Kol; and, finally, he has confirmed the general overriding of the whole Pamir system northward.

Water Powers of Canada.[1]

UNDER the above heading, the Canadian Department of the Interior has just issued a brochure of 94 pages replete with up-to-date information respecting what is perhaps the most striking of all the natural resources of the great northern Dominion. In a foreword, the Deputy Minister, Mr. W. W. Cory, says: "In the vast domain of Canada, the countless rivers and streams, flowing with never failing replenishment from upland to sea, provide to the people of the Dominion an extraordinarily valuable and widely distributed asset in water-power resources which, already, has contributed in great measure to industrial progress, and which assures a supply of low-cost energy sufficient to meet expanding requirements for many years to come." To this may be added from the report itself: "It is not too much to say that, apart from the human factor, water-power is the most vital force behind Canadian industrial development."

As the subject of water-power development in Canada was dealt with by Dr. Brysson Cunningham in two articles which appeared in NATURE on Aug. 27 and Sept. 3 last, it is not necessary to recapitulate such information as is therein contained, but, the present report being of later date, there are several supplementary details of interest to which attention may be directed. The total turbine installation has now (Nov. 1, 1927) been increased to 4,883,266 horse-power, of which 4,012,428 horse-power is in connexion with central electric stations and 526,731 horse-power in connexion with pulp and paper mills, leaving a residue of 344,107 horse-power distributed over a miscellaneous group of industries, ranging from electro-chemical plants of considerable size to the lowly grinding mill serving local needs with a 5-horse-power wheel. The average of 513 horse-power per thousand of the population places Canada second to Norway in *per capita* development, while in aggregate installation she ranks second to the United States. The capital invested in the water-power industry in Canada is estimated at nine hundred million dollars, or more than that invested in any other single manufacturing industry. The corresponding figure in 1910 was 121,000,000 dollars, so that the increase in seventeen years has been more than six hundred per cent.

The outstanding significance of the location of the Canadian water powers is their favourable distribution for development purposes. Eighty-two per cent. of the developed water-power and roughly sixty per cent. of the total resources are situated in the coal-less provinces of Ontario and Quebec, where more than eighty per cent. of the manufacturing industry of the Dominion is carried on. It is this propitious circumstance which has not only enabled Canada to compete successfully with mass production in other countries, but has rendered her industrial structure largely independent of foreign fuel. Moreover, it is attracting to the Dominion important industries from abroad. Already 1400 branches of United States factories are stated to have been established in Canada. In certain specialised products the raw material from other countries is being imported for treatment by low-cost water-power. The bearing of this economic factor on the future welfare and progress of the Dominion can scarcely, as yet, be adequately estimated, but it is bound to be of great importance.

The brochure not only contains a wealth of figures and statistics, detailing the development in each of the provinces of the Dominion, but also it is illustrated by maps, diagrams, and a number of interesting photographs.

[1] Department of the Interior, Canada: Dominion Water Power and Reclamation Service. Water Resources Paper No. 60: Water Powers of Canada. Pp. 94. (Ottawa: F. A. Acland, 1927.)

The Relation between Rainfall and Flow-off.

IN Great Britain, knowledge of rainfall distribution is relatively detailed and exact. Moreover, most of the rainfall measurements which have been made are available to all who desire to consult them. On the other hand, the information which has been published regarding the flow-off of rivers is, by comparison, very slight in amount and most incomplete. A fair amount of data regarding flow-off has been spasmodically collected by various parties who are interested in the yield of certain rivers from the point of view of water-supply, but for reasons which are not connected with the increase of scientific knowledge, such data generally remain unpublished and inaccessible to the general student of the economy of rivers.

In some other countries the case is quite otherwise. Thus, the data published about the run-off of the more important rivers of the United States of America is very considerable, and would easily bear comparison with the corresponding rainfall data available for that country.

As a result of the conditions prevailing in Great Britain, there has grown up a devious method of obtaining an estimate of the average annual flow-off of a river. This method starts with an average annual rainfall map of the area drained by the river, and proceeds to make allowances for losses by evaporation, percolation into other river-basins, etc., and so arrives at an estimate of the average annual yield of the stream. As a rule, next to nothing is known about the magnitude of the losses, and in practice a quantity equivalent to from 10 to 14 inches of rainfall over the area is assumed to represent them. It needs but little consideration to appreciate the fact that measurements of evaporation from water-tanks and of percolation, as usually made, are carried out under conditions which bear but little resemblance to the corresponding conditions in the drainage area, and that they, therefore, find no direct application to the problem.

When a local authority produces a scheme for the appropriation of the water of a stream for purposes of water supply, it is of course incumbent on the authority to obtain parliamentary sanction for the adoption of the scheme. It is interesting to note that, in the records of the proceedings of the parliamentary committees which are appointed to hear evidence for and against such schemes, it is common to find considerable argument developed around the value to be assigned to the average annual rainfall over the catchment area, even if the various estimates of the value do not markedly differ among themselves; whereas the empirical figures which are deducted on account of losses by evaporation, etc., are often accepted without question. No doubt the reason for this unscientific procedure is that rainfall data are numerous and there is ample scope for argument in reference to the method of applying them to the problem in hand, whereas trustworthy data for evaporation from the area are entirely wanting, so that in the absence of run-off data, no opportunity for argument occurs in respect of the allowance to be made for losses.

The present investigation by Capt. W. N. McClean

of the rainfall over the area drained by the River Garry in Inverness-shire and of the run-off of the stream [1] is of considerable interest from this point of view, for it provides the means of comparing the two quantities and so forming an estimate of the losses due to evaporation and percolation in that area. The River Garry is situated in one of the wettest regions of the British Isles, the average annual rainfall being in excess of 90 inches. The investigation is the first of its kind to be made in Great Britain in respect of a stream in an abnormally wet region.

A map of the average annual distribution of rainfall over the area is the basis of the rainfall side of the work. A method is then developed whereby the total quantity of rain which falls over the area in any day can be estimated from measurements made at a few gauges in the valley. It is very difficult to assess the accuracy of these estimates. No doubt the error may be considerable on an individual day, but over a period of about a month the aggregate error should be much less.

The estimates of run-off of the stream were made by means of a continuous record of water level, combined with measurements of velocity at various points in the cross-section of the stream, and on various occasions. A calibration table is thus drawn up which enables values of water-level to be immediately converted into values representing the discharge of the stream.

[1] "Rainfall and Flow-off, River Garry, Inverness-shire." By Capt. W. N. McClean. Institution of Water Engineers, Dec. 9, 1927.

In comparing rainfall with run-off due allowance is made for the storage in the river basin.

A balance-sheet of rainfall and flow-off is prepared by dividing the observation period of the three years 1913 to 1915 into parts each about a month in length, beginning and ending at times when rainfall was slight and the water in transit had fallen to a minimum. The net loss of each period is thus determined. These losses are presumed to be accounted for by evaporation, percolation, and (in winter) by storage in the form of snow. In spring, and sometimes in winter, the balance-sheet may show net gains: these are ascribed to the effects of melted snow which had previously been stored. The average loss is about 8½ inches (of rain) per annum. The figure is a low one in comparison with the values usually accepted. It could readily be increased by supposing that the rainfall has been underestimated, and for such a supposition there is some ground.

The three years included the year 1915, which had an abnormally dry summer in the North of Scotland. From this circumstance the author is able to compile a valuable table of estimated lowest possible flow-off. This table depends only on the measurement of flow-off. The table in turn provides the necessary data for the computation of the maximum storage required to provide a continuous rate of draw-off.

The paper is a valuable contribution to our knowledge of the economy of a river situated in a region where the rainfall is very large.

R. CORLESS.

Anthropometric Measurements and School Progress.

A PAPER entitled "Body Measurements, Respiratory Tests and School Progress," which has an important bearing upon the methods and uses of anthropometric measurements of school children, was read before the Royal Anthropological Institute on Dec. 20, by Dr. A. A. Mumford, Medical Officer of the Manchester Grammar School. Body measurements have been taken annually at the Manchester Grammar School by the inspector of physical training on a uniform system since 1881. These measurements have been used to test growth and stimulate the use of the gymnasium by individuals below normal. Since 1909 the School Medical Officer has used these measurements to assist him in forming judgments about the satisfactoriness or otherwise of the boys' growth. With the co-operation of form masters it has been possible to correlate them with the boys' school work and conduct, and the records of each individual have been kept on cards which show the whole of the boys' school career at a glance.

By adapting a method suggested in a paper published in NATURE by Mr. Cecil Hawkins, height, weight, and chest girth were arranged and graded in half-yearly age groups in 5 per cent. percentiles. These groups made it possible to distinguish tall and small, thin and stout, narrow- and broad-chested, and also indicated in which one boy surpassed or was behind another.

It became apparent that it was desirable to carry out tests of functional as well as structural peculiarities, and respiratory tests were added. The tables were then graded on a time increment basis, which showed advances on the average in units of six months. The metric system of measurements was adopted, making it possible to use measurements of height and chest girth for calculations of volume, the true specific gravity being obtained in the swimming bath. Measurements were also made of particular parts of the chest. It was thus possible to advise parents and masters as to the kind of activity which would appeal most strongly to the boy or of which he stood in most need.

The observations showed that there was no single or uniform ideal boy, but that there were natural and essential differences which had to be found out, studied, and if possible measured. In seeking for a guiding principle to body build and shape in relation to physical activity, much help was obtained from the study of ancient brasses and from scientific tailoring, as well as from the measurements of records for the American Army, from which it was realised that there are special forms of body build which stand in relation to special forms of bodily exercise, and that each form of exercise makes special demands on body form and requires special methods of respiratory action. Hence the School Medical Officer needs to appreciate how wide are the differences in physical equipment between different individuals in relation to subsequent as well as school life. The basis of these differences is anthropological and must be studied in terms of functioning of the whole body. Sir Arthur Keith in his work on the mechanism of respiration in man, on the posture of man, its evolution and its disorders, and on the evolution of human races in the light of the hormone theory, has contributed greatly to the needs of the School Medical Officer.

Inquiry shows that body measurements and respiratory tests are also related to mental activity, and of the capacity to withstand and to recover from the mental strain in school life. The measurements of the School Medical Officer should be compared with the reports of the boys' progress furnished by the masters. Without such periodic reviews it is impossible to judge the effect of mental concentration on the boy's present growth or future fitness. Observation has shown that although undue absorption in either mental or physical activity involves

damage, proper exercise of physical powers is probably very beneficial to the cultivation of mental powers. An inspection of figures relating to boys who have gained entrance scholarships to Oxford or Cambridge during the past twenty years points in a similar direction. It was evident that boys winning scholarships at Oxford and Cambridge tended to display a somewhat accelerated physical growth when compared with the average boy. They also possessed a slightly better physical frame. This was most marked in boys winning first-class honours, and indicated that these boys maintained their position with less strain owing to a combination of higher mental ability and a superior bodily physique. In the boys of the next two grades the acceleration was less marked, indicating the strain of a lesser mental and physical ability. On the whole, the honours group excels in sports as well as brain.

The study of the adaptability of the human frame to meet the demands of energy involved by the various forms of mental and bodily work required in modern civilisation should be one of the principal objects of the modern School Medical Officer.

University and Educational Intelligence.

Cambridge.—Mr. H. L. H. H. Green, Sidney Sussex College, has been appointed demonstrator in anatomy.

An election to three Beit Fellowships for scientific research will take place on or about July 16. Candidates must be of European descent and graduates of a university of the British Empire or of equivalent standing. The fellowships are of the annual value of £250 and are tenable at the Imperial College of Science and Technology. Forms of applications and all information may be obtained, by letter only, from the Rector, Imperial College, South Kensington, London, S.W. Applications must be received on or before April 20.

Two Theresa Seessel research fellowships, each of the value of £300, are being offered by Yale University for the promotion of original research in biological studies. Preference will be given to candidates who have already obtained their doctorate, and demonstrated by their work fitness to carry on successfully original research of a high order. The holder must reside in New Haven during the college year, October to June. Applications, accompanied by reprints of scientific publications, letters of recommendation, and a statement of the particular problem which the candidate expects to investigate, should be made to the Dean of the Graduate School, New Haven, Conn., U.S.A., before Mar. 1 next.

We have mentioned before in these columns "Poverty Problem" lectures of the University of Calcutta. The lecturer, Captain J. W. Petavel, has epitomised them in a volume entitled "The Plan of the Educational Colonies Associations." These associations have been formed, one in India and the other in England (Hon. Sec., J. B. Pennington, 3 Victoria St., Westminster, S.W.), to encourage pioneer efforts to put the plan into operation. Teachers in the proposed colonies are to be paid only on a half-time basis, as most of their time will be spent in running their own small farms or workshops with the help of groups of pupils. The scheme has received influential support in Calcutta. In the June number of *School Life*, the organ of the United States Bureau of Education, there appeared an account of the Educational farm colony of Rabun Gap, Georgia. This colony is based, in the main, on the principles on which Captain Petavel relies; that is to say, each family resides on its farm, the labour of the children is largely utilised, under skilled direction, in conducting the necessary farm operations, the produce furnishes nearly everything that is eaten in the colony, and a market is thus created for the farmers. The whole plant is utilised for educational purposes, and especially to make better farmers and citizens.

A distinguishing feature of the Rabun Gap colony is its system of 'rotating farm homes.' Each of the 20 families accommodated on the colony's 1500 acres is admitted for a period of five years only, and this is liable to be curtailed if the family does not 'make good.' At the end of its tenure it is expected to have attained to high standards of farm practice and of living, and to carry these with it elsewhere; its children meanwhile having had a good grounding in the ordinary school subjects and a training that should enable them eventually to become successful owners or managers. The scheme has been in successful operation on a self-supporting basis for twenty years. A contributory cause of its success is that the families are chosen from among more or less isolated hill crofters accustomed to a meagre and rough life. Whether it would have succeeded with people of the type of those from among whom Captain Petavel proposes to recruit his colonists is open to doubt. It is now, owing to a disastrous fire, to be re-established as a public utility corporation associated with the local education authorities. Half a million dollars are to be spent on the equipment of the reorganised colony.

We have received a new and revised edition of "A List of the Serial Publications available for consultation in the Libraries and Scientific Institutions of the Union of South Africa." The List has been compiled for the Research Grant Board of the Department of Mines and Industries by Mr. A. C. G. Lloyd, the librarian of the South African Public Library, Cape Town, who has had the assistance of Mr. Percy Freer and Miss M. Ralling, members of the staff of the library. Notices of previous issues of this list appeared in Nature in 1912, 1917, and 1921. It is remarkable that the number of serial publications catalogued in the list has more than doubled since 1921, having increased from 1350 to 3117. We must suppose that the greater part of this increase must be ascribed to the energy shown by Mr. Lloyd in collecting the necessary information from the various libraries and institutions scattered throughout South Africa, and we congratulate him on the successful accomplishment of a very difficult piece of work. Some forty-four libraries have been consulted, and these include the fine mathematical library of Sir Thomas Muir, which is destined to form part of the South African Public Library. After the title of each publication an indication is given as to the libraries in which it may be found. In every case all gaps in the sets are carefully noted, so that an opportunity is given for bringing pressure to bear upon librarians who should take steps to complete their sets. English and American serials are entered in their alphabetical order, but foreign publications are entered under their place of publication. We prefer the alphabetical arrangement of all journals as carried out in the "World List of Scientific Periodicals." However, the South African list has an alphabetical index containing the names of most of the foreign periodicals, with references to their position in the body of the work.

Calendar of Customs and Festivals.

January 9.

PLOUGH MONDAY, the first Monday after Epiphany, an ancient popular festival which marks the close of the Christmas and New Year celebrations. It has been explained as the day on which agricultural work is resumed after Christmas, and it is compared with St. Distaff or Rock Day, Jan. 7, the day after Epiphany, when the women are supposed to return to their work. On St. Distaff's Day a contest between men and women took place, the men burning the women's flax and the women drenching the men with water. A similar contest sometimes took place on Plough Monday. If the ploughman could rise sufficiently early in the morning to place his whip, ploughstaff, or other field implement by the fire before the maid put the kettle on it, the maid lost her shrove-tide cock, and vice versa.

Although Plough Monday is said to mark the return to work, the observances recorded have also been described as a festivity of the workers similar to that enjoyed by their masters during the holidays. Superficially they have that appearance rather than of a resumption of labour. Before the Reformation, candles were burnt before some of the images in the church, and a collection was made for the cost of the 'Plough lights'; but this part of the custom did not survive the change, although the levy of money continued to be made.

The essential feature of the custom was that a band of young men, sometimes with their shirts worn over their coats, sometimes in their shirt sleeves, and bedecked with ribbons, drew a plough, also dressed in ribbons, and sometimes called the 'fool plough,' to the principal houses in the neighbourhood, where they expected to be regaled with bread and cheese and ale, or to receive gifts of money. If there were no immediate response, and a tremendous din of shouting and blowing of horns produced no result, the ground in front of the door was ploughed up. The day ended with a merrymaking on the proceeds. The men who drew the plough were known as 'plough bullocks'—in Huntingdonshire as 'plough witchers.' In Lincolnshire the procession included thrashers carrying their flails, reapers with sickles, and all who were in any way connected with the work of the field, even to the smith who sharpened the plough, and the miller. As usual in folk mummings, important personages were 'the Fool' and 'Bessy,' a man dressed in woman's clothes. The latter carried the money box; the former had an inflated bladder, and was dressed in the skin of a calf, or in one case of a fox with dangling tail. Bessy sometimes had an ox-tail dangling beneath his skirts. It is significant that chasing and belabouring with sticks a man dressed in a calf skin was a Hogmanay custom in Scotland.

When brought into relation with customs found elsewhere, the object of the Plough Monday celebration becomes clearer. Certain Rumanian observances will serve. In the ceremony of 'the great plough' (*Plugul Cel Mare*), which takes place on the morning of Jan. 1, a number of young men go around to the houses of the wealthier people. Eight are harnessed to a real plough, one is equipped as a sower who precedes the plough and sows corn in its path, while another carries a friction drum made of wood, goat's skin, and horsehair, with which the lowing of oxen is imitated. On arriving at their objective, two of the party recite a long poem, which describes all the stages of Trajan's harvest from the sowing of the corn and its fertilisation by the rain, to the reaping and carting of the crops, and how Dochia (the daughter of the last king of Dacia conquered by Trajan) makes and bakes cakes for the workers. The verses close by wishing equal good fortune to the inmates of the house.

From these two customs, then, it would appear that the object of drawing the plough about on Plough Monday, a practice which had degenerated into little more than a noisy piece of horseplay with the object of raising contributions towards a merrymaking, at an earlier stage had been to wish or, more properly, to secure good luck and prosperity to those to whom visits were paid. Like other festivals of the kind, it must originally have been communal in character. The circulation among neighbouring houses at first was probably inclusive, a communal rite intended to secure the well-being of the whole society, as is usually the case. Among the Gilyaks, for example, at the slaying of the sacred bear, the animal was taken round to every house in the village.

Such a communal purpose may suggest an explanation of the even more primitive features. The Fool and Bessy, the two characters who appear constantly in folk dances, may usually be taken to represent the male and female principles in Nature, and their presence in the ceremony the promotion of fertility: the Fool in wearing the skin of the calf is identified with the animal itself, which is further indicated by the appellation of 'plough bullocks' given to those who draw the plough.

As a parallel may be cited the wolf dance of the Sioux, in which the dancers identify themselves with the wolf by wearing wolf skins and gather round the one who represents the buffalo to pull him down, thus magically securing the supply of buffalo meat; and the buffalo dance of the Mandans, as recorded by Catlin, in which they wear buffalo skins. The Fool and those who draw the plough may therefore actually be regarded as a survival of the belief in their identity with the oxen, the beating of the cow skin in Scotland possibly being a representation of the killing of the sacrificial animal to promote the strength of the deity which it represents. Sir James Frazer has shown that the corn-spirit is often represented by a bull or other animal which is sacrificed. The high leaps of Bessy, which showed her stockings and breeches, may be compared to the leaping of the dancers of many parts of Europe, by which women in a mimetic dance promote the springing of the corn.

HANSEL MONDAY.—The first Monday in the New Year, or more commonly Old Hansel Monday, on the first Monday after Jan. 12 (*i.e.* Jan. 1, O.S.) in Scotland was celebrated by gifts similar to our Christmas boxes. A liberal entertainment at breakfast was given to the farm-hands, and the rest of the day was a holiday. Servants were also engaged for the year. It was the principal day for making trial and forecasts of the future. In Skye a form of weather divination was practised at this time. It is a common and widespread custom to regard the weather of each of the next twelve months as being foretold by that prevailing on each of the twelve days between Christmas and Epiphany.

In Scotland the twelve days were sometimes reckoned in this period, then known as "the twelve days of Christmas"; by some from New Year's day; but in Skye, the period began with Hansel Monday. In the Balkans "a dry Epiphany and a dripping Eastertide" foretell plenty, and may be compared with "a green Yule makes a fat churchyard." Apart from the weather, the period between Christmas and Epiphany was peculiarly favourable for all forms of popular prognostication.

Societies and Academies.

LONDON.

Optical Society.—Dec. 8.—**T. Y. Baker**: The design of reflecting prisms. In the majority of reflecting prisms used in optical systems, reflections most frequently take place at angles of 45°; and the planes of successive reflections are either the same or perpendicular to one another. The reason seems to be that these systems are easily portrayed on a drawing board. Any angles of incidence and any alterations in the plane of reflexion can be dealt with by the construction of a spherical diagram, either by measurement of an accurately drawn diagram on a sphere, or by computation by spherical trigonometry. From the data derived from the diagram, a wire model of the axial ray in its passage through the prism can be constructed. Next a wooden model of the full beam of light is constructed, and finally a model of the complete prism. Among the systems examined is that used in the prism binocular. Apparently a systematic examination of the possible prisms has never been made, but if it were done a skew prism of compact form and without re-entrant angles which could be made in a single block of glass might be found.

Geological Society, Dec. 14.—**Edward Greenly**: The Lower Carboniferous rocks of the Menaian region of Carnarvonshire: their petrology, succession, and physiography; with palæontological notes by **Stanley Smith**. The term Arvon is a convenient designation for the region. The Lower Carboniferous rocks of Arvon consist in the main of a limestone series with many beds of sandstone and shale. This is underlain by a singular formation, composed of yellow and red loams and breccias, which are studded with pisolites of göthite and kaolinite. The blocks in the breccias are angular, and the loams are unstratified. The loams are of alien, the blocks of local, derivation. The limestones are rich in corals and branchiopoda, and are all in the zone of Dibunophyllum. The structure is that of an asymmetrical synclinal infold, truncated by a large boundary-fault. The series rests with complete unconformity upon the Mona complex and the Ordovician rocks; and there is rapid overlap in a west-north-westerly direction. From the direction of the overlap, and from the contents of the conglomerates, it is inferred that the region which is now Snowdonia was completely submerged in Lower Carboniferous times. At first, the climate seems to have been arid, with a large diurnal range of temperature; but, as the subsidence advanced, moist and genial conditions began to set in, persisting throughout the remainder of the period represented by the limestone series.

Linnean Society, Dec. 15.—**K. Münster Störm**: Recent advances in limnology. The object of limnology as a synthetic science is to investigate the reciprocal action of biotopes and biocenoses, and the cycle of organic substances within the microcosms represented primarily by the lakes. Recent researches confirm that the three biological lake types, *eutroph*, *oligotroph*, and *dystroph*, recognised by Naumann and Thienemann, must be regarded as natural, and should form the basis of attempts to establish more detailed classification schemes. A scheme embracing all lake types known at present is put forward which is based upon the (N+P), Ca, and humus 'spectra' proposed by Naumann for expressing the position of an individual lake with regard to those essential factors.—**T. A. Stephenson**: On species among the Cœlenterata. Cœlenterate species are difficult to define. The characteristics of the nematocysts have been suggested as useful criteria, for they are characteristic and their variations appear to be arbitrary. The species of British Actiniaria are sharply marked off from one another by their methods of reproduction. The structure of the nematocysts is a useful generic and family character, and their size sometimes distinguishes species; but in critical cases they give no assistance, and differences of habits are the decisive factors.

EDINBURGH.

Royal Society, Dec. 5.—**E. T. Whittaker**: The influence of gravitation on electric phenomena. The address described the attempt of Faraday to find experimentally a connexion between gravitation and electricity, and the discovery by Einstein of the true principle of the connexion. The author has recently completed work on electric phenomena in the field of a single gravitating mass and in a uniform gravitational field.—**C. G. Darwin**: The new outlook on the mechanics of the atom. The address gave an account of the recent developments in the wave theory of matter, with especial reference to the description of motions, as opposed to stationary states.—**N. B. Eales**: The anatomy of a fœtal African elephant, Part 2. The muscles of the trunk and limbs. The dorsal muscles and ligamentum nuchæ are strengthened to carry the weighty head, which is heavier than in and other terrestrial mammal. Occipital muscles are fixey so far back as the thoracic vertebræ, and some of the cervical and thoracic muscles are firmly fixed to the pelvis and sacrum. Both limbs have enhanced extensor and weak flexor muscles. The five digits are prevented from spreading by strong lateral ligaments. In its musculature the elephant shows no close affinity with the Ungulata.—**H. W. Turnbull**: The invariant theory of the quaternary quadratic complex, Part 1. The reduced system. By a reduced system is meant a set of symbolic factors in terms of which any concomitant of the given ground form and of all possible types of quaternary variables, can be expressed. It differs from the ordinary set of factors given by the fundamental theorem for symbolic methods by being easier to handle. The investigation throws light on the properties of the Riemann-Christoffel curvature tensor.

PARIS.

Academy of Sciences, Dec. 5.—**Paul Appell**: The application of the theorem of virtual work to movement with friction.—**Maurice Hamy**: A particular case of diffraction of the solar images at the focus of a telescope.—**de Sparre**: The danger that may arise from cavitation in the case of a sudden stoppage of pumps feeding a main.—**G. Friedel**: The forms assumed by myeline in contact with water. Reply to a criticism by M. Nageotte.—**E. Mathias, C. A. Crommelin**, and **H. Garfit Watts**: The rectilinear diameter of ethylene. Ethylene obeys the law of the rectilinear diameter. The deviations from the straight line are larger than those for hydrogen and neon, and are of the order of 1 per cent.—**E. Bataillon**: The mitoses of simple activation in crossings of batrachians.—**Ragnar Frisch**: The theorem of determinants of Hadamard.—**Hadamard**: Remarks on the preceding communication.—**Pierre Vernotte**: A property of the method of least squares.—**Mandelbrojt**: Suites of holomorph functions.—**Julius Wolff**: The series $\Sigma A_k/(z-a_k)$.—**Henri Cartan**: Some theorems of R. Nevanlinna.—**J. Villey** and **Et. Hochard**: A strabometric manograph with deformable electric condenser. An elastic metallic mem-

brane receives on one face the cyclic pressure to be studied, and on the other face a permanent known pressure. The membrane forms one plate of a condenser, and is balanced against a known condenser through an electrometer. The sensibility of this instrument is limited only by the error of reading an ordinary static manometer used to control the readings.—**Henri Bénard**: Vortices in bands and Rayleigh's theory. Description of experiments confirming the theoretical predictions.—**Emile Belot**: The seismicity of the sun and the periodicity of magnetic storms. The lines traced by magnetographs on the earth are regarded as the electromagnetic translation of the curves which would be recorded by seismographs placed at the surface of the sun.—**A. Schidlof**: A construction furnishing the mass of the charged material point in the universe of five dimensions.—**L. Décombe**: Electrified spherical pellicles and spectral series.—**C. Raveau**: The reversible triangular cycle. Demonstration of several classes of thermodynamic relations.—**Mlle. O. Jasse**: A new interferential method of measuring the refractive indices of liquids.—**Georges Simon**: The use of the spectroscope in the regulation of superposition fringes.—**Georges Vaudet**: The spark spectrum of chlorine and bromine in the Schumann region. The lines given extend from wave-length 2252 A. to 1302 A.—**J. Rossignol**: Spectroscopy of the spark of mercury produced in an oscillating high-frequency circuit in permanent regime.—**Salomon Rosenblum**: The powers of slowing down by the atom relative to the α-rays.—**Mlle. C. Chamié**: The phenomenon of grouping of atoms of radioelements. Additional experiments are described showing that the atoms of radioelements can be associated in groups in various media and under varying conditions.—**A. Seyewetz and D. Mounier**: The action of light upon nitrated colouring matters. Phenols or amines containing the nitro group turn brown when exposed to sunlight or ultra-violet light. It is probable that a reducing action has taken place, but the presence of the amino group could not be proved.—**Ch. Quillard**: A method of distinguishing aluminium alloys based on the use of pH indicators.—**Charles Prévost**: The allyl transposition and the mechanism of esterification.—**Urion**: The preparation of 1, 5-heptadiine and 2, 6-octadiine. These hydrocarbons are produced by the interaction of the dimagnesium derivative of dipropargyl and methyl sulphate.—**Paul Fallot**: The mountainous region between Priego and Cabra (Andalusia).—**L. Gaurier**: A particular form of filling up in some high mountain lakes.—**Adolphe Lepape**: The origin of the radioactivity of the springs of Bagnères-de-Luchon. There is a relation between the radioactivity and the amount of sulphur present in the waters.—**William Herbert Hobbs**: The expeditions to Greenland of the University of Michigan. An account of the work done during the summers of 1926 and 1927. The object of the expeditions was to extend our knowledge of the glacial anticyclone.—**Lucien Daniel**: The variations of the secretory apparatus in various grafted plants.—**R. Dostal**: Morphogenic observations on *Caulerpa prolifera* of the bay of Villefranche-sur-mer.—**J. Dumont and B. Ganossis**: The deflocculation and the plasmolysis of the earthy coatings.—**Emile Saillard**: The coefficients of diastatic inversion.—**Louis Bounoure**: The chondriome of the primary gonocytes in *Rana temporaria* and the search for the genital elements in the early stages of development.—**Paul Chabanaud**: The nasal organ of *Solea vulgaris*.—**F. X. Lesbre and R. Tagand**: A triple monster of the ovine species. A description of a lamb, born dead, which had one head and neck, was double in the middle and triple below.—**Denis Bach**: The nitrogenous nutrition of the Mucorineæ. The assimilation of uric nitrogen.—**Angel Establier y Costa and Charles Kayser**: The effects of puncture of the fourth ventricle: hyperallanturia and troubles of thermal regulation.—**J. E. Abelous and H. Lassalle**: The influence of the section of a nerve on the general excitability of the nervous system.—**Michel Polonovski and René Hazard**: The action of N-methylgranatoline on the circulation, the pneumogastric and the heart.—**Perret-Maisonneuve**: The secretion and utilisation of the wax in the bee (*Apis mellifica*). Bees will utilise any suitable material for making their cells, and the conclusion is drawn from the experiments detailed that the secretion of wax under the normal conditions of existence of the bee is an economical necessity and not a biological function.—**Maürice Pietrre and André Chrétien**: The influence of some electrolytes on the phenomena of agglutination. Researches on the agglutination of bacilli of the paratyphoid group by specific immunosera. The age of the organism does not appear to be an essential condition, the most important factor being the chemical state of the bacillus.—**A. Blanchetière**: The hydrolysis of ovalbumen by pepsin in its relations with the formation of the diacipiperazines.—**Jean Delphy**: The constitution of the nuclear apparatus in the Infusoria: the Anoplophryimorphs.—**G. Lavier**: Particulars of the nucleus in the trypanosomes of the Brucei group, of recent isolation.—**Raymond Poisson**: A new ecorinid, *Tæniellopsis orchestiæ*, a protophyte parasite of the rectum of *Orchestia bottæ*. Its evolutive cycle.—**Jules Amar**: The laws of pathogenic action.

CAPE TOWN.

Royal Society of South Africa, Oct. 19.—**J. F. V. Phillips**: *Olea laurifolia* Lam. (ironwood): an introduction to its ecology. This is a highly important tree ecologically, sylviculturally, and economically. Despite its slowness of growth and the various disabilities to which it is subject, the species is fully capable of holding its ground in the Knysna forests and even of increasing its frequency if not kept in check. There is a steady demand for the timber.—**H. G. Fourcade**: (1) A new method of aerial surveying: second paper. The adjustment of an aerial traverse to terminal conditions is developed. An instrumental method of transferring, without computations, the vertical point from plate to plate is described, and a simple procedure for determining the directions of successive air bases is worked out. The ground control may be limited to single points at the end of traverses, instead of the clusters of 3 formerly thought necessary for fixing the positions of the terminal pairs of plates. (2) The principal point and principal distance in photogrammetry. The principal distance gives the angular scale of photographs and, in consequence, is a fundamental constant of the photogrammetric camera. The principal point, being the origin from which plate measures must proceed, is equally important. Former methods for determining these constants lacked precision because they depended on linear measurements of a central projection made upon a commercial plate, which usually is by no means plane, and either ignored distortion or treated it as an accidental error.—**P. R. v. d. R. Copeman**: Studies in the growth of grapes (Part 4). The acid-sugar ratio. An expression of the form $y = b/x - c/x^2 - a$ may be used to express the acid y in terms of the sugar x. The constants are affected to a greater extent by changes in locality than by seasonal changes. If r be the ratio acid-sugar, then $rx = b/x - c/x^2 - a$, and therefore the ratio may be calculated from the sugar content of the juice.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 13, No. 10, October).—**J. S. Nicholas**: The application of experimental methods to the study of developing Fundulus embryos. From the time when the embryo of this marine fish has attained a definite form, it can be safely removed from the egg-shell; the technique is described. The embryos so obtained develop in sea water, fresh or distilled water, and were used for experiments. These show that determination of tissues occurs at an early stage.—**J. H. Bodine**: The action of Na, K, and Ca chlorides on the egg of Fundulus. The embryo dissected from the egg is resistant to sodium chloride solution although the larva is killed. Both the other chlorides kill the embryo quicker than the egg, and the larvæ are very sensitive. Mixtures of sodium and calcium chlorides are not toxic for eggs, but very toxic for embryos.—**T. P. Abello**: Absorption of ultra-sonic waves by hydrogen and carbon dioxide. Waves of a frequency of 612,000 per second from a piezo-electric crystal were passed through a tube 5 cm. long and the intensity of the emergent beam was measured by a torsion vane. Plotting percentage volume of carbon dioxide or hydrogen in the air in the tube against the intensity gives points which follow a logarithmic curve.—**W. H. McCurdy**: On the fine structure of some mercury lines.—**Leonard B. Loeb**: On the duration of the existence of doubly charged positive ions in gases, and their detection. A critical discussion of recent results leads to the conclusion that while doubly charged positive ions are undoubtedly generated by the ionising agent in certain cases, they are few in number, and it is doubtful if they exist in the gas as multiply charged ions for sufficient time to be studied as such in ordinary ionic experiments.—**G. A. Miller**: Groups generated by two operators of order three, the cube of whose invariant is invariant.—**R. L. Moore**: Some separation theorems.—**John Belling**: A working hypothesis for segmental interchange between homologous chromosomes. Assuming that a break in the chain of genes of a chromosome takes place when the chain is at maximum extension (leptotene stage), then when two homologous chromosome conjugate, the breaks may or may not coincide. In the former event, should the four ends not be even or a twist have occurred, there is opportunity for interchange as the genes link up again.—**Robert E. Burk**: The heterogeneous thermal decomposition of ammonia in strong electric fields. One method by which a contact catalyst may function is by weakening appropriate bonds in the adsorbed molecules by atomic disturbances, *i.e.* distortion of the electronic orbits by the surface fields of the catalyst. With molybdenum wire 0·005 cm. diameter and fields of 44,000 volts per cm. at the surface, and platinum wire 0·0005 cm. diameter and fields of 150,000 volts per cm. at the surface, no change in rate of decomposition was observed.—**Bernard Lewis**: The photochemical decomposition of hydrogen-iodide; the mode of optical dissociation (see NATURE, April 2, 1927, p. 493).—**Jacob Papish and L. E. Hoag**: The detection of uranium by a photoluminescence test. A bead of fused sodium or potassium fluoride, when 'activated' by a trace of uranium, gives a brilliant and distinctive luminescence if illuminated by ultra-violet light or by a condensed iron spark. Columbic acid gives a similar luminescence with sodium but not with potassium fluoride, but the latter is not so sensitive as a reagent.—**Herbert L. Lombard and Carl R. Doering**: Cancer studies in Massachusetts. (1) The relationship between cancer and density of population in Massachusetts. The earlier finding of increased cancer death-rate with density of population among natives born of native parents is negatived on making adjustments for age and sex distribution. The statistics for foreigners are insufficient to give significant results, although the cancer death-rate appears to be higher than among natives. Part of the density phenomenon may be due to better facilities for diagnosis.

Official Publications Received.

BRITISH.

Nigeria. Proceedings of the First West African Agricultural Conference, held at Ibadan, Nigeria, March 1927. Pp. 196. (Lagos: Government Printer.)

British Museum (Natural History). Picture Postcards. Set M3: Oceanic Angler-Fishes, Series No. 1. 5 cards in monochrome. 6*d*. Set M4: Oceanic Angler-Fishes, Series No. 2. 5 cards in monochrome. 6*d*. (London: British Museum (Natural History).)

The Marine Biological Station at Port Erin (Isle of Man): being the Forty-first Annual Report of the former Liverpool Marine Biology Committee, now the Oceanography Department of the University of Liverpool. Drawn up by Prof. Jas. Johnstone. Pp. 32. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd.) 1*s*. 6*d*. net.

Proceedings of the Royal Physical Society for the Promotion of Zoology and other Branches of Natural History, Session 1926–27. Vol. 21, Part 3. Pp. 109-158. (Edinburgh: Oliver and Boyd.) 6*s*.

Air Ministry: Meteorological Office, London. Southport Auxiliary Observatory (The Fernley Observatory of the Corporation of Southport). Annual Report, and Results of Meteorological Observations, for the Year 1926. By Joseph Baxendell. Pp. 28. (Southport: Fernley Observatory; London: Meteorological Office.)

Torquay Natural History Society. Transactions and Proceedings for the year 1926–7. Vol. 5, Part 1. Pp. 81+4 plates. (Torquay.)

FOREIGN.

Sveriges Geologiska Undersökning. Ser. Aa, No. 160: Beskrivning till Kartbladet Klintehamn. Av Henr. Munthe, J. Ernhold Hede och G. Lundquist. Pp. 109+1 tavla. 4.00 kr. Ser. Aa, No. 164. Beskrivning till Kartbladet Hemse. Av Henr. Munthe, J. Ernhold Hede och Lennart von Post. Pp. 155+1 tavla. 4.00 kr. Ser. Aa, No. 166: Beskrivning till Kartbladet Lurö. Av R. Sandegren. Pp. 43+1 tavla. 4.00 kr. (Stockholm.)

United States Department of Agriculture. Technical Bulletin No. 24. The Magpie in relation to Agriculture. By E. R. Kalmbach. Pp. 30. (Washington, D.C.: Government Printing Office.) 10 cents.

Museums of the Brooklyn Institute of Arts and Sciences. Report upon the Condition and Progress of the Museums for the Year ending December 31, 1926. By William Henry Fox. Pp. 71+8 plates. (Brooklyn, N.Y.)

Cornell University Agricultural Experiment Station. Memoir 107: Experimental Studies of Cultivation of certain Vegetable Crops. By H. O. Thompson. Pp. 73. Memoir 108: Studies of the Influence of Menhaden-Fish Meal on Calcification in Growing Animals. By L. A. Maynard and R. C. Miller. Pp. 23. (Ithaca, N.Y.)

Smithsonian Institution: Bureau of American Ethnology. Bulletin 85: Contributions to Fox Ethnology. By Truman Michelson. Pp. vii+168. (Washington, D.C.: Government Printing Office). 75 cents.

Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditures and Condition of the Institution for the Year ending June 30, 1926. (Publication 2879.) Pp. xii+551+125 plates. (Washington, D.C.: Government Printing Office.) 1.75 dollars.

Department of Commerce: U.S. Coast and Geodetic Survey. Terrestrial Magnetism. Serial No. 393: Results of Magnetic Observations made by the United States Coast and Geodetic Survey in 1926. By Daniel L. Hazard. Pp. 18. (Washington, D.C.: Government Printing Office.) 5 cents.

CATALOGUES, ETC.

Catalogue de livres anciens et modernes rares ou curieux relatifs à l'Orient. (No. 5.) Pp. 117-180. (Paris: Libr. Adrien-Maisonneuve.)

Sotheran's Price Current of Literature: Catalogue of Science and Technology, No. 3. Annotated and Classified List of Rare and Standard Works on Exact and Applied Science. Part 3: including 12, Mining and Metallurgy. (No. 806.) Pp. 641-928. (London: Henry Sotheran and Co.)

Old and Modern Books: English and Foreign Literature, Modern First editions, Voyages and Travels, Americana. (No. 18.) Pp. 72. (Newcastle-on-Tyne: William H. Robinson.)

A Rough List of Recent Purchases of Valuable Books on Zoology, Botany, the Physical and Mathematical Sciences, Sport, etc. First Portion. (New Series, No. 20.) Pp. 60. (London: Wheldon and Wesley, Ltd.)

Diary of Societies.

SATURDAY, JANUARY 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. N. da C. Andrade: Engines: Putting the Furnace in the Cylinder (Juvenile Christmas Lectures) (V.).

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch) (College of Technology, Manchester), at 4.—H. S. Primrose: Electric Melting of Non-Ferrous Metals.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section) (at 36 George Street, Manchester), at 7.

WESTERN JUNIOR GAS ASSOCIATION (at Works of Bath Gaslight and Coke Co.).—W. D. Ashman: Some Notes on Water Softeners and Water Softening.—H. C. Feltham: Future of the Gas Engine.

MONDAY, JANUARY 9.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Dr J. Horne: Obituary Notice of Laurence Pullar.—Prof. J. Lorrain Smith: Obituary Notice of Prof. Henry Harvey Littlejohn.—Penelope M. Jenkin: Note on the Sympathetic Nervous System of *Lepidosiren paradoxa*.—Prof. D. Noël Paton: Reflex Postural Adjustments of Balance in the Duck.—Dr. E. A. Baker: The Photographic Latent Image as a Phenomenon of Luminescence (third paper).—Edith Philip Smith: A Comparative Study of the Stem Structure of the Genus Clematis, with special reference to Anatomical Changes induced by Vegetative Propagation.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—Capt. P. P. Eckersley: Technical Principles of Broadcasting (Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—A. E. Loe and others: Discussion on Portable Power Appliances.

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30. Open Discussion.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Award of Prizes and Studentships ;.Criticism by L. Sylvester Sullivan on Work Submitted.

SURVEYORS' INSTITUTION, at 8.—C. H. Bailey: The Reports of the Royal Commission on Mining Subsidence.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Dr. T. G. Longstaff: The Nanda Devi Problem.

INSTITUTE OF CHEMISTRY (Manchester and District Section) (at Manchester).—Prof. H. S. Raper: Some Inter-relations of Chemistry and Physiology.

TUESDAY, JANUARY 10.

INSTITUTION OF MINING ENGINEERS (Annual General Meeting) (at Geological Society), at 11 A.M.—Prof. H. Louis: Presidential Address.—Prof. H. Briggs and Prof. H. Louis: The Rhéolaveur Coal-washer in Belgium.—Dr. J. S. Haldane and Dr. R. V. Wheeler: The Use of a Lamp-room Photometer.—T. A. Southern: Life-saving in Colliery Explosions and Fires.—J. P. Rees: The Measurement of Low Air-velocities in Mines.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. N. da C. Andrade: Engines: Heat Engines which produce Cold (Juvenile Christmas Lectures) (VI.).

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Dr. L. Dudley Stamp: The Connexion between Commercial Oil Deposits and Major Structural Features, with Special Reference to Asiatic Fields.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Sir Dugald Clerk: Standards of Thermal Efficiency for Internal-Combustion Motors.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—T. R. Thomas: The Effect of Type and Disposition of Machinery on the Strength of Ships.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—A. C. Banfield: Bridges, Pictorial and Otherwise.

INSTITUTION OF ELECTRICAL ENGINEERS (*North-Western Centre*) (at Engineers' Club, Manchester), at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.15.—H. T. Harrison: The Problems of Public Lighting by Electricity.

INSTITUTE OF METALS (*North-East Coast Local Section*) (at *Armstrong* College, Newcastle-upon-Tyne), at 7.30.—G. Mortimer: Permanent Mould Casting in Aluminium Alloys.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—C. C. Swatman: Cleaning Mud Gatherings for Diatoms.—M. Burton: Deep Sea Sponges and the Beauty of their Structure.

SHEFFIELD METALLURGICAL ASSOCIATION (Annual General Meeting), at 7.30.

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN, at 8.—Sir William J. Pope: Colour Photography (Lecture).

ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Dr. W. Brown: Theories of Suggestion.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Centre) (at Broadgate Café, Coventry).—M. Platt: The View-point of the Owner Driver.

INSTITUTION OF THE RUBBER INDUSTRY (Liverpool Section) (at Common Hall, Hackins Hey, Dale Street, Liverpool).

WEDNESDAY, JANUARY 11.

ROYAL SOCIETY OF ARTS, at 3.—Prof. A. Smithells: Flame (Dr. Mann Juvenile Lectures) (II.).

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—G. M. Lees: The Geology of South-Eastern Arabia.

OVERHEAD LINES ASSOCIATION (at Institution of Electrical Engineers), at 5.30.—Major T. Rich: French Regulations.

INSTITUTION OF CIVIL ENGINEERS (Informal Meeting), at 6.—Roger T. Smith: The Effect of Acceleration and Deceleration on the Wear of Railway Track.

GLASGOW UNIVERSITY ALCHEMISTS' CLUB (jointly with E.U. Chemical Society), at 7.30.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch, Graduate Section) (at Middlesbrough), at 7.30.—G. Booth: Colliers.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Institute of Chemistry), at 8.—J. R. Nicholls: The Determination of Small Quantities of Benzoic and Cinnamic Acids, with some Notes on the Colorimetric Determination of Salicylic Acid.—The Preservatives Determination Committee of the Chemists of the Manufacturing Confectioners' Alliance, Food Manufacturers' Federation: A Rapid Method of Determining Sulphur Dioxide, and Four Additional Papers.

ROYAL SOCIETY OF MEDICINE (Laryngology, Medicine, and Odontology Sections), at 8.15.—Special Discussion on The Influence of Naso-oral Sepsis on the Lungs and Gastro-Intestinal Tract. Openers: E. D. D. Davis and C. A. S. Ridout (for Section of Laryngology); Dr. R. A. Young and Dr. T. I. Bennett (for Section of Medicine); J. G. Turner and A. Bulleid (for Section of Odontology).

CERAMIC SOCIETY (at North Staffordshire Technical College, Stoke-on-Trent).—Prof. E. L. Collis: Dust Inhalation with special reference to Silicosis.

SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section).—S. R. and E. R. Trotman and J. Brown: Action of Acids on Wool.

THURSDAY, JANUARY 12.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. W. E. H. Berwick: Soluble Sextic Equations.—J. Wishart: A Problem in Combinatorial Analysis giving the Distribution of Certain Moment Statistics.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Colour Group), at 7.—Informal Meeting.—E. A. Bierman: Colour Plate Technique, with Display of Autochromes through the Lantern.

INSTITUTE OF METALS (London Local Section) (at 83 Pall Mall), at 7.30.—Dr. G. D. Bengough: Corrosion, with Special Reference to Standard Tests (*Lecture*).

ROYAL SOCIETY OF MEDICINE (Neurology Section) (at National Hospital, Queen Square, W.C.), at 8.—Clinical Meeting.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch) (at Glasgow).—E. G. Herbert: Cutting Temperatures: Their Effect on Tools and on Materials.

INSTITUTION OF MECHANICAL ENGINEERS (Leeds Branch) (at Leeds).—L. H. Fry: Some Experimental Results from a Three-cylinder Compound Locomotive.

INSTITUTION OF MECHANICAL ENGINEERS (Cardiff Branch) (at Cardiff).—Prof. C. J. Hawkes: The Marine Oil-Engine (Thomas Lowe Gray Lecture).

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 8 St. Martin's Place, W.C.).—R. G. Daniels: Some Points in the Manufacture of Zinc Oxide.

INSTITUTION OF THE RUBBER INDUSTRY (Birmingham and District Section) (at Grand Hotel, Birmingham).—F. W. Lanchester: India-rubber as an Auxiliary to Suspension.

FRIDAY, JANUARY 13.

ROYAL ASTRONOMICAL SOCIETY, at 5.—E. A. Kreiken: Some Remarks on the Orbits of Spectroscopic Binaries.—A. T. Doodson: Application of Numerical Methods of Integration to Tidal Dynamics.—Nizamiah Observatory, Hyderabad, Occultations of Stars by the Moon, 1926 January–1927 September.—Hong Kong Observatory, Transit of Mercury observed at Hong Kong, 1927, Nov. 10.—S. Rosseland: On the Time of Relaxation of Closed Stellar Systems.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Newcastle-upon-Tyne), at 6.—J. Calderwood: Diesel-Engine Drive for Generators and other Auxiliary Machinery on Board Ship.

PHILOLOGICAL SOCIETY (at University College), at 8.—Dr. W. Perrett: Greek Music.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.—W. S. Duke-Elder: Factors controlling Intra-ocular Pressure.—M. L. Hine: Report on a Case of Neuro-fibromatosis of the Eyelid and of an Artificial Eye which burst in the Socket.—E. Wolff: A Bend in the Sixth Cranial Nerve and its Clinical Significance (Anatomical Specimen).

JUNIOR INSTITUTION OF ENGINEERS.—N. E. Jackson: Air Conditioning: A General Survey of its Uses and Application.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Chemical Society).—H. R. S. Clotworthy: The Manufacture of Artificial Silk: with special reference to Viscose.

SATURDAY, JANUARY 14.

INSTITUTION OF MECHANICAL ENGINEERS (Bristol Branch) (at Bristol).—Prof. C. J. Hawkes: The Marine Oil-Engine (Thomas Lowe Gray Lecture).

EXHIBITION.

JANUARY 10 TO 12.

ANNUAL EXHIBITION OF THE PHYSICAL SOCIETY AND THE OPTICAL SOCIETY (at Imperial College of Science and Technology), *from* 3 *to* 6 and from 7 to 10.—Discourses at 8 :—

Jan. 10.—A. Whitaker: Progress in the Recording and Reproduction of Sound.

Jan. 11.—V. E. A. Pullin: Recent Application of X-Rays.

Jan. 12.—Dr. J. W. T. Walsh: Artificial Daylight.

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SATURDAY, JANUARY 14, 1928.

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Education and Industry.

"INTELLECTUAL forces are . . . broken and unco-ordinated. Stores of rich material and reservoirs of valuable experiences have been accumulated in national and local collections, and in the professional and other scientific and commercial associations. But the channels of communication . . . are scanty. . . . Each of some 140 local education authorities provides technical education suitable to its own local needs and limited by a generous or a parsimonious financial policy. Is the total effect a patchwork or an organic whole? Wasteful or efficient? . . . how can industrial organisations . . . and local industrial experience be brought into closer co-operation with those who provide the funds and control the schools and colleges? . . . Finally, there is left the question of which Central Authority is to direct the operations of the intellectual forces. . . . Some half-dozen government departments are engaged, directly or indirectly, in the application of education and research to industrial (including agricultural) problems. But there does not appear to be any minister in any department whose duty it is to see that these departmental efforts are duly co-ordinated."

These extracts from a recently published Report [1] give some indication of the problems which faced the committee responsible for its compilation. The Report falls into three main divisions. The first, from which we have already quoted, briefly summarises the history of the wide problem of education and industry. Inevitably it recapitulates the arguments and conclusions to which other bodies, dealing with similar tasks, have been forced; arguments which are so simple that it is a matter for astonishment that they should fail to be grasped and applied. Their base has been outlined in these columns over and over again when we have urged a revision of traditional educational philosophy. It is that within a relatively brief period we have passed from a non-scientific to a scientific age. The face of industry has changed: its conditions have radically altered; and these conditions and changes have had their reflection in the ordinary national life. "Life itself has been extended," says the Report. "The engineer, the chemist, and the medical officer have broadened the basis, protected our food supply, and safeguarded the public health. The statistician and the press register daily records of the temperature, the pulse, and the blood-pressure of national existence. Science has given us a new era."

The second division assumes a particularly high value. It is a report collated by the Federation of British Industries, and may therefore be regarded

[1] Report of an Inquiry into the Relationship of Technical Education to other Forms of Education and to Industry and Commerce. Pp. 50. (A.T.T.I. Offices, 29 Gordon Square, London.) 1s.

as the industrial view of the Committee's problems. Too frequently, when efforts have been made to bridge the gap between education and industry, has the charge been made that it is the prejudiced voice of the educationist which speaks, and not the voice of those daily in practical touch with industrial and commercial activities. This division of the Report to which we now refer is, we understand, solely the work of the F.B.I., and is the result of "replies of a number of Associations and also individual opinions of manufacturers in all trades throughout the country." At least in one respect it ought to destroy the notion, still cherished in some academic circles, that industry refuses to recognise its own weaknesses, and shelters them behind loud criticism of the educational system. For, although it does not fail to criticise "the incomplete nature of elementary education" and asks for closer consideration to the question of securing suitable teachers in technical institutions (here, indeed, another popular charge against industry is upset, for "it is suggested that the emoluments are in some cases not sufficient to attract those best equipped for the training of our technical school students"), it states quite frankly that a complete expression of industrial opinion is difficult to obtain, since, "generally speaking, there has been no formulated policy regarding technical education, and in many trades it has not even been considered."

Clearly, it is difficult for busy manufacturers to prepare detailed educational schemes for their individual business, and the very sensible suggestion is therefore made that a memorandum should be prepared "*covering the main features* desired in any technical training. This memorandum, being of a national character, could then be expanded by trades in consultation with the technical authorities into comprehensive courses." Although industry may regard itself as unable to give a complete solution to the educational problems it desires to have solved, there are two outstanding points in its contribution to the Report. First, in reply to the direct question, "Do you regard technical education as essential to the conduct and development of your industry?" the replies showed "an overwhelming body of opinion as to not only the desirability, but the absolute necessity of an adequate technical education." Then comes the suggestion, which shows clearly that no mere vocational training in separate processes is confused with the term 'technical education': to be complete, it "must envisage not only the technique of production, but also the selling and distribution and the interlocking of these three aspects with costing and other statistics leading to management and administration."

The third division of the Report consists of summaries of the answers received in reply to special *questionnaires* sent to local education authorities, technical institutions, and schools of art in England and Wales. Since these summaries embody the results of thirty-eight searching questions, space precludes any attempt to deal with them at length. It is to be noted, however, that the difficulty of recruiting staffs composed either of teachers experienced in industry who understand the art of teaching, or experienced teachers with a wide knowledge of industry, presents a special problem.

While advisory committees are the usual means of linking schools and industries, employers serve on many governing bodies, but employees (as such) rarely do so. This question of a stronger link was further emphasised when information was sought as to whether technical education should be organised by local education authority areas or by industrial areas (*e.g.* cotton, heavy chemical trades, coal mining, printing, etc.). The replies included such suggestions as (*a*) a joint board of local education authorities and representatives of industry (over industrial areas); (*b*) the centralising of teaching at new faculties of modern universities; (*c*) advisory committees; (*d*) central colleges for advanced courses (costs to be apportioned over the area served); and (*e*) inter-county arrangements. Obviously, however, the value of technical colleges as places of research is *of vast importance in the further co-ordination of* education and industry, and here the Report expresses astonishment at the rarity of any relationship with research institutes. There are, of course, outstanding examples, such as the close relationship at Manchester and Bolton with the British Cotton Industry Research Association; at Bradford and Nottingham with the British Research Association for the Woollen and Worsted Industries; and at Loughborough with the Iron and Steel Institute.

Much remains to be done, however, in this direction. Outside consulting work done by colleges helps to some extent, but that there does not appear to be any general method of its organisation, and that it is subject to varying conditions and regulations in different places, is shown by the dissimilar arrangements for the allocation of fees charged to authority and teacher. But the main obstacle to research appears to lie in the conditions of the Teachers' Superannuation Acts. "The

London County Council suggests that the reaction on both staff and students, of actual contact with works problems, is of considerable importance; that the arrangements in force regarding superannuation . . . makes official recognition of research impossible." The importance of this matter is shown strikingly by the fact that, prior to present regulations, this authority had in view the adoption of a rule making the carrying out of some research work by individuals a condition of employment. Not only in London is research appreciated. A "considerable amount is conducted" at Loughborough, and the "governors are anxious to develop" it; in Leicester it is strongly "encouraged"; "every facility" is afforded in Nottingham (University College); at Bristol (Merchant Venturers) it is "encouraged in all departments"; Bradford provides "ample facilities and every encouragement"; Hull Education Authority is "considering relieving staff from teaching duties to undertake research."

In spite of the valuable information which is presented by the Report, however, it is, at first sight, disappointing in that it puts forward no definite conclusions. Certainly, in a brief paragraph the essentially liberal qualities of technical education are emphasised, but no attempt seems to have been made to sketch out the kind of new educational philosophy which must, in view of our changing and complex modern life, take the place of the older traditions. Present relationships between technical schools, secondary schools, and universities are shown rather by implication than by definite clear-cut statement, and there appears to be no suggestion as to what should be the next step. After collecting such valuable evidence, the Committee seems content to submit "that the facts set out in this Report and in the documents which accompany it, justify its appeal for taking stock of the present condition of technical education, its relationship to general education, and, above all, of the obstacles to closer co-operation with industry."

We presume that this appeal is made to the Board of Education, and we are, of course, aware that already an influential deputation, led by Lord Gainford, and consisting of representatives of education, employers, and trade unions, has already presented the Report to the President of the Board, who has promised to see the Committee again after he has read it. But if the next move lies with the President, it becomes difficult to reconcile that with industry's view that "it would appear to be of very doubtful value to press for any further Government activity in the immediate future until efforts have been made to establish the closer relationship" of technical education and industry. Clearly, the Committee has itself established unique machinery; for we do not remember when, in the educational and industrial history of Great Britain, so many powerful bodies were drawn together to attempt the solution of this imperative question. We would therefore have expected that some suggestion might have been made as to how this present machinery might have been used to reach the ends desired.

When, however, we consider the history of this movement to link education and industry, we realise that the Committee may have done wisely in avoiding the temptation to map out definite schemes. The problem is so wide and far-reaching, and already some aspects of it have been discussed by the Hadow, Malcolm, and Balfour Reports. We recall, too, that when the present Committee submitted its purpose to the President of the Board of Education more than two years ago, the latter hinted that until he had before him the findings of all the committees concerned he would not be able to give any pronouncement concerning the steps which ought to be taken to accomplish the end all of them had in mind. The Hadow and the Malcolm Committees have already presented certain definite proposals. The Balfour Committee, like the present Committee, hesitated, in the first part of its industrial survey of "Factors in Industrial and Commercial Efficiency" (see NATURE, April 9, 1927, p. 517 *et seq.*), to make any definite recommendations. Its aim was rather to assemble and analyse facts and tendencies and so to prepare the way for further intelligent study of issues which are so supremely important to national well-being. Definite recommendations from various committees are apt to be mutually cancelling.

Still, there are now four reports available for the President of the Board of Education (our own comments on the Hadow Committee appeared in NATURE of Feb. 5, 1927), and we shall await with some anxiety any official pronouncement of their effect upon future progress.

In the meantime we congratulate the Committee responsible for the Report before us, not only on the collection of its invaluable evidence, but also upon its own unique constitution. We would emphasise that that constitution includes, in addition to all types of teaching bodies and learned and professional organisations, the Federation of British Industries and the General Federation of Trade Unions. Surely here is machinery which must not be allowed to cease functioning.

The Nature of Solutions.

The Scientific Work of the late Spencer Pickering, F.R.S. By Prof. T. M. Lowry and Sir John Russell. With a Biographical Notice by Prof. A. Harden. Pp. ix + 247. (London: Harrison and Sons, Ltd., 1927.) 4*s*.

THE origin of this work is the following clause in the will of the late Mr. Pickering, who died in December 1920:

"I give to the Treasurer of the Royal Society of London, Burlington House, Piccadilly, free of duty, the sum of £1000 upon trust to procure the writing and publication in book form of an account of my work in pure science or of such part of it as may seem suitable for such treatment."

Spencer Umfreville Pickering, to use words written of Fleeming Jenkin, by R. L. Stevenson, was "a man much more remarkable than the mere bulk or merit of his work approves him." An aristocrat by birth and breeding, in appearance and manner, of very determined individuality, he was yet one of the gentlest and most sympathetic natures possible in face of the few whom he knew towards whom he was drawn. No cold recital, such as that before us, of his feats with thermometers—which were stupendous, both the thermometers and the feats—and in disputing the discontinuities in curves with the ungodly or of his freakish treatment of fruit trees can give the faintest picture of the man, of the artistry in his composition and the rare nobility of his character. You saw and felt ancestry in him. To understand him, the family history must be studied—in the autobiography which he lovingly edited, written by his mother, also but incidentally in the works of his younger sister, Mrs. W. A. Stirling, especially in "William de Morgan and his Wife" (Thornton Butterworth, Ltd., London, 1922), in part the life of their elder sister, Evelyn, an appreciated painter of most beautiful decorative pictures in the manner of the Burne Jones school, who married (1887) William de Morgan, the noted potter and novelist, son of Augustus de Morgan, professor of mathematics in University College, London. Pickering, therefore, in middle life, was associated with a highly original artistic circle; he was himself an accomplished musician and a lover of art and literature.

"Of the intellectual qualifications of the Pickerings as a race," Mrs. Stirling remarks, "it is possible to speak with an unusual degree of certainty from a remote period." "I apprehend," said Sir Isaac Heard, Garter King of Arms, writing to their grandfather, "that there is scarcely any family in England so well descended as yours and who can so well authenticate it, not merely by the pedigree but by the records of the kingdom, combining ancient nobility and royalty."

Pickering's father was a Q.C., Recorder of Pontefract, Attorney-General for the County Palatine and sometime Treasurer of the Inner Temple. At Eton, he was known by his long hair and his good looks were proverbial. He became a great friend of young William Ewart Gladstone, who for many years afterwards kept up a correspondence with him in which he expressed himself enthusiastically Tory in principle; only his change in politics, later in life, made a severance between the friends. At the Bar he was noted for his eloquence, his penetration and his sense of humour. When past forty, he married the daughter of Lady Elizabeth Spencer Stanhope. Mrs. Pickering, on her father's side, came of two families—the Spencers and the Stanhopes—who had been settled in Yorkshire since the Middle Ages—a race of fine old country squires. The story of the family has been told by Mrs. Stirling in "Coke of Norfolk and his Friends." Lady Elizabeth was a direct descendant of Thomas, Earl of Leicester, the great dilettante of the mid-eighteenth century. Thomas Coke, who on a barren part of the Norfolk coast erected a palace of Italian art and filled it with choice treasures of antiquity, was the possessor of a master mind and left the impress of genius on all with whom he dealt. His nephew and successor, the father of Lady Elizabeth, better known as 'Coke of Norfolk,' although his best energies were concentrated on agriculture and questions of practical utility, exhibited gifts which equalled those of his predecessors.

Mrs. Pickering, we are told, was a woman of exceptional intellect, whose cleverness lay in deep thought and extensive study. She early devoted herself to the development of her children's minds. Recognising how much she had suffered from the narrowing influence of governesses, at her instance, masters came and went to the house, the most efficient that money could procure. From the first, brother and sister (Pickering was three years Evelyn's junior) profited by the same instruction—learning Greek and Latin, besides French, German and Italian, classical literature and mythology, the mother inspiring in them actual love of knowledge as distinct from the drudgery of lessons. Mrs. Stirling's description of her method is most fascinating:

"In all her children, a recollection of their early years was connected with what proved to them the happiest period of each day, the hour when they

were summoned to a flower-laden room and their mother read aloud to them from some volume of absorbing interest. To her, reading aloud was a gift; she delighted in it; and her clear, musical voice ever after seemed indissolubly linked with the books which she first made them love. The range of literature thus covered was wide and comprehensive; but where the books which were available on any particular subject did not convey the exact impression she wished to produce, she herself supplied the deficiency. Thus history, she found, was apt to be written in a fashion which failed to grip the imagination of a child, so she wrote a history of England for her children of arresting interest, dwelling on the vital facts to be remembered and making the whole so graphic that it became to her small listeners a living actuality teeming with romance. Scientific books, too, she found were inevitably couched in language ill-adapted to the intelligence of her audience, so she wrote for them volumes which read like a fairy-tale: she described the wonderful prehistoric world, where Man was not but where strange beasts abounded and the dim antediluvian forests which æons of time had fashioned into coal, pieces of which were then burning in the grate of the cosy little room; she dwelt on the discoveries of astronomy, the grand riddle of the stars which looked like glittering dust strewn over the dome of heaven; the marvels of chemistry, of geology, of the practical application of many recent discoveries. She wrote fluently, without effort and with few erasures; indeed, the charm and the facility of her style hint what success in the literary world would have been hers had she not confined her talents solely to this labour of love."

What a lesson in method for mothers and teachers generally!

Pickering in his nursery days was a child who arrested attention by his beauty; his hair of bright gold fell in a luxuriant mass of long curls. Even when these were shorn later on, curls still clustered thickly over his shapely head, so that at Eton, on account of his good looks and classical features, he was known as the young Antinous. The picture given as a frontispiece to the volume, though a likeness, in no way does him justice. He entered Balliol College, Oxford, in January 1877, where he remained until the Lent term 1880. Even as a schoolboy he was devoted to chemistry and had his laboratory in the home of the family in Bryanston Square, where all his original work was done up to 1902. Several of his papers had been published in the *Journal of the Chemical Society* before he left Oxford. His chemical precocity is clearly apparent in all of these, especially in the study of the interaction of copper and sulphuric acid and of the loss of sulphur by cupric sulphide.

I learnt to know Pickering at the time of his first appearance at the Chemical Society, of which I was a secretary. We became fast friends and I was witness of and almost a partner in all his attempts to force his work and views on 'The Nature of Solutions' into notice. In this he was both determined and uncompromising—he was so sure of his work and so entirely obsessed by honesty of scientific purpose.

We are carried back to the days when the study of the properties of solutions was beginning to attract the attention of workers generally—to the summer of 1887, when the great Russian chemist, Mendeléeff, visited Great Britain and captured us all by his picturesque appearance and charm of manner. Mendeléeff was present at the British Association meeting in Manchester in 1887. He there gave an account of his views on solutions in a short paper on "The Compounds of Ethyl Alcohol with Water," in which he showed that the curve representing the change in density of solutions of alcohol in water as the concentration was varied could be resolved into several linear terms by plotting the first differential coefficient ds/dp against p. He regarded the points of intersection as *loci* of hydrates. I at once secured the paper from him for the Chemical Society and it appeared in the October number of the *Journal*. Not only so. I induced my pupil Holland Crompton, an able mathematician, to apply the method to Kohlrausch's most striking curve showing the variation in electrical conductivity of solutions of sulphuric acid and to other electrolytes. His paper was read at the December meeting of the Society and after it in the *Journal* was printed a "Note on Electrolytic Conduction and on Evidence of a Change in the Constitution of Water," in which I summarised my views on electrolytic conductivity.

Crompton found that the Kohlrausch curve was resolved only at the second differentiation. I therefore claim, following Mendeléeff, to have started the curve-hunt. Pickering at once joined in and became an enthusiastic user of the method. Having been engaged in studying the thermal behaviour of salts towards water and thereby led to the discovery of breaks which he had supposed to be due to changes in the state of hydration, he was in a highly receptive state of mind and henceforth devoted himself to intensive study of the subject. He made an extraordinarily careful and probably unsurpassable examination, particularly of the densities, of solutions of sulphuric acid and developed a method of analysing his curves with the aid of a bent lath. He came to the conclusion that the curve could be split up into a great number of intersecting elements and urged that the points

of intersection—no less than seventeen in sulphuric solutions—were indications of the formation of distinct hydrates.

There was universal disbelief in the validity of Pickering's conclusions and particularly of the method he used. Rücker, the physicist, was strongly opposed to it. When I consulted my mathematical colleague, Henrici, the authority on graphics, at the time, he gave the opinion that, if the results could be shown by independent methods to be valid, no objection could be taken to the method. Otherwise, it was not possible to pronounce for or against it. Pickering had to fight his way to publication through the by no means encouraging reports of referees chosen from outside the chemical circle and therefore credited with superior authority—but coldly aloof from chemistry, if not unsympathetic. "You can't go outside the opinion of a man like Rücker, you know," was the kind of argument used by objectors. The work was so obviously good, however, so exact and thorough, that he could not well be denied: still, the treatment he received soured his proud nature; he felt he was not being helped, that no sympathy was accorded him. Moreover, he was up against the great wave of fashion which soon set in through Ostwald's persistent advocacy of Arrhenius. No one was prepared to reason.

A so-called discussion took place at Leeds, at the British Association meeting in 1890, which, at the time, struck me as being singularly hollow, lacking both in breadth and logic. Ostwald's contentions were chemically absurd. I notice that, at the recent meeting, the president of Section B referred to Pickering and me as having been 'diehards' at the time. Seeing that we had so recently unfurled our banners, which were quite distinct—I was never an advocate of a mere hydrate theory, at least in Pickering's sense—and that Arrhenius's speculation was also of recent birth, in its accepted form younger than ours, we should have been 'die-easy's' had we lowered our flags at Teutonic challenge, seeing how entirely our antagonists avoided the chemical issue—and have so done to the present day. As Bancroft recently admitted, the function of water in solutions still has to be considered and properly evaluated. Although, forty years ago, I could picture it as having a constitution, it is still worshipped, in all the textbooks, as Aitch-too-oh!

It is not difficult to understand that Pickering should have been anxious to have judgment delivered upon his work after his death. The question is—to what extent is the attempt made to do him justice satisfactory? In my opinion it is neither adequate nor properly judicial but lacks both the breadth and critical acumen the subject demanded. Pickering, I am sure, intended and desired that the situation in general should be considered—not merely the validity of *his* work and arguments. His joy was in exact work and his desire: to establish truth.

Pickering directed in his will that *an account* of his work in *pure science* should be procured and published in book form. Instead, we have two accounts, one of his experiments at Woburn on fruit farming, which certainly was not work in *pure science*. This occupies fully one-third of the book. It is written by Sir John Russell with his accustomed skill and ability to summarise an agricultural situation. Sir John makes clear the departure Pickering made from the practice of fruit-growers, the main results of his trials and observations, the new issues raised—in a very interesting manner. We may thank him for the summary.

What Pickering had in mind and desired, I feel sure, was an extensive monograph on "The Nature of Solutions," in which proportionate notice was taken of his work and its bearings. Instead, we have a mere appreciation of the work he did and of his method of interpreting curves, together with an account of his chemical work in general in the form of brief abstracts which read as though they were prepared for the Chemical Society. A wrong note is struck, in the introduction, in the statement, "For the purpose of preparing this memoir, I have received two bound volumes of 'Scientific Papers,' etc." It was the reporter's duty to consider not merely what was put into his hands but the subject at large. Pickering asked for something much broader than a mere consideration of his scientific papers: he would not have assigned £1000 for this purpose. He was a gentleman and never sought the limelight—nor was it ever flashed upon him, so little able were we to appreciate the character of his labours and the example he gave. Even the Chemical Society took no notice of him. In science, as elsewhere to-day, the sensational counts; the value of prolonged exact inquiry is seldom recognised.

Prof. Lowry was peculiarly fitted to appraise the value of Pickering's physical studies of solutions on the practical side, as he is a most accomplished worker himself in the physical field. He does justice to his subject in this respect and finally gives *his opinion*, that Pickering was justified in his conclusions that solutions exhibit a multitude

of discontinuities but takes the view, common among us at the time the work was under discussion, that these are not to be taken each as evidence of a distinct hydrate.

Prof. Lowry leaves the great problem of the nature of solutions undiscussed—makes no attempt, in fact, to bring under notice the vast amount of work done during the past fifty years. He has nothing to say of the solvent—of water itself. He shows that he has neither imagination nor a free mind, no sense of logic. He is willing to accept any freakish new view as it comes along, such as the chess-board conclusion: that there is no bond of union between the constituents of common salt. He declares himself a syncretist by the confession (p. 32), that early in his career "he was faced with the necessity of finding for his own use a scheme which should be compatible with the two rival points of view [dissociation and hydration]. This he found in the idea that *both* views were correct, that their incompatibility was imaginary and not real, and that the hydration of the ions not only provided a way of reconciling the two theories of solution, but also supplied a motive for the electrolytic dissociation of a salt."

The fact is, *pace* Arrhenius, Ostwald and Co., we know nothing of the processes at work in solutions—it was for this reason that Pickering wished to have the subject fully discussed. We need to have all the *facts* assembled and contrasted: then perhaps we shall see a way through the maze. Actually, the facts never are considered but instead various fancy sums are worked on paper and chemical considerations are left out of account, probably physical as well. As Lodge put it in 1889, "chemists have permitted themselves to be run away with by a smattering of quasi-mathematics and an overpressing of empirical formulæ."

The physical chemist has been neither chemist nor physicist at heart. The late Prof. Bateson, I believe, always advocated the view that the production of a 'mutation' involved the loss of a factor: the mutation from chemist to physical-chemist certainly seems to have involved the loss of the primary factor in chemistry: chemical feeling. We have to recover this or chemistry will be imperilled. At least, we should be honest, consider *cons* as well as *pros*, not merely formulate conclusions without any semblance of logic behind them. It was this dogmatic tendency that my friend Pickering always strove to combat. A true analysis of his efforts has yet to be given.

Himself he fell a victim to the modern disease, physical measurement — unavoidable, doubtless, like measles, yet like this disease often followed by severe after-effects, especially loss of the imaginative faculty. He became so much the slave of subminute precaution, that chemical artistry went out of him. He so lived the life of the recluse, in his aristocratic contempt of the Little-enders, that we never recovered him to that broader service in chemistry of which he showed himself capable particularly in his first essay and in his devotion to the fruit of the soil.

HENRY E. ARMSTRONG.

Isaac Newton.

Isaac Newton, 1642–1727. A Memorial Volume edited for the Mathematical Association by W. J. Greenstreet. Pp. vii + 181 + 9 plates. (London: G. Bell and Sons, Ltd., 1927.) 10*s.* 6*d.* net.

THE genesis of this volume is explained in the preface. The Council of the Mathematical Association desired to commemorate the bicentenary of the death of Newton by a special number of the *Mathematical Gazette*. The response to the editor's appeal for contributions was generous and varied. It soon became clear that the limits of a single number would be far exceeded and that interest in the material would not be confined to members of the Association. Hence it was decided to issue it as an independent book. It has taken the form of a symposium of nineteen separate chapters. Mr. Greenstreet is indeed to be congratulated upon the distinguished names that answered his appeal.

Each contributor chose his own subject and treated it in his own fashion. The absence of a connected plan reduces any review to little more than a list of titles. In some of the chapters Newton's name is not much more than a text, and it is the preacher's own views that are heard from the pulpit, which may be more or less interesting according to one's point of view. In this class are Prof. Eddington's treatment of Absolute Rotation, and Prof. Forsyth's discussion of the Problem of Least Resistance. Perhaps Prof. H. E. Armstrong's chapter on the Forms of Carbon and Chemical Affinity should be put under the same class. Others again, though they cannot be said to contain any matter that is not already in print and quite accessible, show a deep and just appreciation of Newton's point of view, admirably presented. Newton's Work in Optics, by Prof. Whittaker, is of this kind, and Prof. Proudman on Newton's Work

on the Theory of the Tides. Rather more might be said of the Rev. J. J. Milne's article on Newton's Contribution to the Geometry of Conics, and Prof. H. Hilton's Newton on Plane Cubic Curves. The lifelong special studies of both authors make their chapters more than historical enumerations. If ever the often desiderated general editor of Newton should appear, he will be very grateful for such articles.

There are several others, indeed, that he will not afford to put by. Mr. D. C. Fraser on Newton and Interpolation is a direct contribution from the author's researches in the Newton MSS. at Trinity College. Mr. J. M. Child on Newton and the Art of Discovery, though not quite of the same class, is truly illuminating as to the kind of tentative construction through which Newton gradually made his way to the binomial theorem and other discoveries. It shows how often the greatest minds climb upwards step by step, rather than leap. Plagiarism in the Seventeenth Century, and Leibniz, provides Prof. L. J. Russell with an interesting theme. Prof. A. E. Heath on Newton's Influence on Method in the Physical Sciences, and Prof. E. A. Bartt on the Contemporary Significance of Newton's Metaphysic, are contributions on the philosophical side. Mr. J. A. Holden, treating of Newton and his Homeland, gives some interesting particulars, but repeats uncritically many exploded fables. Prof. G. N. Watson gives an account of Trinity College in the Time of Newton, but curiously omits to mention his laboratory. Mr. H. Zeitlinger gives an interesting conspectus of the Bibliography of Newton's writings, containing much that would not be easy to find elsewhere. The late Dr. J. L. E. Dreyer was overtaken by his last illness before he was able to complete a promised contribution to the volume, but is represented by some letters he collated from Corpus Christi College, Oxford.

To complete the list of contributions, Prof. D. Eugene Smith contributes three chapters, the first containing Two Unpublished Documents of Sir Isaac Newton, and the second and third on Portraits and Portrait Medals. All three are valuable. But we cannot agree with the pride of place he awards to the portrait by Gandy which is reproduced as a frontispiece. There is one truthful portrait of Newton at least—the death mask, faithfully rendered in Roubiliac's statue. It shows that Newton, like many men of genius, had a receding forehead, with rather blunt features of extreme decision. Gandy has followed the usual convention of a dome-like brow and has given the face delicate features and a general neurasthenic air.

The volume concludes, for no particular reason, with a Latin composition "supposed by the Rev. and learned Dr. Francis Lockier, Dean of Peterborough; reduced into an epitaph by the Sec. of the Gentleman's Society at Spalding," which is in the usual eighteenth century style of such compositions, with its pointless adulation and its long lines and its short lines extending almost *ad infinitum*.

It cannot be said the volume is adequate to the occasion, but what volume would have been? It is an interesting book, for the most part very readable and containing quite a proportion of matter that is either new or well worthy of recall.

European Echinoderms.

(1) *Handbook of the Echinoderms of the British Isles.* By Dr. Th. Mortensen. Pp. ix + 471. (London: Oxford University Press, 1927.) 38*s.* net.

(2) *Les échinodermes des mers d'Europe.* Par Prof. R. Koehler. (Encyclopédie scientifique: Bibliothèque de Zoologie.) Tome 2. Pp. ii + 339 + 9 planches. (Paris: Gaston Doin et Cie, 1927.) 35 francs.

WITH the completion of Prof. Koehler's account of the echinoderms from European seas, and with Dr. Mortensen's English work on those from British seas, the European, and particularly the British, student is fully provided, so long as he takes both books. Dr. Mortensen nowhere precisely defines what he means by British seas, but since he includes the greatest depths, and since, as Prof. Koehler points out, forms found at those depths generally prove to have a relatively wide distribution, therefore, on the probable chance that the British list may be greatly extended, he has comprised in his account the whole of the echinoderm fauna known from the north-east Atlantic. In this respect Dr. Mortensen is more comprehensive than Dr. Koehler; thus, among crinoids he describes the deep-sea forms *Democrinus parfaiti*, *Ilycrinus carpenteri*, *Monachocrinus* 3 spp., *Atelecrinus helgæ*, *Pentametrocrinus atlanticus*, *Trichometra delicata*, and *Orthometra hibernica*; some of these are mentioned, but none described, by Dr. Koehler.

The other classes show the same difference of treatment by the two authors. On the other hand, Prof. Koehler describes twenty-seven species confined to the Mediterranean, many of which are not mentioned by Dr. Mortensen. Eight species marked

by Koehler as special to the Mediterranean do, however, find place in Mortensen's book as Atlantic forms. There are also eleven Arctic species described by Koehler, but not mentioned by Mortensen. It follows that, for a complete account of the European echinoderm fauna in the widest sense, both books are needed.

(1) Dr. Mortensen's "Handbook" is on the same lines as his "Pighude" in "Danmark's Fauna," reviewed in NATURE, Nov. 22, 1924, but naturally includes more species. The tonic accent on the Latin names, which we approved, was apparently beneath the dignity of the Oxford University Press. On the other hand, the index is said to give the English and popular names, but we do not find such obvious examples as 'rosy feather-star,' 'cushion-star,' 'cross-fish,' and 'piper,' not to mention many that might have been taken from Forbes's "British Starfishes." Dr. Mortensen does not seem so familiar with that classical work as one would expect: in referring to a famous passage he gives it on the authority of G. H. Lewes. Forbes used the word 'star-fishes' in a very wide sense, and there is something to be said for Dr. Mortensen's use of 'sea-stars' to denote the 'true star-fishes' as Forbes called them.

In his classification of the Asteroidea, Dr. Mortensen advances a step beyond his Danish book, now giving three orders: Phanerozonia, Spinulosa, and Forcipulata. For the Ophiuroidea he does not see his way to use any of the new classifications, and the orders of Echinoidea also remain as before. Among Holothurioidea the main change is the transference of the Synallactidæ from the Elasipoda to the Aspidochirota. The diagnoses throughout are restricted to those characters necessary when only species from the north-east Atlantic are considered. Special attention is paid to larval forms, parasites, and other ecological features. It seems a pity that a book so admirably adapted to the needs of the working zoologist and the serious amateur should have been produced in a style more suited to the shelf of a reference library than to the pocket or the cabin work-table: it weighs 2 lb. 6 oz.

(2) Prof. Koehler's two volumes (the first was reviewed in NATURE of May 23, 1925) weigh together only 1 lb. 9½ oz., and each will go comfortably into a side-pocket. The whole work costs less than a quarter the price demanded for the English book. The present volume contains the sea-urchins, crinoids, and holothurians. With the last class Dr. Koehler has an intimate acquaintance, and his discussion of some involved questions of specific identity is very detailed. A distinctive feature of this volume is the chapter on geographical distribution and the lists of species according to the following regions: littoral Arctic, abyssal Arctic, littoral Boreal, littoral Lusitanian, abyssal Boreal and Lusitanian, Mediterranean. Still, however, we miss from both books any comparison of the fauna with that in other regions.

F. A. BATHER.

Our Bookshelf.

Root Development of Vegetable Crops. By Prof. John E. Weaver and William E. Bruner. (McGraw-Hill Publications in the Agricultural and Botanical Sciences.) Pp. xiii + 251. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1927.) 20*s.* net.

CONSTANT endeavours to improve crop growth have led to the accumulation of a mass of information concerning the aerial parts of plants and the factors influencing their development. Our knowledge of the underground parts, whether roots or stems, has not increased at the same rate, largely owing to the mechanical problems which render investigation difficult and laborious. This is the more to be regretted, in that the environment of the root can to a large extent be controlled by cultivation and manuring, thus giving scope for the direct amelioration of growth conditions, whereas climatic and light factors, which directly affect the aerial parts, are beyond control by human agency.

Prof. Weaver and his colleagues have already done much to extend our knowledge of the roots of field crops, and in the present volume they continue the investigation into the root system of vegetable crops, thus benefiting the gardener or small grower as well as the farmer. Typical root systems of the more important vegetable crops are described at various stages of growth, and scattered information from various sources is correlated with the results obtained.

The book is rendered more valuable to the practical man by the discussion of root development in relation to cultural practice, in which the advantages and disadvantages of the different soils, methods of cultivation and manuring are considered in relation to individual crops. Knowledge of root systems should enable the grower to combine his various crops to the best advantage, in order that the soil may be adequately filled with roots, drawing evenly on the available plant food, without undue competition in any one place combined with untapped areas elsewhere on the field. The many illustrations are from drawings made *in situ* as the roots were excavated, and the surprising extent of the root systems, even of such a small crop plant as the common radish, gives food for much thought to all, from the amateur gardener to the scientific plant physiologist.

The Theory of Integration. By L. C. Young. (Cambridge Tracts in Mathematics and Mathematical Physics, No. 21.) Pp. viii + 53. (Cambridge: At the University Press, 1927.) 5*s.* net.

THE integral calculus was founded two thousand years ago by the Greeks, who applied it with much success to the determination of areas and volumes. Its first appeal to the mathematical world was that of a new and powerful instrument of calculation. When interest was re-aroused in science after the Middle Ages, the infinitesmal calculus developed rapidly under the stimulus of new symbolism, progress being mainly in manipulation until the end of the eighteenth century. Up to then there was little advance on the rigour of the ancients, which, though possibly misplaced, was very severe. There followed a period of criticism, initiated by Cauchy's theory of limits, when the logical ideas at the foundation of the subject were examined. It was found that many of the results obtained by the methods of the calculus would not stand the scrutiny of the new analysis. Such ideas as the treatment of infinite series by the processes of finite algebra were found to need revision.

A still more refined outlook on functions of a real variable was introduced by Cantor in his theory of sets of points. This has been made the foundation of the modern theory of integration by Lebesgue, W. H. Young, and Hobson. In the tract before us, Mr. Young gives a successful exposition of this branch of his father's work in a style that shows much of the vigour and freshness of youth. Although the author stresses the fact that he assumes a minimum of mathematical knowledge, many readers will find the logical sequence of ideas embodied in the tract to be hard reading. Integration is here treated as a subject in itself, apart from differentiation, and the usual fundamental theorem of integral calculus is not mentioned. The complete absence of algebraic manipulation and of even the best-known integrals must be accepted as a tendency of an extensive branch of present-day mathematics, but will appear to some readers as novel. Still, the fact that it is possible to develop a theory of integration on these lines is a striking testimony to the power of the modern treatment. W. E. H. B.

The Performance and Design of Direct Current Machines. By Dr. Albert E. Clayton. (Engineering Degree Series.) Pp. xi + 418. (London: Sir Isaac Pitman and Sons, Ltd., 1927.) 16*s.* net.

A VERY large number of books have been published on the design of electrical machinery. Most of these contain formulæ which are not much greater help to the designer than rule-of-thumb methods. To give accurate formulæ is impossible, as the reluctance of the magnetic circuit is in general a variable quantity, and the permeability of iron is also variable. The magnetic flux produced by a current is only proportional to the current when the magnetic field has constant permeability, and this assumption can only be made by assuming that the dynamo is built without iron. To assume also that the end connexions of an armature coil have constant 'inductance' is scarcely justifiable. Notwithstanding these assumptions and many similar ones, designers do find formulæ a real help. They are kept on the right lines by comparing their theoretical calculations with the results obtained by experiment. For a particular make of machine, they are soon able to predict the performance with quite satisfactory accuracy.

Dr. Clayton's book is intended for use primarily by students in universities and technical colleges. The reader is supposed to have an elementary knowledge of electrical engineering principles. A balance has been struck between the requirements of a practical designer and the requirements of a student looking forward to an academic examination. For the latter, the numerous examples given at the end of the book, many of which are taken from the University of London papers, will be found very helpful.

The Neurotic Personality. By Dr. R. G. Gordon. (International Library of Psychology, Philosophy and Scientific Method.) Pp. x + 300. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1927.) 10*s.* 6*d.* net.

DR. GORDON has presented us with a most excellent book, in which he pleads strongly for a rational viewpoint towards the psychoneuroses. He refers frequently to emergent evolution which forms the basis of his previous book on personality. He gives us a very sound review of the Freudian, Adlerian, and Jungian attitudes towards the neurotic personality, and stresses particularly the need for the study of each case entirely on its merits and its treatment without any preconceived notions, using both pure medicine and psychotherapy; in other words, the application of calm common sense.

The author's opinion that the neurotic never becomes insane will not meet with universal approval. At the same time, he qualifies his opinion by stating that many early cases of insanity are difficult to differentiate from neurosis; in other words, if an apparent neurosis develops into insanity, it was obviously not a neurosis.

Winterstein's Die Alkaloide: eine Monographie der natürlichen Basen. Zweite neu bearbeitete Auflage von Dr. Georg Trier. Erster Teil. Pp. 356. (Berlin: Gebrüder Borntraeger, 1927.) 18 gold marks.

THE first part of the new edition of this standard work on the alkaloids is devoted entirely to a treatment of various classes of bases the constitutions of which have in most instances been settled ("die chemisch näher bekannten Basen"). The sectional headings are (1) aliphatic bases (including amino-acids), (2) aromatic and fatty-aromatic bases, (3) amides, (4) urea derivatives (including the purines), (5) heterocyclic bases of the pyrrole-pyridine group (including coniine, pelletierine, atropine, cocaine, and nicotine). There is a historical introduction of 34 pages, but no title-page, summary of contents, or index is supplied at this stage in the publication.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Transmission of Sonic and Ultrasonic Waves through Partitions.

IN other places I have pointed out that recently devised methods of experiment with ultrasonic waves offer possibilities for a more complete experimental solution of certain acoustic problems than can conveniently be carried out with low or ordinary pitched sounds. A case in point is the reflection from and transmission through material partitions of acoustic waves.

The late Lord Rayleigh, following the classical methods of Green, offered a mathematical treatment of the problem of reflection of longitudinal waves and their transmission through partitions; but the theory until recently had never been tested directly by any experiment. The theory is exact enough for practical purposes, and is analogous to the optical problem of the passage of light waves through a parallel-sided transparent plate. On applying the appropriate boundary conditions in the acoustic problem, it can be deduced that when a train of plane longitudinal waves impinge at perpendicular incidence on a parallel-sided, infinite partition, of homogeneous material, obstructing the waves in a medium, the ratio (r) of reflected to incident energies is given by

$$r = \frac{\left(\dfrac{V\rho}{V_1\rho_1} - \dfrac{V_1\rho_1}{V\rho}\right)^2}{4\cot^2 2\pi\dfrac{d}{\lambda_1} + \left(\dfrac{V\rho}{V_1\rho_1} + \dfrac{V_1\rho_1}{V\rho}\right)^2}.$$

Here ρ and ρ_1 stand for densities, and V and V_1 for velocities in the medium and partition respectively. Thickness of partition is d, λ_1 is the wave-length in its material. It follows that when $V\rho = V_1\rho_1$, or what amounts to the same thing, if $\rho\lambda = \rho_1\lambda_1$, λ being the wave-length in the incident medium, r is zero; or in the words of a convenient rule, remembered by a few experimenters, "when the *mass of a wave-length* in incident and reflecting media is the same, reflection is nil and transmission is perfect." Given a solid and large enough plate of any material as reflector, the relation above indicates that the proportion of energy reflected depends on the thickness of the reflector. It is quite possible for a thin plate to cut off more energy than a thicker one, or a thick plate to let through more energy than a thinner one. For if d above equals $n\frac{\lambda_1}{2}$, where $n = 0, 1, 2, 3$, etc., corresponding thicknesses of plate will be integral numbers of half wave-lengths, in which cases the reflection will be minimum and transmission maximum; if $d = (2n+1)\frac{\lambda_1}{4}$ . . ., corresponding thicknesses will be integral odd numbers of quarter wave-lengths and reflection will be *maximum* and *transmission minimum*. There is nothing in the theory to prevent its validity at any frequency high or low, but it must be noticed that all considerations of energy dissipation, *i.e.* absorption, within the partition are neglected.

When due precautions are taken, probably the most convenient and accurate method of measuring ultrasonic energy is by the torsion pendulum, the method having been adapted first by Langevin. Types of pendulums and mountings as used by me have been described in *Trans. Roy. Soc. Can.*, **19**, 179; 1925. The vane of a torsion pendulum placed in the track of an ultrasonic beam is itself a small plate reflector of the waves; in consequence its readings should depend on the thickness of the vane, and the pendulum itself may be made to yield information concerning the reflection.

In a short paper (*Trans. Roy. Soc. Can.*, **21**, 115; 1927), describing preliminary experiments carried out some years ago by Mr. J. F. Lehmann and myself, it was shown, by using ultrasonic waves of frequency 135,000 cycles per second travelling in water and striking lead pendulums, that the reflection from the lead was a maximum and transmission a minimum at a thickness of vane about a quarter wave-length; and *reflection was a minimum and transmission a maximum* at a thickness of half a wave-length. Later, many other experiments of this kind, in which different materials and different frequencies were employed, were carried out by Mr. D. K. Froman and me, with results all similar to the original ones. Recently Mr. D. O. Sproule and I performed a series of *direct* experiments on the same problem, in which the energy transmitted through a metallic plate, intercepting at right angles the path of an ultrasonic beam in water, was measured with a torsion pendulum placed in the 'ultrasonic shadow' behind the plate. The particular frequencies employed were 300,000 and 528,000 cycles per second. Arresting facts like the following were observed. With a frequency of 300,000 cycles per second, a 2 mm. plate of type-metal, which was the obstructing material used in those experiments, could block off completely the ultrasonic beam, while a plate two or four or six times this thickness allowed the larger part of the energy to emerge through it. It was quite clear that, at plate thicknesses of an odd number of quarter wave-lengths, reflection was maximum and transmission minimum, while at thicknesses of a small integral number of half wave-lengths the reverse was the case and nearly all the incident energy got through.

One significant condition prevails in all this work—the velocities as deduced from plate thicknesses work out very appreciably higher than that calculated from Young's modulus and the density. The reasons for this result will later be explained elsewhere. Papers on the experiments referred to are being prepared.

The theory outlined by Rayleigh is straightforward, since analogous theories are accepted for other and all types of vibratory motion. In the case of acoustic waves the half wave-length is the thickness requisite for a *resonant* longitudinal vibration of the reflecting partition. We can imagine a partition or plate of this thickness picking up the incident energy, setting itself in resonant vibration, and handing on the energy through the medium on the other side. At a quarter wave-length thickness the plate, so far as concerns its own vibration, is most inert, offers the most impedance to the impinging waves, and reflects them back.

Considerations of resonance would apply also to partitions which shut off waves of ordinary sound, if the practical conditions usually holding were appropriate. No doubt they do apply in a few rare cases, for example, where the partition can execute 'drum-like' vibration or vibrate flexurally. It may be recalled that Watson (*University of Illinois Bulletin*, **19**, 127) once reported a very interesting and apparently strange experimental result. He blocked up the doorway of a room containing a source of sound with cork boards and on the outside measured the sound energy which got through. He found that a thickness of 1½ in. of the cork reflected less and transmitted more sound than did either ¾ or 2¼ in. On trying obstructions of *paper-lined* hair-felt he

obtained a similar result. It is likely that some condition of resonance of the partition explains the fact of minimum reflection and maximum transmission at the intermediate thickness.

In materials generally used for sound absorption, such as hair-felt, the sound is transmitted mostly through pores; but the late W. C. Sabine, on finding that the absorbing power of some felts was *a maximum for certain frequencies*, thought it possible that the felt absorbed partly by the dissipation of the waves in its pores and partly by the yielding of its mass as a whole. In an interesting paper on the transmission of sound through hair-felt by Davis and Littler (*Phil. Mag.*, **3**, 177; 1927) the thickness-transmission ratio curves showed not much sign of curvature to indicate any condition of partition resonance at the frequencies used in the experiments; but the authors point out that such is the result only for porous material, and that probably the case would be different with partitions transmitting "an appreciable fraction of the incident sound by diaphragm-like vibration."

R. W. BOYLE.

University of Alberta,
Nov. 21.

The Evidence for Hybrid Vigour in Insects.

IN several reports on the introduction of *Aphelinus mali* into New Zealand and its colonisation, Dr. R. J. Tillyard has stated that by crossing three different strains from America he has produced a more vigorous strain which is now established over the greater part of New Zealand. To quote from one of his articles— "The story of how the three strains of *Aphelinus* were crossed, producing the very vigorous strain which is now being distributed all over New Zealand, is too long to tell in detail here, but the main points may be mentioned."

This aspect of applied ecology or biological control is of great importance to entomologists, and therefore it is necessary to examine the evidence upon which this statement is founded.

Turning to Dr. Tillyard's reports, we find that he received six boxes of parasitised aphis from America, two from Washington State, two from Connecticut, and two from Arkansas. These three consignments were placed together in one breeding box and eighteen specimens hatched. By his own account only five specimens, two females and three males, which hatched out between Feb. 6 and Feb. 15, formed the parents of all his future colonies used in establishing the insect in New Zealand, where they have multiplied and spread and been of great benefit to the country.

The fact that insects are collected from three places, although considerable distances from one another, does not carry with it the fact that they are distinct strains. It is necessary to show some slight biological difference between them. As all the material received was placed in the same breeding box, it is impossible to say whether the eighteen specimens hatched from only the material from one or from two or from all three localities. It is quite possible that they hatched from material from the same locality, and even that they represent one family, being brothers and sisters. Any superiority that might be observed might then be due to an unconscious selection of a superior genetic mutation.

Is there any superiority in the present New Zealand strain, or is their flourishing condition only due to the same factors as caused their host (the woolly aphis) to flourish, namely, congenial climatic conditions, abundance of food, and absence of enemies? Judging by our work in the Hawaiian Islands, I should say that it was so. The idea which underlies this subject is hybrid vigour, and it would be of importance to establish by proper experiments how far this applies to insects. The evidence we have in Hawaii is more in the negative than in the affirmative. In the case of certain Coccinellidæ, inbreeding in captivity has led to reduced fertility, but here we are not quite sure how much of this is due to inbreeding and how much to the conditions of confinement. In a number of cases a small colony has been received from one locality and the insect established in the islands; after many years (some more than twenty) they are as vigorous as ever and show no signs of failing. In certain cases of small parasitic Hymenoptera the insect has carried on generation after generation parthenogenetically, only one or two males ever having been seen out of many hundreds of thousands of individuals. Our examples are not confined to Hymenoptera, but include Diptera, Coleoptera, and Neuroptera.

Most insects that become established in a new country and become a pest are introduced as small colonies from one locality, and in most cases are only introduced once, so that there must be a great amount of inbreeding in a few years. Unfortunately they show no lack of vigour.

The question of hybrid vigour in insects therefore stands in an uncertain condition, and any statement must therefore be supported by evidence for the species in question; no general conclusion can be laid down. In the case in point the necessary evidence is lacking.

While it may be a good policy to get several consignments from different localities when trying to introduce and establish an insect, this is not often possible. Also, the dangers which cannot be entirely eliminated when bringing in a colony are thereby increased. For the latter reason we have always tried to establish our introductions in Hawaii from a single small colony which can be handled more easily. Unfortunately this cannot always be done.

F. MUIR.

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Honolulu, T.H.

The Radiation from Explosions of Carbon Monoxide and Oxygen to which Hydrogen has been added.

THE speed of explosion of mixtures of carbon monoxide and oxygen is accelerated by the addition of water or substances containing hydrogen, as was shown by Dixon. The acceleration of the speed is invariably accompanied by a reduction in the emission of radiant energy and vice versa (Garner and Johnson, *Phil. Mag.*, **3**, 97; 1927). The radiant energy emitted from these explosions consists mainly of two bands with maxima at $2 \cdot 8\mu$ and $4 \cdot 4\mu$, which are the emission and absorption bands of carbon dioxide. The emitters of this radiation are the molecules of carbon dioxide which have been set in vibration and rotation by the chemical energy liberated during the explosion.

Experiments by Johnson (unpublished) have shown that about 10 per cent. of the total chemical energy of the explosion is emitted as radiation when a mixture of dry carbon monoxide and oxygen is exploded in a long cylindrical bomb 1 inch in diameter. This is reduced to 2·5 per cent. when 1·9 per cent. of water is present. Since the flame of the moist gases is hotter than that of the dry gases, the radiation cannot be entirely black body. At least 7 per cent. of the chemical energy of the dry gases is emitted as chemiluminescence.

Further experiments on dry explosive mixtures to which varying percentages of hydrogen are added, have thrown light on the nature of the effect. The

results are shown in the accompanying diagram (Fig. 1). The currents generated in a thermopile when the radiation from an explosion falls on it, are given as ordinates and the percentage H_2 as abscissæ. The radiation falls very sharply on the addition of 0·07 per cent. H_2, and is still falling slowly when 2 per cent. of this gas is present.

The hydrogen was introduced into an equimolecular mixture of carbon monoxide and oxygen as electrolytic gas.

Since hydrogen has no absorption bands between 2μ and 6μ, it is clear that the reduction of radiation is

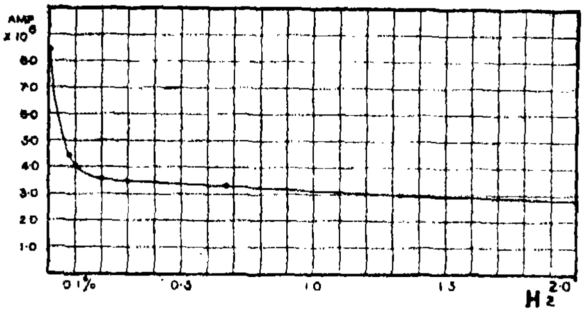

FIG. 1.

not due to absorption in front of the explosion wave. It is also unlikely that the reduction is due to the absorption by water vapour formed in the wave front, for the relation $\log R'/R_0 = kx$ does not apply. (R' is the radiation emitted in the presence of x per cent. of hydrogen, and R_0 is the radiation from the dry gases.)

When the form of the curve is known with greater exactitude, it should be possible to elucidate the nature of the mechanism by which this reduction is brought about, whether it be due to collisions of H_2O, H_2, or H, with the activated molecules of carbon dioxide, or to some other cause.

W. E. GARNER.
F. ROFFEY.
Department of Physical Chemistry,
The University,
Bristol.

Subsidiary Rectangles as applied to the Formation of Magic Squares.

WITH non-consecutive numbers it is possible to make an 'associated' rectangle 8 × 3. It is not possible to do so out of the first 24 consecutive numbers. In using this 'associated' rectangle 8 × 3 to form a magic square also 'associated,' and 'pandiagonal' with subsidiary rectangles 8 × 3, it is further necessary that the 3 diagonals one way should also sum to the same amount as the rows. This is so in the following rectangle, where the rows and the diagonals from left to right sum each to 120 and the columns each to 45.

1	23	19	24	22	9	20	2
16	12	5	13	17	25	18	14
28	10	21	8	6	11	7	29

By means of this rectangle two formative rectangles can be made according to De la Hire's method, one 24 × 3 for the index numbers with 7 replicas, and one for the radix numbers 4 × 24 with 5 replicas. The resultant magic square will be both pandiagonal and associated with 24 subsidiary rectangles 8 × 3, each of whose 3 long rows will sum to 3480 and each of whose 8 short columns will sum to 1305. The 24 rows, 24 columns, and 48 diagonals of the square will sum to 10,440. The intervals for the radix numbers I have taken at 30 instead of 29 for ease of calculation.

The above is the smallest rectangle that can be constructed, consisting of 3 rows, that will give this dual requirement, namely, to be associated, and for the diagonals one way to sum to the same amount as the rows; 4 × 3, 5 × 3, 6 × 3, and 7 × 3 are unable to provide such rectangles without repeating some numbers. This can be proved by algebra.

In the case of 6 × 3, however, the requirement is not necessary, as squares can be formed in other ways. I give the following examples to demonstrate this:

4 × 3

7	8	14	3
4	14	2	12
13	2	8	9

32 × 24

5 × 3

5	9	14	11	1
4	10	8	6	12
15	5	2	7	11

40 × 24

24	29	14	12	11
5	1	18	35	31
25	24	22	7	12

90 × 54

6 × 3

79	30	5	32	19	75
36	29	67	13	51	44
5	61	48	75	50	1

240 × 120

7 × 3

14	10	33	30	26	12	1
5	20	11	18	25	16	31
35	24	10	6	3	26	22

126 × 54

These rectangles are all associated and have their diagonals from left to right summing to the same amount as the rows, but they all repeat numbers in certain places. If in these places numbers are repeated they are not difficult to construct.

With rectangles with 4 rows the necessity for the diagonals one way summing to the same amount as the rows does not arise, but rectangles 6 × 4 for order 24 are not the smallest that will produce associated squares with subsidiary rectangles 6 × 4. Order 20 can comply with subsidiary rectangles 5 × 4, the whole square being pandiagonal and associated. But order 24 can be composed of 24 rectangles 6 × 4, each one of which is associated and the whole square pandiagonal. This is impossible with subsidiary rectangles 8 × 3 in order 24 or with subsidiary rectangles 5 × 4 in order 20.

J. C. BURNETT.
Barkston, near Grantham, Lincs.,
Dec. 20.

The Palæolithic Implements of Sligo.

I THINK that Prof. Macalister and his colleagues have quite fairly stated their opinion (NATURE, Dec. 31, 1927) upon the geological aspect of the sites examined by Mr. Burchell in Sligo. So far as I am concerned, I do not feel entitled to discuss or argue upon the details of this aspect of the matter, for the reason that—as I made clear in my original note in NATURE—I have not yet visited the sites in dispute. I have, however, had abundant opportunities for making an examination of the specimens collected by Mr. Burchell, and of subjecting them to a prolonged and careful examination; and I entertain no doubt whatever that these specimens are humanly flaked, and that their forms and method of flaking are such as were in vogue in Early Mousterian-palæolithic times. Further, I am of opinion that no natural force—or combination of natural forces capable of flaking stone—such as fortuitous pressure, percussion, or thermal action, could in any circumstances produce these forms. This is my sincere belief, and it is because I possess it that I consider it my duty to support Mr. Burchell in this matter.

In these discussions I am always prepared, and perhaps prefer, to stand unaided, and I do not wish, or feel it to be necessary, to call others to my support in this instance. But in the interests of scientific truth it is needful again to direct attention to the fact that every well-known and competent archæologist to whom the Sligo specimens have been shown has, without exception, or any hesitation, accepted them as the work of man. I cannot doubt but that if Prof. Macalister and his colleagues examined these specimens they would also agree with this conclusion. It is because I am convinced that the Sligo material is of human origin I am compelled to conclude that the geological views of Prof. Macalister and his colleagues regarding the Rosses Point site are incorrect. The specimens, too, found by Mr. Burchell embedded deep in Boulder Clay at Ballyconnell, though, I admit, not so conclusively of human agency as those from the other sites, are, I believe, nevertheless artificial, and exhibit the same technique as those discovered at Rosses Point and elsewhere.

J. REID MOIR.

One House, Ipswich.

Sun Images through Window Glass.

SUNLIGHT comes in through an east window and falls upon the whitened wall of a room; a blind is drawn so as to stop the sunlight except for two vertical strips about two inches wide. The two strips of light seen on the wall are not of even illumination, but consist of a series of distorted images of the sun overlapping each other throughout the whole length of the strips. A 'control' to the observation is made by pulling the window down at the top; the overlapping images are not seen now; this is shown in part A of the photograph, which is separated by the horizontal framework of the window from the part B, in which are the 'through the window' images.

FIG. 1.

The glass is evidently responsible for the effect, though to the naked eye or touch, there is nothing unusual about it.

Perhaps some readers of NATURE would suggest an explanation of the observation.

S. RUSS.

Little Hawkwell, Pembury, Kent, Nov. 25.

Red Sensitive Photoelectric Cells.

WE have found that it is possible to make photoelectric cells of the Elster-Geitel type sensitive to the extreme red, and having a colour sensitivity approaching that of the eye much more nearly than those used at present. The new cells have a limit above $700\mu\mu$ and a very useful sensitivity at $650\mu\mu$; their sensitivity extends also to the violet limit of the visible spectrum, and their total sensitivity to white light is of the same order as that of existing cells.

These cells are not yet marketed in the ordinary way, but we could make a limited number of them available to those who have serious use for them. Inquiries should be addressed here.

Though our process for making these cells works consistently, we do not profess yet to understand it completely. If we described it, we might insist on unessential rather than essential details; and accordingly prefer to postpone a description until our investigations have progressed further.

C. C. PATERSON.
(Director.)

Research Laboratories of the General Electric Company, Ltd., Wembley.
Dec. 5.

The 'Green Flash.'

IF in my letter in NATURE of Dec. 3, I am understood to have suggested that the green flash seen at sunset had no cause other than a physiological one, I withdraw any implied or hinted suggestion in that direction; for it is evident that a great weight of authority is in favour of a physical cause. My letter, indeed, admitted the likelihood of greenish atmospheric effects; but I wished to contribute a simple fact of observation, which suggested to me—and still suggests—that a suddenly disappearing light may stimulate a momentary green sensation in some persons, even when atmospheric and other conditions for actual colour are absent.

It was, I admit, rather hasty to send a letter on so small a point; but readers of NATURE may be glad of the consequent reiterated assurances of high meteorological authorities in the issue of Dec. 17 that the solar occurrence of the phenomenon is objective.

OLIVER LODGE.

Normanton House,
Lake, Salisbury,
Jan. 3.

The Two Calories.

MUCH confusion is caused by the use of the word calorie in two different senses—one to signify the amount of heat required to raise the temperature of one gram of water 1° C., and the other to represent what is really a kilocalorie, or the amount of heat required to raise 1000 grams of water 1° C. The only difference between the means of distinguishing the two units is that the large Calorie is spelt with a capital initial letter, and unless great care is taken this may be set up as a 'lower case' letter by the compositor. May I suggest that the confusion could be avoided—at least so far as the printed word is concerned—by spelling the large unit with a capital letter K, thus, 'Kalorie.' The use of the letter 'k' in this way is in conformity with the principle adopted in the designation of metric units generally.

PERCY L. MARKS.

10 Matheson Road,
London, W.14.

Marsh Gas from Plants.

IN Black's "Lectures on the Elements of Chemistry," published in 1803, there occurs the footnote in reference to marsh gas (spoken of by Black as 'inflammable air'): "The *Dictamnus Fraxinella* emits it from its flowers in such abundance in a calm evening, that it may be set on fire by a candle, nay, take fire of itself."

I shall be very glad if any readers of NATURE can give me information which will enable me to trace this statement to its source, or any information whatever on the point.

ALEX. FINDLAY.

The University,
Aberdeen.

Natural Steam Power Developments at Larderello.

THE problem of utilising the earth's internal heat is no new one, but the general attention of scientific workers and of technologists has been directed to this most interesting topic in a more special manner during these last few years, since a practical application of geothermal energy has been successfully achieved at the Boracic Works of Larderello, in the neighbourhood of Larderello, in Tuscany. This plant, which was originated and brought to its present satisfactory state of development by Prince Piero Ginori Conti, was briefly described in NATURE of Jan. 12, 1924. A few additional details as to further results obtained will doubtless be welcomed by many readers of this journal.

The fumaroles of Tuscany, better known under the local denomination of *soffioni*, are a notable example of the only form of volcanic activity which is suitable for exploitation, active volcanoes being evidently quite out of the question—at least so far as our present means are concerned. It has been proposed to sink tubes into the hot soil surrounding certain volcanoes, but such schemes do not appear to be practical, as experience has proved that heat transmission, even from incandescent lava, is exceptionally poor, so that enormous heating surfaces would be required to obtain a sufficient quantity of heat to be worth utilising. This observation applies to schemes depending on the utilisation of the geothermal gradient, as by sinking wells to considerable depths in order to reach high temperatures.

Natural steam springs, or fumaroles, are therefore, at the present stage of our experience, the only efficient source of natural heat supply. Very interesting discussions have arisen as to the origin of natural steam such as occurs in California, Oregon, Chile, New Zealand, Java, and Tuscany, where steam springs or fumaroles appear to be a phenomenon allied to vulcanism, but not entailing the immediate neighbourhood of a volcano. Thus, for example, the Tuscan *soffioni* appear to be connected with the trachitic eruptions which took place in central Italy in the latter part of the Tertiary Period, but the traces of these eruptions are found at considerable distances from the spots where the fumaroles are situated. These fumaroles differ, therefore, from those which abound near Vesuvius, Etna, and several other active or quiescent volcanoes, notable among others being those of the "Valley of Ten Thousand Smokes" in Alaska, which issue from the imposing masses of matter erupted from the Katmai volcano, covering a very large area of territory. This latter class of fumaroles is less accessible to investigation, but in some cases, such as the *solfatara* of Pozzuoli near Naples (which is not in the immediate vicinity of Vesuvius, but situated in the crater of an extinct volcano), experiments can be made. A scheme for utilising the *solfatara* of Pozzuoli is being studied.

FIG. 1.—General view of the Larderello works.

Modern theories as to the internal structure of our planet lead us to consider that the origin of volcanic phenomena should be traced to magmatic deposits which underlie the upper crust of sedimentary rocks, and in some instances are situated at no very great depth below the surface. The steam which is present (either in its proper form, or dissociated in its component gases) in all volcanic

manifestations is mainly the result of crystallisation of such glassy siliceous magma: phreatic or surface waters, penetrating to adequate depths, are in many cases present and condense the magmatic steam, thus forming almost all the ordinary thermal springs, though the presence of phreatic or surface waters can be traced also in the steam of fumaroles. This theory is supported by geophysical evidence, and has been amply illustrated and discussed in more than one instance, and notably in the case of the fumaroles and thermal springs which abound in the United States. Identical conclusions had been arrived at as a result of the geophysical studies carried out on the district surrounding Larderello, under the patronage of Prince Ginori Conti.

The *soffioni* of Tuscany have been utilised since 1818 for the extraction of boric acid, the presence of which in the waters resulting from the condensation of the natural steam was discovered in 1777, but the production of mechanical power by means of these *soffioni* was begun only in 1904. The first machine with which Prince Ginori Conti made his experiments was a very small cylinder engine which he fed with the volcanic steam used, up to that date, only for heating purposes in connexion with the chemical works and especially with the apparatus for concentrating boric waters. This first experiment was a very important one, as it proved the possibility of working continuously in such conditions with an engine. A slightly larger engine was afterwards tried, with excellent results, and a further step was taken in 1913, when a 250-kw. turbine was installed.

The steam of the Tuscan *soffioni*, besides boric acid and other substances, including ammonia, is accompanied by a certain percentage of gases, mainly carbon dioxide, with minor quantities of hydrogen sulphide, some methane, hydrogen, nitrogen, and oxygen, and smaller quantities of argon and helium. The presence of such non-condensable gases would have proved a great hindrance to the efficiency of the condensing apparatus required in connexion with turbines, and it was therefore decided to heat, by means of the volcanic steam, appropriate evaporators generating pure steam for feeding the turbines. The same method was adopted when, in 1916, three 2500-kw. turbo-alternators were put up at Larderello. This system, though theoretically correct, did not give very good results in practice on account of leakages often occurring in the evaporator tubes, through which the gases found their way into the turbines and the condensers, greatly reducing the vacuum which is essential to the efficiency of the low pressure turbines (0·25 atm. eff.) used at Larderello.

FIG. 2.—The turbine room at Larderello; three turbo-alternators of 2500 kw. each. The turbines are fed with volcanic steam which has been stripped of about 90 per cent. of the accompanying gases.

Considerable improvement was obtained by doing away with the evaporators and substituting, in their stead, special depurating apparatus which eliminates about 90 per cent. of the gas. Such depurators, which are extremely simple, are working most efficiently at the Larderello power station. The non-condensable gases are sent on through pipes to a special department of the chemical works, where carbon dioxide is separated and liquefied: part of it is used at Larderello, together with ammonia which is obtained from the volcanic steam, to make carbonate of ammonia. The depurators also yield a considerable amount of boric waters which are utilised in the chemical department, which, by concentrating the liquors and allowing the acid to crystallise by cooling, extracts boric acid.

More than 5000 kw. is now generated at the Larderello power station, but in the near future three units will be running instead of two, thus adding a further 2500 kw.

The Larderello wells were giving, in the beginning of 1927, more than 120,000 kgm. of steam per hour, but quite recently an exceptionally powerful well was struck, yielding more than 60,000 kgm. of steam per hour at a pressure of 2 atm. eff., so that the supply of steam may be considered as superabundant until sufficient depurators and turbines are installed to deal with it. These very remarkable results are due to the improved methods of drilling which have been gradually introduced. The making of steam wells is an operation which calls for a very careful technique, which can only result from extensive practice in dealing with volcanic soil; it is not exempt from risks, and skilled labour is required, as accidents are not uncommon, steam being sometimes found quite suddenly.

Regular drilling in the volcanic soil of Larderello was begun so far back as 1836, when steam was merely used for its boric acid content, but the old wells were of small depth and their diameters were

also small. Gradual improvements were introduced and outputs of 25,000 kgm. per hour were obtained from single wells when the power station was built; but far better results followed about three years ago at the Castelnuovo works, about 3 miles south of Larderello, where about 60,000 kgm. per hour were given out by a new well at 1 atm. eff., while considerable outputs were available from the same well at a pressure of 3 atm. At the older wells, the output falls rather rapidly as the pressure increases. The pressure of a well attains its maximum when the well is closed down, while the gradual opening of the head valve lowers the pressure as the output increases. Measures of output are made with different gauged tubes, thus allowing a diagram to be plotted showing the linear variation of output with variation of pressure.

The remarkable results of the Castelnuovo well (though not so brilliant as those which have since been obtained at Larderello, as recorded above), besides similar ones at other works, were responsible for the experiment of a small, direct feed, free exhaust turbine which was installed at the Serrazzano works and ran in the most satisfactory manner for more than a year. A further experiment was carried out at Castelnuovo in 1925 with a 650-kw. turbine, which has since been followed by two other 750-kw. units. The Castelnuovo plant is ideally simple, the impulse type turbines being fed directly with the *soffioni* steam: the steam enters the turbine at 2 atm. and free exhaust pressure is about 0·1 atm. All expensive and complicated condensing apparatus, with attendant paraphernalia of pumps, cooling towers, etc., are entirely done away with and exhaust steam is sent on to the chemical department for heating concentrating apparatus dealing with boric waters. During its progress from the turbines to the concentrators, the steam is 'washed,' that is, it is made to give up part of the boric acid which it carries. This operation is performed very simply by allowing a jet of water to enter the pipes conveying the steam, by means of an injector device; the water dissolves part of the boric acid and is extracted farther down along the piping. This operation, though not always performed in the case of steam used for power generation, is very extensively resorted to in other instances at the Larderello works and provides part of the boric waters used in the chemical department, the remainder being obtained from the soil where natural jets of steam partially condense.

The new Castelnuovo power station, in comparison with the Larderello plant, has a higher steam consumption per kilowatt-hour, but, on the other hand, cost of plant and expenses of running and upkeep are far lower. Each system has its advantages and, where considerations of expense are of paramount importance, while natural steam is abundant, the free exhaust system appears to be preferable.

At the present moment the total output of power generated by means of natural steam at the Tuscan Boracic Works is more than 6500 kw., with the three power stations of Larderello, Castelnuovo, and Lago, the latter being only a small experimental plant generating about 200 kw. New plants are being studied, and it is confidently expected to attain a total power of at least 10,000 kw. The Società Boracifera di Larderello, which owns all the natural steam springs of the district, has eight different works for the extraction of boric acid, at all of which steam is more or less plentiful, and drillings are being actively carried on in most of these works.

Since the first publication, in 1918, of the results obtained by Prince Ginori Conti, other schemes of the same nature have been proposed in different parts of the world, notable among which is that for utilising the important steam springs of Sonoma County in California, commonly, but improperly, called 'geysers.' According to the reports published, the outputs of steam obtained there by drilling are quite notable, but, so far at least, no machinery of any importance has been installed. Other experiments are reported to be in progress in Java.

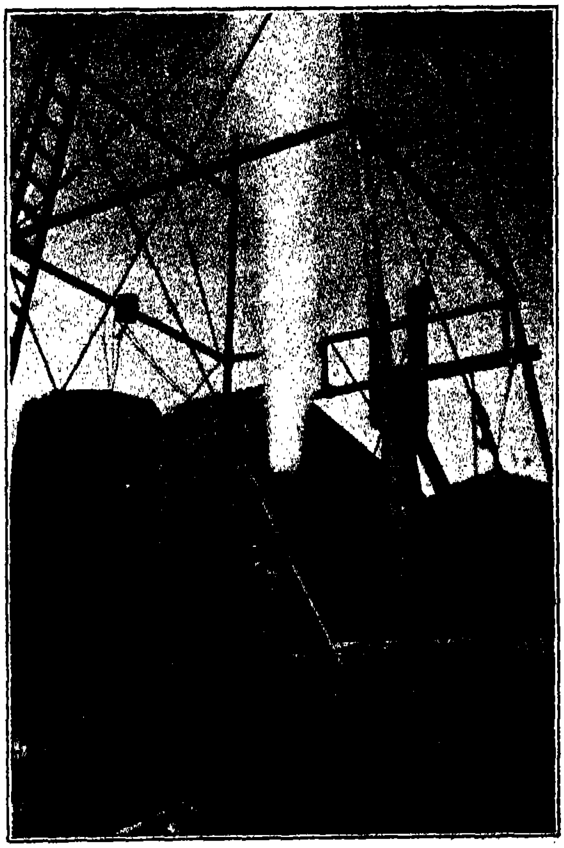

FIG. 3.—A powerful well at Larderello. This well gives more than 60,000 kgm. of steam per hour at 2 atm. efficiency. The steam is seen issuing from a gauged conical tube used for measuring the output of steam.

The Larderello plant is, however, the only concern in the world which is actually working and supplying power derived from natural heat. Larderello is distributing power to the region surrounding the works and is also running in parallel with

the important hydroelectric stations which feed the main distribution lines of the western part of Tuscany.

Another striking feature of the Larderello geothermal plant is the utilisation of natural steam not only with regard to its heat contents but also on account of its chemical components. Power is, in fact, an intermediate product, boric acid and its derivates, carbonate of ammonia and carbon dioxide being the final products. From this point of view also, it is undeniable that the methods applied at Larderello constitute the first successful attempt at a complete and rational utilisation of the volcanic or pseudo-volcanic phenomena through which subterranean heat is brought within reach of human efforts.

Parallel Evolution among Protophyta.[1]

By Prof. F. E. FRITSCH.

THE present-day freshwater Algæ represent the most elementary types of holophytic plant-life to which we have access. The probability that such forms will ever be found preserved in the fossil state in sufficient numbers and showing the necessary details of cell-structure to be of any value for comparative morphological study or for the elucidation of the mode of origin of the multicellular plant, appears at the best to be remote.

The relation of the different types of construction that can be distinguished among the lower Protophyta to one another, and to the more elaborate parenchymatous soma usual in land-plants, must always remain in part a matter of conjecture. There are, however, certain definite facts which emerge from a comparative study of the simpler holophytic organisms and that have an important bearing on these problems.

It is now nearly thirty years since the doctrine of the flagellate origin of the Algæ became firmly established by the discovery in Sweden of Chloramœba and Chlorosaccus. These two simple forms agreed with a number of others in the possession of yellow-green chloroplasts containing an excess of xanthophyll and devoid of pyrenoids, the storage of oil, and the possession of a motor apparatus consisting of two very unequal cilia attached at the front end. These and other minor characteristics served to separate out from the extensive group of the Chlorophyceæ a small set of Algæ which became known by Luther's name, Heterokontæ (yellow-green Algæ). The remainder of the Chlorophyceæ were renamed Isokontæ, a designation based upon the fact that here the motile stages bear equal cilia (commonly 2 or 4). In the Isokontæ the chloroplasts are often large and few in number and are commonly provided with pyrenoids; they contain the same pigments as those of the higher plants and, so far as we know, in roughly the same proportions. Most Isokontæ, moreover, store starch.

Already at the end of last century practically every conceivable type of simple plant-body was known in the Green Algæ, ranging from the motile or motionless unicell, through manifold colonial forms, to a more or less highly elaborated filament. This extremely varied somatic development corresponds to a remarkable range of habitat and goes hand in hand with a great diversity in reproductive processes. There is in fact no other group of simple organisms showing such a wide scope in all these respects. By contrast the Heterokontæ, when first distinguished, included only relatively few forms. By degrees, however, many additional members have been discovered, and in the course of this century it has become increasingly apparent that there exists a far-going parallelism between these two classes, Isokontæ and Heterokontæ, which are so sharply segregated by their metabolism and other features that the vast majority of algal workers have regarded them as quite separate evolutionary lines, in no way related to one another.

The Heterokontæ do not, however, exhibit anything approaching the multiplicity of forms that are seen among the Isokontæ; in particular they do not appear to have evolved the motile colony. The less vigorous development accords with the fact that only a few of the more specialised members of the class exhibit sexual reproduction and that this has not passed beyond the phase of isogamy.

The ciliated members of Heterokontæ without exception show 'flagellate' characteristics; that is to say, they are devoid of a cell-wall, their plasmamembrane (periplast) is more or less rigid but usually admits of some change of shape, multiplication is effected by longitudinal division, the protoplast readily encysts, and sexual reproduction is not known to occur. Some of the palmelloid members (*e.g.* Chlorosaccus), possibly all, also show these features. The many motile and palmelloid types among the Isokontæ are, on the other hand, for the most part on a higher plane of organisation and reproduction, being true Algæ provided with a firm cell-wall and usually exhibiting sexuality. When, however, the parallelism between the two classes is recognised, the distinction between flagellate and algal organisation loses force, and it is realised that the assumption of 'algal' characteristics has taken place at an earlier stage in the evolution of the one and at a later stage in that of the other.

These conclusions, however, do not apply only to Isokontæ and Heterokontæ. It is now clear that, in *all* the classes of pigmented Protophyta, an analogous evolutionary sequence has been followed, but that the features associated with what may be called 'algal organisation' have appeared, if at all, at different points in the sequence in the diverse classes. It is no longer feasible to separate the Algæ from the holophytic Flagellata as distinct

[1] From the presidential address to Section K (Botany) on "Some Aspects of the present-day Investigation of Protophyta," delivered on Sept. 1 at the Leeds meeting of the British Association.

groups of Protophyta. There is reason to believe that every series of holophytic Flagellates could potentially have acquired algal characteristics, although on the present evidence some have failed to do so.

These points are well illustrated by a consideration of Pascher's Chrysophyceæ which, until relatively recent times, were only known to include a wealth of flagellate types, the Chrysomonadales, represented by motile unicells (*e.g.* Chromulina, Ochromonas), by motile colonies (Synura, Uroglena, etc.), and by numerous epiphytic forms. The palmelloid type is also well represented, reaching an exceptionally high differentiation in Hydrurus. But within the last dozen years a quite considerable number of algal members of this class have been discovered on the Continent (for example, Chrysosphæra, Thallochrysis), and it is clear that the Chrysomonadales too have progressed in the same direction as Isokontæ and Heterokontæ, but that here the bulk of the forms have remained flagellate and the minority have become algal.

Another striking instance may be mentioned. The Peridinieæ (Dinoflagellata) are a very distinct and rather specialised class of motile forms, abundant in freshwater and marine plankton. Their most striking characteristic lies in the division of the body of the cell into two usually slightly unequal halves by a transverse furrow harbouring one cilium, whilst the other trails out behind into the water.

In 1912, Klebs described a number of forms that were clearly algal members of this class. His Hypnodinium shows the derivation clearly; it consists of large motionless spherical cells provided with a firm membrane and possessed of the chromatophores and nuclei characteristic of the class. When reproduction takes place, the protoplast contracts somewhat and develops the distinctive furrows, but this is followed by division without resort to a motile phase.

As an antithesis to classes like the Chrysophyceæ and Peridinieæ we have the Myxophyceæ (Cyanophyceæ), where motile types are altogether unknown and all the forms exhibit an algal organisation. Even in this very sharply circumscribed class a considerable degree of parallel with those previously considered can be recognised. Other distinct classes of Protophyta exhibiting holophytic nutrition, but of more restricted range and generally showing special development in one direction or another, are the Bacillariales (Diatoms), the Cryptophyceæ (including the flagellate Cryptomonadineæ and a few little-known algal types), the Chloromonadineæ, and the Eugleninеæ. In all of these, one or other organism can be recognised as parallel with types in the classes that have been previously discussed, although none has evolved the branched filamentous habit so far as at present known. It seems clear that in all the nine classes mentioned evolution has progressed along similar lines and in many cases has led to the production of analogous forms of plant-body.

Amongst the numerous filamentous Isokontæ it is possible to distinguish four separate series, of which the Oedogoniales and Conjugatæ are specialised along directions of their own. Of the other two, the Ulotrichales are the simpler and the Chætophorales the more complex, both possibly originating from a common stock. Many authorities, in fact, fail to distinguish these two groups, but the organisation of the Chætophorales is so distinct from that of the Ulotrichales that, from the viewpoint of comparative morphology, their separation is desirable. Whereas in the Ulotrichales we have a simple or branched filament attached by a more or less elaborate basal cell, the central types among Chætophorales are distinguished by the possession of a plant-body showing differentiation into a prostrate system of creeping threads, serving *inter alia* for attachment to the substratum, and a projecting system which is more or less richly branched.

This type of construction is not encountered in any of the other nine classes of Protophyta previously mentioned. An analogous differentiation of the filamentous thallus into a creeping and a projecting system is, however, characteristic of many Ectocarpales (*e.g.* Ectocarpus) and Nemalionales (for example, Chantransia), which include the simplest known members of the Phæophyceæ and Rhodophyceæ respectively. In fact, it appears that this kind of plant-body represents a definite stage in the evolution of various classes of Protophyta, affording another instance of parallelism. But, whereas in the Isokontæ it represents the most advanced type of which we have any knowledge, in the two great marine groups it is seen in the simplest of the present-day forms, since no unicellular or palmelloid members of these classes are certainly known to exist.

Of all the holophytic Protophyta, the Phæophyceæ and Rhodophyceæ have alone attained to a high degree of morphological and anatomical specialisation, often affording in one feature or another marked instances of parallel with those groups of the vegetable kingdom which are now dominant on the land. The totally differing metabolism obviously renders impossible, however, any direct derivation of the land-flora from forms belonging to either class.

It will be generally agreed that we must seek the origin of terrestrial plants in organisms possessing the same plastid-pigments and the same essential metabolism as they do. The only representatives of such forms among Protophyta at the present day are afforded by the numerous Green Algæ, the Isokontae. These, however, as has previously been pointed out, stop short at a level of morphological differentiation of the thallus at which the two marine groups commence. Roughly speaking, too, the stature of the most highly differentiated Isokontæ is approximately equivalent to that of the simpler Brown and Red Algæ.

In the Isokontæ we thus have a class of great morphological diversity in which almost every conceivable type of simple plant-body has been realised and is still existent at the present day, but which stops short at a massive parenchymatous construction and forms of large stature. In the

Brown and Red Algæ, on the other hand, where no simple forms of plant-body are certainly known, plants of large size and possessed of a highly developed parenchymatous soma are abundantly represented. It appears improbable that a class like the Isokontæ, showing such extreme capacity for morphological elaboration in every direction and for adaptation to very diverse habitats, should have failed to develop further in the direction generally indicated by Phæophyceæ and Rhodophyceæ. Moreover, it must be remembered that they possess the photosynthetic equipment which has evidently proved to be the only successful one on the land, and that practically every group and family of Isokontæ has its terrestrial representatives.

What then, it may be asked, has become of the more highly elaborated members of this class? It seems to me that there is every reason to suppose that, approximately at the level of morphological differentiation and stature reached by the Isokontæ of the present day, the terrestrial habit was adopted in the remote past, that the more highly elaborated Green Alga became a land-plant, the early forms of which are perhaps yet to be disclosed by palæontological research. In this connexion it is not without significance that the oogamous members of this class for the most part occupy a peculiarly isolated position, appearing as outliers well in advance of the rest, although for none of them is there, to my thinking, any possible connexion with the higher land-plants.

If one recognises among Phæophyceæ and Rhodophyceæ many features of anatomy, life-history, etc., that recall the characteristics of land-plants, I can see in that only a confirmation of the belief that environment has little to do with the broad evolution of the plant-organism, and that these features are a natural outcome of the evolutionary trend in the vegetable kingdom and no positive evidence for the view that they must necessarily have originated in a marine environment. The comparative study of the simpler forms of plant-body in the different classes of Protophyta lends great support to such a concept of a general evolutionary trend.

Obituary.

PROF. BERTRAM B. BOLTWOOD.

THE tragic death on Aug. 14, 1927, of Bertram B. Boltwood, professor of radiochemistry in Yale University, removes an outstanding scientific personality who played an important part in the rapid expansion of our knowledge of radioactive transformations in the early days of radioactivity. Prof. Boltwood was born on July 27, 1870, in Amherst, Mass. His father, a graduate of Yale, was of English descent, and his mother of Dutch extraction. He entered the Sheffield Scientific School of Yale in 1889, taking chemistry as his chief subject. After graduation he spent two years at the University of Munich under Prof. Krüss, paying special attention to analytical methods and to the rare earths. The knowledge and technique thus gained was to prove of great importance in his subsequent researches in radioactive minerals. In 1894 he returned to Yale as an assistant in the chemistry department, and did some research work both in organic and inorganic chemistry. In 1900 he left the University to take up work as a consulting chemist, but continued research in his private laboratory.

It was during this period that Boltwood became interested in the study of uranium minerals and the possible genetic relations between the radioactive elements. In 1903, Rutherford and Soddy had put forward the disintegration theory of the radioactive elements and had indicated that radium might prove to be a transformation product of uranium. If this were the case, radium should grow from uranium, and the amount of radium in old unaltered minerals should be proportional to their content of uranium. It was to this latter problem Boltwood first devoted himself in 1904. This involved a systematic chemical analysis of minerals for their uranium and radium content. The amount of radium with the uranium in solution was determined by boiling off the emanation and introducing it into an electroscope. This method in Boltwood's hands became a weapon of precision, and he was able to show that in properly selected minerals the amount of radium was always proportional to the amount of uranium, thus proving that a genetic relation existed between them. If uranium were transformed directly into radium, a solution of uranium, initially freed from radium, should grow radium at a rate that could easily be measured in a few days or weeks. He found, however, no trace of the growth of radium in a carefully purified solution of uranium over a period of about one year, and concluded that an intermediate product must exist between uranium and radium. We now know, due to the work of Soddy, that radium ultimately does appear in uranium solutions, the growth depending on the square of the time; but the small amount of radium produced in the first year is difficult to detect even by the delicate emanation method.

Investigations were then made to see if it were possible to isolate chemically from a uranium mineral the intermediate substance which is transformed directly into radium. A radioactive body was separated which Boltwood found grew radium at a rapid rate. From the similarity of the chemical properties of this body with those ascribed at that time to actinium, he naturally concluded that actinium was the direct parent of radium. Later investigations, however, showed that the properties of actinium had been wrongly described, and that the parent of radium was not actinium at all, but a new radioactive element which he named 'ionium.' In these experiments some thorium was added to the uranium mineral to effect a complete separation of the ionium. Boltwood found that it was impossible by chemical methods to separate the added thorium from the ionium. This

was one of the first cases observed of inseparable elements, of which a number of examples came to light in later years. It was on observations of this character that Soddy later put forward the conception of isotopes which has proved to be of so much significance not only for the radioactive but also for the ordinary elements.

By comparing the rate of growth of radium in the separated ionium with the amount of radium in equilibrium with uranium in the mineral, Boltwood was able for the first time to fix by a direct method the average life of the radium atom. In later researches he was able to show that a genetic relation also existed between actinium and uranium, but that the amount of actinium was only a few per cent of that to be expected if it were in the main line of descent. This work suggested that the actinium must be regarded as a branch product at some point of the uranium-radium series. This is a conclusion we hold to-day, but the exact point of branching is still uncertain.

These investigations, which were carried out with great experimental skill and accuracy, thus yielded results of fundamental importance. Boltwood had not only proved a genetic relation between uranium and radium, but also had isolated the new element which was the immediate parent of radium, and had shown that actinium was also genetically connected with uranium but not in the main line of descent.

I must not omit here to refer to another deduction which has proved to be of great importance. As a result of his own analyses and the analyses of Hillebrand, Boltwood found strong evidence that the amount of lead in old minerals of the same geological age is proportional to their content of uranium and increases with the geologic age. This led him early (1905) to suggest that lead was the final inactive product of the uranium-radium series of transformations. The correctness of this view has been abundantly verified in recent years. We know that the end product of uranium is an isotope of lead of atomic weight 206, and the end product of the thorium series is another isotope of weight 208. These observations have thus supplied a definite method of estimating the age of radioactive minerals and thus of the geological horizons in which they are found.

The importance of Boltwood's work was at once recognised by Yale University, where he was appointed assistant professor of physics in 1906 and professor of radiochemistry in 1910. He took an active part with the late Prof. Bumstead in building the new Physics Laboratory in Yale, and later, in 1918, as professor of chemistry, in building the new chemical laboratories. The labour and detail involved in such undertakings, which he cheerfully undertook, made serious inroads not only on his time for research but also on his energy. He had a breakdown in 1922, and never completely recovered from its effects.

I first made the acquaintance of Boltwood in 1904, when he was carrying out his first radioactive experiments. One could not fail to be impressed by the breadth and accuracy of his scientific knowledge, and by his scrupulous care and accuracy in experimental work. He possessed to an unusual degree the power of anticipating experimental difficulties which were likely to arise and in arranging his apparatus and methods to overcome them. This characteristic feature of Boltwood's work was well illustrated in his investigations with me in the University of Manchester in 1910 on the rate of production of helium by radium and other radioactive bodies. Every detail of the complicated apparatus and arrangements was so carefully thought out beforehand that not a single change was required for the successful conclusion of the measurements.

A man of cosmopolitan tastes, Boltwood was much attracted by many aspects of European life and spent many of his summers on the Continent. He took an active interest in the undergraduate life of his university and had the gift of gaining the interest and confidence of young people. His premature death will be mourned by a wide circle of friends, who held him in high esteem for his personal qualities as well as for his outstanding scientific achievements.

E. RUTHERFORD.

MR. W. H. DINES, F.R.S.

BY the death of Mr. William Henry Dines, meteorology loses an outstanding figure. It is scarcely possible to overrate the importance of his work. He was a meteorologist of the first rank before he began the upper air work for which he is best remembered. Born in 1855, he was the son of George Dines, himself a meteorologist of note. He was educated at Woodcote House School, served an apprenticeship as a railway engineer, and then went to Christ's College, Cambridge; he obtained first class honours in the Mathematical Tripos, and took his B.A. degree in 1881. The bent of his first meteorological work was occasioned by the disaster to the Tay Bridge, which, only recently opened, was destroyed by a gale while a train was crossing it. So George Dines investigated wind pressure and his son helped him. Later, as a result of this work, W. H. Dines designed the pressure tube anemometer. This instrument in its final form records each gust of wind and each transient change of direction, and is the standard recording anemometer for all serious purposes.

Dines's most notable work, that of upper air research, began in 1901 with kite ascents. When possible, Dines always preferred to design and make his own apparatus, and it was his modification of the box kite, his winding gear, and his meteorographs which were used. The meteorograph was simple, efficient, and cheap, a great point for upper air research, when instruments are apt to be lost or broken. Dines took observations at Crinan, on the west coast of Scotland, in the summers of 1902 and 1904, flying kites from a shore station, from a tug in 1902, and from H.M.S. *Seahorse*, lent by the Admiralty for the purpose in 1904. He also used his house at Oxshot in Surrey, and later at Pyrton Hill, near Watlington, as an upper air observatory.

As the investigation progressed, greater heights were required than could be attained by kites, and Dines used sounding balloons. His balloon meteorograph with its metal case weighed only two ounces, and cost only about one-twentieth of the price of instruments used on the Continent and in the United States. Being so light it allowed much smaller balloons to be used. The whole cost and difficulty of sounding balloons were so much reduced that the Department of Physics at the University of Manchester was able on two occasions to send up a balloon every hour for twenty-four hours. He designed also a very ingenious apparatus for calibrating the meteorographs. Accounts of these and many other instruments, and many papers on meteorology, especially on wind pressure, upper air research, and, later, on radiation, are to be found in the publications of the Royal Society, the Royal Meteorological Society, the Meteorological Office, and elsewhere.

Dines had a wonderful insight as to what was necessary in an instrument. He could design it, make it himself in many cases, use it to the best advantage, and afterwards discuss the results obtained. It was the possession of these qualities, seldom all united in one person, that marks the genius that he applied to meteorology. It was as an amateur that he worked. Most sciences have been started by amateurs, but by degrees they have grown out of the stage when an amateur can usefully apply himself to their problems. Meteorology has possibly reached this stage. Dines was the last and the greatest of the amateurs who built up the science, and he has left it in a very different condition from that in which he found it. Now it is recognised as a real science worthy of study by mathematicians and physicists of the first rank. He had a great share in bringing it to this stage.

Most of the sounding balloon work was done by Dines at Benson, near Wallingford, where he went from Pyrton Hill. It was chosen as being in a part of England most favourable for balloon ascents. Dines himself hoped that Benson would become ultimately a permanent aerological observatory, and indeed at one time this was to have been its destiny. Fate, however, intervened, and to the regret of many the dream will not come true.

Dines joined the Royal Meteorological Society in 1881; he was for a number of years a member of council; he was president in 1901 and 1902; and in 1914 he received the Symons Gold Medal of the Society. In 1905 he was elected a fellow of the Royal Society. From 1905 until 1922 he was Director of Experiments on the Upper Air for the Meteorological Office, and a small annual grant was made for the maintenance of the establishment, first at Pyrton Hill, afterwards at Benson; but Dines received no personal emolument; so far as his own services went, his position was an honorary one. Perhaps because he was never in the employment of any Government office, or the holder of any public post, perhaps because he was of a very modest and retiring nature, and would never have dreamt of pushing himself into public notice, he received no public honour of any kind. Probably in no country but Great Britain would such eminence in a science which has become of such great practical importance have passed unrecognised.

Dines was a real student, wrapped up in his work, and in the subject he had made his own. He was singularly retiring, and had the constitutional shyness which not seldom goes with genius. But those who penetrated his reserve found that he could have, and maintain, strong opinions, and that he had a quiet but very real sense of humour. He was ever ready to help others who were working on the same lines as his own, and took infinite pains in this way, as the writer can testify from the experience of many years. He is survived by a widow, and by two sons who carry on the family tradition of meteorology into the third generation, for they both have posts in the Meteorological Office.

The early years of the century will stand out by reason of great advances made in many sciences, especially in physics and astronomy. Meteorology advanced rapidly at the same time, and in Great Britain it was Dines who led the way. Physics and astronomy are still in the period of rapid advance. Meteorology shows signs of decreasing acceleration. Can we look forward to a further advance, which only research can ensure? Given the will, it is possible; but we shall not so easily find again the genius of a Dines.

C. J. P. CAVE.

DR. HERMANN KAST, well known for his work on explosives, died on Sept. 6, 1927, aged fifty-eight years. After a period of study in A. W. Hofmann's laboratory in Berlin, Kast graduated in 1893. For many years he was a member of the council and deputy-president of the Berlin Bezirksverein deutscher Chemiker. In addition to numerous original scientific publications, Kast published two comprehensive works dealing with explosive materials.

WE regret to announce the following deaths:

General Henry L. Abbot, the distinguished U.S. Army engineer, who was elected a member of the National Academy of Sciences in 1872, on Oct. 2, aged ninety-five years.

Mr. Leon Gaster, honorary secretary of the Illuminating Engineers' Society, on Jan. 7, aged fifty-five years.

Prof. H. W. Mackintosh, formerly professor of zoology and comparative zoology in the University of Dublin, a post which he held for nearly fifty years, on Jan. 8.

Dr. Frederick C. Newcombe, emeritus professor of botany in the University of Michigan, and secretary in 1897 of Section G of the American Association for the Advancement of Science, who worked particularly on the sensitive reactions of plants, on Oct. 1, aged sixty-nine years.

Dr. Geo. A. Osborne, emeritus professor of mathematics at the Massachusetts Institute of Technology, on Nov. 20, aged eighty-eight years.

Prof. F. W. Very, director of the Westwood Astrophysical Observatory at Westwood, Mass., since 1906, on Nov. 23, aged seventy-five years.

News and Views.

TUESDAY last, Jan. 10, marked the one hundred and fiftieth anniversary of the death of Linnæus. Carolus Linnæus—afterwards Carl von Linné—was born on May 23, 1707, the eldest child of Nils Linnæus, pastor of South Råshult, in the south of Sweden. After a schooling that lasted until he was twenty years old, Linnæus spent one year at the University of Lund and five years at the University of Upsala, the latter period interrupted by his famous five months exploration of Swedish Lapland in the summer of 1732. Then followed a fruitful three years' sojourn abroad—mostly in Holland, but with visits to England and France—succeeded by three years as a physician in Stockholm. Finally, he was appointed in 1741 to the chair of natural history in Upsala, a post which he held until his death.

IF we make in modern fashion a fanciful aeroplane survey of the rich, varied, vast, and ever-broadening territory occupied by the biological sciences during the last one hundred and fifty years, it is easy to lose sight of the small tract of thorny wilderness out of which they were trying to struggle before the coming of Linnæus. Before him there were pioneers like Bauhin, Gesner, Ray, and Tournefort, who had attempted to clear a track to the open country, but it was Linnæus who transformed their cumbersome and uncertain direction finders into instruments of precision, who brought the wanderers out of the jungle and laid down a base line for the survey of the promised land beyond. Although Linnæus had but a glimpse of the fair regions which those who have come after him enjoy, and although some of his instruments have been superseded and others refined, his base line still remains. All collective knowledge depends on the correct and accepted use of names, and the incomparable service rendered by Linnæus in his "Species Plantarum," "Systema Naturæ," and other works, was to establish, in the study of all things that live or have lived, an accurate and universally accepted system of nomenclature. To amplify the expression of one of the greatest of living zoologists, Linnæus was the Adam of the biological sciences. So all who labour to increase man's knowledge of himself and all other creatures, great and small, do well to hold his name in honourable remembrance.

METEOROLOGICAL conditions, and especially the swollen state of the upper Thames resulting from the melting of snow, had doubtless a good deal to do with the recent abnormal tides and floods which caused loss of life and much distress in Westminster and low-lying parts of London. There were also astronomical factors to reinforce the effects of the gale and the swollen river. The night tides at winter full moons are helped by the north declination of the moon at such times. On Saturday morning, Jan. 7, the moon's north declination was 25°, so that it was only 26½° from the zenith in London, and the sun was only 28° from the nadir. Also the sun was near the earth, having passed perihelion on Jan. 4. The moon was in perigee late on Jan. 3, and was still considerably nearer the earth than its average distance. The night tides at full moon are higher than the day tides, the moon being nearer in the former case by nearly the diameter of the earth. The day tide at midsummer new moon is also high, but less so than the midwinter night tide, owing to the greater distance of the sun. The conditions on Jan. 7, when the floods occurred, were not the most favourable possible, the moon being more than three days from perigee, but they were much above the average. The actual conditions are less simple than those sketched here, the British tides depending on the conditions in the ocean at some distance away, rather than on the direct action of the moon on the narrow seas round Great Britain. It is for this reason that the highest spring tides do not generally come until one and a half days after new and full moon. But on Jan. 7 the highest tide appears to have come on the actual night of full moon; this must have been due to the prevailing meteorological conditions, which piled up the water in the North Sea and prevented the flow out of the river, rather than to astronomical causes. The tide is said to have reached the highest point ever known in the Thames.

THE Egyptian Minister of Education has just issued invitations for the celebration next December of the centenary of the Faculty of Medicine in Cairo, which is to take the form of an International Congress of Tropical Medicine and Hygiene under the patronage of the King of Egypt. The chequered history of the Cairo School of Medicine presents a number of incidents that suggest romantic stories from the Arabian Nights rather than sober history. From the time of the famous Alexandrian School of Herophilus and Erasistratus, which created the systematic study of anatomy, there was nothing worthy of the name of a medical school in Egypt until a century ago. The story goes that one afternoon the Viceroy, Mohammed Ali, was driving through the streets of Cairo on the way to the Shubra Palace when he ordered his coachman to stop and, summoning a well-dressed Frenchman who was walking along the street, informed the stranger that he wanted him to create a medical school in Cairo! When the latter protested that he was a wine merchant and not a medical man, the Viceroy refused to listen to his excuses and insisted on his orders being carried out.

CLOT BEY, in spite of his ignorance of medicine, was an able man, who accomplished the task thus entrusted to him with conspicuous success, which was recognised later by the conferring of the M.D. degree on him by the University of Paris. Napoleon I. had founded a military hospital in Cairo, and around the civil hospital which afterwards replaced it, and later was transferred to Kasr el Ainy, the medical school was built up. Among the able staff which Clot enlisted was the anatomist Bilharz, whose discoveries in helminthology have made his name familiar to every student of medicine. Thirty years ago the late Lord Cromer recommended the reformation of the School, which

had become moribund. Acting on the advice of Sir Cooper Perry, the school and hospital were in large measure restaffed and developed in accordance with British ideas, so that they became important instruments of medical education and research. With the granting of Egyptian independence, the medical school passed under the control of the new Egyptian university. The Congress marking the centenary of the school should be one of exceptional interest.

IT is unlikely that the attempts which are being made in the French press to discredit the findings of the International Commission on Glozel will carry any weight with those who are competent to form a judgment on the evidence. If, however, there should be any who still, after the publication of the Report, find a difficulty in forming an opinion, they should be convinced by Sir Arthur Evans's letter in the *Times* of Jan. 7. Not only does he fully endorse the findings of the Commission, but he also thinks they might have found stronger expression. He points out that beyond the material findings to which the Commission has confined itself, there are certain considerations which should be borne in mind. "To accept as genuine," he says, "the accounts of these discoveries would be to destroy the whole fabric of our knowledge of the successive stages of the earlier and later Stone Ages." He goes on to point out how the immediate juxtaposition of the Magdalenian period and Glozel, itself dated no earlier than the end of the neolithic period at Knossos, runs counter to our knowledge of the stages later than the Magdalenian and ignores the high antiquity of the neolithic period, the stratified deposits of which at Knossos lie in places to a depth of 36 feet below the earliest Minoan, itself extending well into the third millennium B.C. Sir Arthur's pronouncement on the finds themselves, which he has now examined personally, will be welcomed by archæologists. In his opinion they are one and all the work of the same industrious hand, and "it is difficult to understand how they can deceive any expert eye." They present the most startling incongruities; the culture is of all ages, while the script contains selections from historic alphabets. The tiles of the glass furnace supplied the models for the bricks, its crucibles for the 'mud-pie' pots, and the inscriptions were derived from the collections or publications of M. Perot of Moulins, a local antiquary.

AT the annual meeting of the Geographical Association, held on Jan. 4-7 at the London School of Economics, Dr. Marion I. Newbigin delivered a lecture directing attention to the need for a new approach in geography teaching. Too much emphasis has been laid, she said, on the logical sequence beginning with climate and leading on to a study of vegetation and human activities. Arithmetically determined 'means' are of little use for children and do not lead to an appreciation of actual climatic conditions. The study of house types should take the place of climatology, which is too prominent a feature of geography teaching. Of supreme importance is the organic response to normal and usual conditions and the degree of tolerance of the abnormal. Sir John Russell, in discussing the agricultural problems of Palestine, showed the necessity for afforestation in that country. The run-off from the arid Jordan slopes of the Judean Highlands is so rapid after torrential rains that the soil is washed away. If trees were to be planted, their roots would hold up the water and springs would issue from the hillside. This water could be regulated and utilised for irrigating fruit gardens in the valley below. Mount Carmel should be re-afforested for the benefit of the Plain of Esdraelon, the swamps of which are being converted into irrigable land. Stock-raising difficulties are the result of the spread of diseases by the flocks and herds of Bedouin nomads. These animals are also responsible for serious depredations among newly planted cypress and fig saplings in the recently afforested areas between Jerusalem and Jericho.

PROF. RODWELL JONES, speaking at the annual meeting of the Geographical Association on the economic development of the Prairie Provinces of Canada, stressed the importance of irrigation in Western Alberta, where the climate favours the growth of hard wheat with a high gluten content. No storage works are necessary in the mountain zone, since the maximum flow of the rivers coincides with the opening of a short growing season. Nevertheless, irrigation is too expensive for general adoption. Vancouver is the main outlet for the region, although the completion of the Hudson Bay Railway to Fort Churchill, not Fort Nelson, is to be hastened. The coal reserves on the Prairie, though easy to extract, are of an inferior quality with a high ash and water content; they crumble on prolonged exposure and have a low calorific value. High-grade coal of the mountain region is difficult to mine. Sir E. Humphrey Leggatt, who delivered a lecture on "Economics and Administration in British East Africa," spoke of the Commission about to visit East Africa to consider possibilities of greater unification in the government of the area. He referred to the growing public demand for news relating to East Africa, especially that concerned with morals. He questioned the advisability of delimiting native reserves, and spoke in high terms of the system of interpenetration adopted in Uganda and Tanganyika Territory. This scheme recognises native rights to the land, and only very small blocks are alienated to Europeans. The total available native labour is inadequate for the vast European estates in Kenya, and further immigration of Europeans, together with additional alienation of land, is not for the good of the colony. It is important to avoid the development of a 'poor white' class as in South Africa.

A STATEMENT by Sir John Marshall that a monograph on the important excavations in the Indus Valley will appear in the coming summer is welcome news to archæologists. They have long awaited the opportunity for careful consideration of the finds on the two sites of Mohenjo-daro and Harappa which will be afforded by the fuller publication of results now promised. In the meantime, Sir John Marshall, in the *Times* of Jan. 4 and 5, has given some account of the

more recently obtained material, and has surveyed the general conclusions to which he has been led by maturer consideration. Of these, perhaps the most important is the view that the early culture which has been revealed here should not be regarded as Indo-Sumerian but should be known as 'Indus' culture, on the ground that there is not so much identity of culture in Sumeria and Northern India as a close connexion due to commercial or other intercourse. As regards dating, Sir John Marshall suggests that the Indian seals found at Susa and elsewhere in Mesopotamia, belonging to the time of Sargon I. of Akkad (2700 B.C.) or before, would give a date of about 3300 B.C. for the first of the three latest cities at Mohenjo-daro, the uppermost cities at Harappa being about contemporary. This would give a very early date for the lower cities with the primitive seals and other antiquities on the latter site.

So far as evidence has been obtained, the inhabitants of Mohenjo-daro were of the dolichocephalic type, with the exception of one brachycephalic skull from a burial. But although they all belong to the chalcolithic period, they were long after the destruction of the latest city. One of the most interesting objects found at Harappa was a model in copper of a two-wheeled cart which, if the dating is correct, would long antedate the representation of a wheeled vehicle recently found at Ur, which in turn antedates the use of the wheel in Egypt by a thousand years. It is also noteworthy that the drainage system and other features suggest a higher standard of amenity than is found at Ur. In certain 'standard'-like objects, Sir John Marshall sees the possibility of a connexion with Egypt.

THE fifth annual meeting of British zoologists was held on Jan. 7, at the rooms of the Zoological Society, ninety-four zoologists attending, and three guests. Owing to illness of the chairman-elect, Prof. W. Garstang, the chair was taken by the vice-chairman, Dr. G. P. Bidder. Prof. Douglas Laurie and Prof. E. W. MacBride introduced the Report of the Committee appointed to consider the question of animal biology in the school curriculum. All present expressed their conviction that the teaching of animal biology in schools is an urgent necessity. Subject to certain suggestions for the further consideration of the Committee, the Report was adopted unanimously, and the Committee empowered to act for the meeting in making the contents of the Report known and in co-operating with other bodies interested in the subject. For the discussion on "The Scale of Pay of Zoologists," the honorary secretary, Prof. F. Balfour Browne, produced a file of returns of salaries to zoologists at various universities, etc. Dr. Chalmers Mitchell, Prof. Stanley Gardiner, and the honorary secretary were appointed as Committee to examine the material and report to the next annual meeting. In a discussion which followed, all speakers agreed that it is difficult now to induce good men to apply for posts as zoologists in Government service. Although the zoological civil servant requires two more years of education than an administrative civil servant, yet at the age of thirty-five his salary is inferior by 30-50 per cent. It was unanimously resolved: (1) "That this meeting of British zoologists urge on the Government and on Universities the necessity for proper pay and conditions for zoologists in their service." (2) "That the Committee appointed to deal with the returns of posts and salaries of zoologists be asked to advise and suggest as to the steps to be taken to carry out this resolution, and meantime be empowered to act for the meeting."

THE meeting then discussed the Great Barrier Reef Expedition of 1928. Sir Sidney Harmer proposed: "That, in the opinion of this meeting of British zoologists, the investigation of the Great Barrier Reef of Australia is likely to produce valuable additions to knowledge, by elucidating questions of fundamental importance in relation to the growth of coral reefs, and the general biology of marine animals and plants in the tropics; and that progress in this direction will materially assist in the development of the economic resources of Australia." The motion was seconded by Dr. C. M. Yonge, the leader of the Expedition, and carried unanimously. The meeting was informed of the promised co-operation of the Royal Geographical Society, and that, in addition to financial assistance promised by the Australian Barrier Reef Committee, the British Association, and the Zoological Society; the Marine Biological Association has given permission for Mr. F. S. Russell to initiate the plankton researches. Private donors have promised £600. Dr. E. J. Allen and Dr. W. T. Calman then opened a discussion on the present position of binomial nomenclature, and the resolution "That this meeting of British zoologists is in favour of a substantial extension of the lists of *nomina conservanda*," was carried.

THE question of the closer relationship and a better understanding between sheep-breeders and woollen and worsted manufacturers has recently been under consideration by the British Research Association for the Woollen and Worsted Industries, with the view of placing the former in a position of having more precise and definite details of the requirements of the latter. In the determination of the quality of wool, various considerations arise, for example, fineness, diameter, staple length, crimp, etc.; all these must be fully investigated before the manufacturer's requirements can be standardised and the wool-breeder informed exactly what the manufacturer's specifications are. With the view of accelerating the investigations considered by the British Research Association for the Woollen and Worsted Industries, the Empire Marketing Board has granted a capital sum of £7000 as well as an annual contribution of £2000 to the Association for the specific purpose of the study and investigation of wool 'quality.' In order that the whole range of investigation may be complete, a joint programme of research work has been arranged between the Research Association and the Animal Breeding Research Department, University of Edinburgh, to which the Empire Marketing Board is also contributing an additional grant.

THIS grant in no way affects the ordinary work of the British Research Association for the Woollen and Worsted Industries ; it is made for a specific problem to be investigated alongside the research work already in hand. In order to carry out the work, sanction has been given for the purchase of additional premises and the creation of new laboratories for biology, biochemistry, colloidal physics, etc., and for the provision of special staff. For the full benefit of the work entrusted to the Association by the Empire Marketing Board to be obtained, additional support for the general programme of research should be forthcoming from the trade itself. In order to encourage this, the Department of Scientific and Industrial Research has agreed to maintain its grant of £4800 for the current year, instead of reducing it to £1200, as would normally have been done. It now remains for the industries themselves to supplement this generous support (based on a careful examination of the work that is being carried out) by increasing their financial interest in this important and vital section of their organisation.

THE annual meeting of the British Ecological Society was held in the New Botanical Department of the University of Birmingham on Jan. 7. Dr. E. J. Salisbury was elected president, Mr. H. Boyd-Watt, vice-president, and the vacancies on the council were filled by Prof. A. E. Boycott and Dr. V. E. L. Anderson. The honorary treasurer in presenting the balance sheet stated that the Society is now in a better financial position than ever before and a further £200 has been invested. The honorary secretary reported that the council has recommended the preparation of a biological flora of Britain which shall contain such information as is available with regard to biological features of ecological significance. A scheme prepared by Dr. Salisbury was approved, and the recommendation of the council that Dr. Salisbury should act as editor was adopted. Mr. Turrill reported that experiments on growing selected plants in various soils have been started at Pottern under the direction of a sub-committee consisting of Dr. A. W. Hill, Prof. Oliver, Dr. Salisbury, Prof. Tansley, and himself. Papers were communicated by Mr. C. S. Elton on "*Animal Communities in the Arctic*"; by Mr. W. Leach on "The Vegetation of Screes"; by Miss M. K. Bishop on "The Ecological Relationship between Some Species of Juncus"; by Prof. F. W. Oliver on "Early Stages of a Sand-Dune"; by Dr. V. E. L. Anderson on "The Root-Hair in the Soil"; by Dr. W. H. Pearsall on "Michigan Sand-Dunes," and by Prof. Adamson on "The Vegetation of Eastern Rhodesia."

IT is announced by the Colonial Office that platinum has been discovered in Sierra Leone. It was first found in May 1926 by the Director of the Geological Survey, Major N. R. Junner, and a recent investigation by him indicates that the platinum-bearing area is about forty square miles in extent, and that the deposits, which are alluvial, are likely to be of considerable importance. One nugget of platinum weighing 7·4 gm. (4¾ dwt.) was found by Major Junner. This nugget and some of the smaller grains of platinum have been presented to the British Museum (Natural History), South Kensington. An analysis made by the Imperial Institute of the platinum shows that it compares very favourably in composition with the platinum from the Urals and from South Africa. The platinum in Sierra Leone is associated with basic igneous rocks resembling those of the Bush Veld igneous complex of South Africa in which important deposits of platinum metals have been found.

DR. E. SCHRÖDINGER is to lecture in London on wave mechanics at the invitation of the Royal Institution. It has been arranged provisionally that the lectures shall be given on Mar. 5, 7, 12, and 14 at 5.15 P.M. The lectures will be held at the Royal Institution, and will be open to the public.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A head of the Chemistry and Industrial Chemistry Department of the Technical College, Cardiff—The Principal, Technical College, Cardiff (Jan. 21). An assistant for technical records work at the Building Research Station, Watford—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (Jan. 21). A city analyst under the Leeds Corporation—The Town Clerk, 26 Great George Street, Leeds (Jan. 25). An assistant at the Low Temperature Research Station, Cambridge, for abstracting scientific and technical papers on the preservation and transport of foodstuffs—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (Jan. 26). A graduate to undertake and direct research work at the Glasgow Royal Cancer Hospital—The Secretary, Glasgow Royal Cancer Hospital, 156 St. Vincent Street, Glasgow (Jan. 31). Temporary assistant chemists at the Government Laboratory—The Government Chemist, Clement's Inn Passage, W.C.2 (Jan. 31). A professor of civil engineering at the Bengal Engineering College, Sibpur, Bengal—The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (Feb. 1). A secretary of the Royal Sanitary Institute—The Chairman of Council, Royal Sanitary Institute, 90 Buckingham Palace Road, S.W.1 (Feb. 11). A professor of zoology in the University of Manitoba—The Secretary, Board of Governors, University of Manitoba, Winnipeg, Man., Canada. Test assistants at the Royal Aircraft Establishment for work in connexion with the airworthiness approval of aircraft—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (quoting A. 232). A junior lecturer at the Port Elizabeth Technical College, South Africa, qualified to teach elementary mathematics, science, and trade drawings—Box "Z.D. 797," c/o Deacon's Advertising Agency, Fenchurch Avenue, E.C.3. A junior assistant, with museum training in natural history, at the Hancock Museum, Newcastle-upon-Tyne—The Honorary Secretaries.

Research Items.

ARCHÆOLOGICAL DISCOVERIES BY AEROPLANE AT DORCHESTER.—In *Antiquity* for December, Mr. O. G. S. Crawford describes an interesting series of archæological discoveries near Dorchester, in Oxfordshire, due to photographs taken from the air in June last by two officers of the Royal Air Force, Flight-Lieuts. W. E. Purdin and B. T. Hood. The photographs revealed two large circles previously entirely unknown, a rectangular enclosure having no relation to existing field divisions, a semi-circular enclosure, possibly prehistoric, a track, either prehistoric or Romano-British, forty feet wide—an unusual width—traces of several barrows, and a small circle about twenty feet in diameter, consisting of twelve holes which had once been filled with uprights of stone or wood. The two concentric circles first mentioned, it is interesting to note, were partly in two fields, one under barley, the other under beans; but it was only the bean field that showed the circles, of which no trace was to be seen at all at ground level. In order to test the circles and seek evidence of their date, excavations were carried out by Mr. Crawford and Mr. R. G. Collingwood in October. Two trenches were cut, the first of which found the inner circle. At one end of the trench the excavators came on sand at a depth of 2 ft. 6 in. through a deposit of reddish-yellow loam. At the other end, sand was reached at a depth of no less than 6 ft. 4 in. of brick earth, the silt filling up the old ditch. The circle-ditch originally must have been not less than 36 ft. across from lip to lip. The second trench cut the outer circle at the point where the crops divided. Here a layer of 2½ ft. of brick earth covered the sand, and the sides could be seen sloping away from the inner lip. At a depth of 5 ft. 6 in. a foot of black stuff represented the middle of the ditch. Beyond two animal bones and some fragments of bone, no finds were made. The dig, as well as the examination in detail to which Mr. Crawford has subjected the photographs, is a useful demonstration of the value of air photographs, and has thrown much light on what may be termed the technique of their use in archæological discovery.

GOITRE IN SCHOOL CHILDREN.—In the recent issue of the *Annals of Eugenics*, Dr. Percy Stocks is continuing his valuable studies on the influence of iodine in reducing or preventing the incidence of goitre in school children, and in particular of increasing the rate of growth of school girls in height and weight. In collaboration with Miss Mary Karn, he corroborates for large towns in England and Wales the inferences drawn from Swiss and American statistics, that there is a positive relationship between the prevalence of thyroid enlargement in children and cancer mortality.

ICE-DRIFTS AND SEAL-FISHING.—Dr. Thor Iversen ("Drivis og Selfangst," *Aarsberetning vedk. Norges Fiskerier*, Hefte 1, Bergen, 1927) gives an interesting account of the northern seal fisheries of the ice-drifts with particulars of the biology of the seals and a detailed history of the seal-fishery. The most important seals for the industry are the Greenland or Harp seal *Phoca greenlandica* and the Bladder-nosed seal *Cystophora cristata*, but for the more northern fisheries the walrus *Trichechus rosmarus*, Bearded seal *Erignathus barbatus* and Ringed seal *Phoca fœteda* are of distinct significance. Most of the work refers to the first two species, especially the Greenland seal. Descriptions are given of its breeding places and habits, distribution, and the methods employed in catching it. Both of these seals are truly sea animals and undertake long migrations, keeping in large herds. Their breeding places are the ice-drifts of Jan Mayen, mouth of the White Sea, the Newfoundland ice and the Gulf of St. Lawrence, where the young are born from early February to April. There is a large industry for the young seals, which are left to fend for themselves very early in the case of the Greenland seal and are captured before they are able to swim. The Bladder-nosed seals, both male and female, on the other hand, defend their young, keeping with them for a longer time, and do not fly from the hunters, who shoot down whole families at one time. The questions asked by the writer with regard to the Greenland seal—do the individual seals keep to one breeding-place throughout their life, do all individuals of a group come from a single stock, and, finally, the large question of preservation, are only partially answered and, as he says, much more work is necessary before any answer can be attempted. Researches are needed similar to those already made on the fur seals, which present much less difficulty, breeding as they do in the summer and on land.

A MITE ON A SILKWORM PARASITE.—An interesting account of *Tyroglyphus muscæ*, a mite infesting *Sturmia sericariæ*, a fly noxious to the silkworm, is given by Dr. Chujiro Sasaki (*Journal of the College of Agriculture*, Imperial University of Tokyo, vol. 9, No. 3, Aug. 1927). *Sturmia sericariæ* passes the winter underground as a pupa which is nearly always parasitised by a small mite, *Tyroglyphus muscæ*, a serious pest to the fly. Experiments were undertaken to find out whether the mite attacks the silkworm directly. For this purpose specimens were introduced into vessels containing silkworms in various stages of development, and it was found that the mite invades both pupa and imago, but specially attacks the silkworm at the time of moulting. The silkworm gradually becomes weak and sickly looking and soon dies. The mite attacks various parts of the body of its host, particularly both the thoracic and abdominal legs, which are marked by brownish or blackish patches. Detailed descriptions are given of both the male and female mite and of the life-history, involving four ecdyses with only about twenty-four hours on an average in between the stages. It thrives best in dark and damp places, and can live for two days immersed in water, perishing under dry conditions.

STOMATAL FREQUENCY.—Some interesting facts regarding stomatal distribution in plants from various habitats, but with special reference to woodland forms, have been published by E. J. Salisbury (*Phil. Trans. Roy. Soc.*, Series B, vol. 216, pp. 1-65). Stomatal frequency in the individual leaf shows great variation, being greatest where suction force and osmotic pressure are greatest, although no general relation between stomatal frequency and osmotic pressure is suggested other than a parallel response to the operation of some other factor. Contrary to what traditional interpretations have taught us to expect, Dr. Salisbury finds stomatal frequency to be higher in sun leaves than in shade leaves, and higher in the case of plants grown under xerophytic conditions than in plants from more humid habitats. Comparison between plants grown in dry and moist air respectively indicates that stomatal frequency is mainly dependent on the humidity of the environment. The term 'stomatal index' is used to denote $100 \times S/(E+S)$, where S denotes number of stomata per unit area, and E the

number of epidermal cells in the same area. By means of this index it is shown that the *proportion* of stomata found in the epidermis is no greater in sun leaves than in shade leaves, but there is a higher positive correlation coefficient between the number of stomata and the number of epidermal cells per unit area. The differences are all shown to be due to differences in the growth of the epidermal cells, and the consequent difference in spacing of the stomata. It is claimed that with the exercise of proper precautions as to region of leaf examined and with due regard to its variable character, stomatal frequency has an important ecological significance as an indicator of the humidity of the environment.

CATALASE AND PLANT GROWTH.—The change in the growth of plants in passing from the merely vegetative phase to the reproductive phase is accompanied in the tissues concerned by a corresponding change in the type of metabolism. In *Memoir of the Cornell University Agricultural Experiment Station*, No. 106, J. E. Knott gives numerous data to correlate the catalase activity of the apical bud of spinach with this change in metabolism. When the reproductive phase begins, catalase activity decreases, but the effect seems localised in the one tissue and is only slightly evident in the leaves. Correlated with this decrease in catalase activity, there seems to be a drop in the respiratory rate as determined by the evolution of carbon dioxide. Yet it seems as if new tissue were being formed much more rapidly in the flower stalk than in ordinary vegetative growth. One would expect, therefore, a higher rate of respiration to provide the requisite energy. This increased respiration may be present, and yet not of a type resulting in the evolution of carbon dioxide or associated with catalase formation. In some types of tissue, catalase seems to be related to total respiration. Catalase from apple fruit tissue maintains its maximum activity after the material has been removed to conditions less favourable for its production, and the rapid disappearance of spinach catalase is possibly related to a lower degree of stability. The response of catalase to nitrogen and carbohydrates is interesting. Knott finds that calcium nitrate added to catalase *in vitro* decreases, while asparagin, sucrose, and soluble starch increase activity after 24 hours; *in vivo* the effects of these substances are practically the opposite, the explanation of which is a problem still to be solved. A useful modification of the Bailey hydrogen electrode for measuring the hydrogen ion concentration of liquids which froth readily is described.

PULSATIONS OF THE EARTH'S CRUST.—Part 5 of vol. 2 (Section 2) of the *Jour. Fac. Sci. Imp. Univ., Tokyo*, is devoted to an interesting paper by T. Matuzawa on pulsatory motions in the earth's crust. These were noticed long ago by Milne, but though often studied their nature remains uncertain. G. W. Walker suggested that they are due to Rayleigh waves set up at the sea bottom by water waves, caused by wind, at the surface of the sea. In Japan they are sometimes of considerable magnitude, 0·5 mm. or more, and to these the suggested explanation seems inapplicable. The paper describes the pulsations observed in Japan, and concludes that changes of atmospheric pressure play the most important part in their production. It is suggested that the movements are probably elastic vibrations of some oscillating system proper to the locality of origin.

A CLASSIFICATION OF IGNEOUS ROCKS.—A new quantitative classification of igneous rocks is proposed by E. T. Hodge, and published with a large chart in a University of Oregon Publication (Geology Series, vol. 1, No. 2, 1927). Four 'classes' based on the percentages of felspars plus felspathoids are plotted in four sectors of a circle. Each is divided radially into nineteen 'orders' based on the ratios of orthoclase to other felspars. Finally, the classes and orders are divided (by concentric belts) into seven 'ranges' based on the principle of silica saturation, beginning with quartz rocks on the outside and ending with 'metal' rocks on the inside. Any rock can therefore be placed somewhere in the resulting subdivisions, all of which can be represented on a single sheet. The arrangement is such that the quantitative mineral composition gives approximately the chemical composition. This is expressed on the chart by contour lines of percentages of the chief oxides, and it is claimed that within reasonable limits either chemical or mineral composition will place a given rock in the same pigeon-hole. There is nothing fundamentally new in the scheme proposed except the arrangement, which, however, is ingenious rather than illuminating.

BITUMINOUS SANDS OF ALBERTA.—Part 2 of the Report of the Scientific and Industrial Research Council of Alberta on the famous bituminous sands of that province, by Messrs. K. A. Clark and S. M. Blair, has now appeared, following their earlier publication on the occurrence of these resources. The problem of separation of the bitumen from the sand is not an easy one for large-scale practice, and it has been part of the policy of the Research Council to devote considerable time and money to its solution. This Report is to be read as a summary of progress and, in point of fact, is a valuable résumé of knowledge derived from comprehensive testing and experiment. Bituminous sands of the kind described are valuable both as raw materials and as sources of bitumen. In the latter connexion the chief advantages of separation are that the market available to bitumen is now more extensive than that available to the impregnated sand, and that since the freight charges on the sand are much greater than those on the bitumen alone, an artificial restriction to output is thus created. Furthermore, the manifold uses of free bitumen give to this commodity an advantage over its occurrence in the crude sand-state, in which form it is only suited to the construction of pavements and other wearing surfaces, and then only after special treatment. The authors describe the well-known hot water separation process, but dismiss it in favour of treatment of the sand with hot dilute sodium silicate solution agitated in excess of hot water, from which complete separation of the sand from the bitumen results. This procedure obviously has great practical possibilities, and though it is still in an experimental stage, it would seem as if the problem of asphaltic sands were well on the way to solution at last. The Report gives much detail of both the method and the plant employed in the work, and early industrial developments are foreshadowed.

THE BREADTH OF X-RAY SPECTRA.—There seems now to be little doubt that the great breadth observed in the lines of a number of X-ray spectra is real, in the sense of being atomic, and not instrumental in origin, but its large magnitude, of the order of ten times that to be expected from classical considerations of the damping of vibrations, is the more disconcerting from the fact that the decay of the light from hydrogen positive rays follows the classical laws fairly closely. The factors which might come into play with radiation of high frequency have been reviewed by D. Coster in the *Zeitschrift für Physik* of Nov. 18, where he has considered, amongst other effects, the possibility of an apparently simple line being actually an unresolved multiplet or a species

of band, without, however, coming to any definite conclusion. He has been able to adduce some evidence that the natural breadth arises partly within the atom, and has pointed out a rule which holds for the relatively few lines that have been examined, to the effect that the more eccentric an electron orbit corresponding to a given energy level, the less well defined is a line arising from a transition involving that orbit.

RADIO OBSERVATIONS DURING TOTAL ECLIPSE.—An interesting account of observations made during the total eclipse of June 29 last is given in *L'Onde Électrique* for Sept. 6, by H. S. Jelstrup. A large 'tilting frame' was erected at Nordre Langen in Norway, longitude 11° 51′ east of Greenwich, which was approximately in the centre of the zone of totality. The observations were made on signals emitted from the relay station for Oslo at Hamar, which consequently had to travel an appreciable distance in the overhead 'conducting layer.' The first half of the eclipse was observed in favourable circumstances, but clouds interfered with the later observations. There was a large number of sunspots, and the instants at which these were eclipsed was accurately known. The intensity of the radio signals received from Hamar was read accurately by a micro-ammeter. There was a sudden increase in the ammeter reading at the moment before totality, and this was maintained, with the exception of a few rapid and sudden fluctuations, until after the period of totality. The ammeter gave its maximum reading at the moment after totality. The most obvious explanation is that the increase is merely a night effect produced by the lunar shadow on the conducting layer. The analogy with the effects produced by the setting sun on radio signals is perfect. The mean intensity of the ammeter readings on the day of the eclipse was much greater than on the following day. Whenever the lunar disc covered a sunspot a strong rhythmical disturbance was produced. This was very pronounced when the sunspot was near the centre of the sun's meridian facing the earth. The moon interrupted sharply the radiation proceeding from the sunspot and, after the time required for the radiation to travel from the moon to the earth, produced a disturbance in the waves radiated, and probably therefore in the conducting layer. There are indications that the moon produces a deviation effect on the rays coming from the sun as it approaches it. Hence at the time of the new moon, similar radiophonic effects are probably produced.

CONDUCTIVITY OF MOLTEN GLASS.—It has been known for many years that glass when heated to a temperature above 200° C. is sufficiently fluid to act as an electrolytic resistance. It is known that the passage of the current is due to the motion of the sodium in the glass. Experiments have proved that various metals when used as electrodes migrate into the glass, which thus becomes curiously marked. It is also known to electricians that an excellent arc can be maintained between glass electrodes when the alternating pressure has a sufficiently high frequency. Hitherto, however, very little information has been available with regard to the conductivity of glass when in the molten state. This property of glass is discussed in a paper by F. F. S. Bryson read to the Society of Glass Technology on June 2 last and recently published. He finds that when an electromotive force is applied to suitable electrodes immersed in molten glass, the current which passes through the glass between the electrodes rapidly diminishes for about a minute and then diminishes gradually until the steady state is reached. This is due to a number of bubbles forming in the molten glass next the positive electrode. These bubbles are the products of electrolysis, and as they gather round the electrode they partly insulate it, thus causing the current to fall. By breaking the battery circuit it is easy to measure the back electromotive force due to the polarisation. With alternating currents of ordinary frequencies the polarisation effects are much reduced, but gas bubbles are still formed. When platinum electrodes are used, the passage of the current is accompanied by a continuous succession of minute flashes. In order to diminish the polarisation effects and so enable approximate values of the conductivity at various temperatures to be measured, the author used high frequency currents. Interesting results with various kinds of glass are obtained, the conductivity increasing enormously with the temperature. The results are of importance in practical work as they show a connexion between viscosity and conductivity, and thus indicate the possibility of using recording electrical instruments to measure the viscosity of the molten glass as it flows from the tank.

THE ATOMIC WEIGHT OF ANTIMONY FROM DIFFERENT SOURCES.—The October issue of the *Journal of the Chemical Society* contains a paper by K. R. Krishnaswami, giving the results of a determination of the atomic weights of five samples of antimony. The metal was extracted from stibnite and cervantite from India and Burma and from Kahlbaum's antimony trioxide, as the trichloride, which was converted into the oxide and reduced. Antimony tribromide was then prepared in an atmosphere of nitrogen and the bromide estimated as silver bromide. The results ranged from 121·744 to 121·754 and are in good agreement with those of other workers in recent years. Muzaffar in 1923 obtained values varying from 121·444 to 122·374, using antimony from different sources, but his method appears, according to Krishnaswami, to be more difficult in practice than the one outlined above.

CONSTRUCTION OF DAMS.—In the usual types of dam—arched and otherwise—employed for power or irrigation purposes, provision has to be made for running away the surplus water retained during flood periods and periods of minimum demand, because if the water were simply allowed to run over the sill and fall hundreds of feet below, it would seriously impair the structure of the dam. Hence tunnels, derivation canals, etc., have to be arranged for, often at great expense. To overcome these difficulties, two French engineers, Messrs. Mesnager and Veyrier, have invented and patented a new type of arched dam which is being tried out in the barrage of the Upper Dordogne at Marège. In this type, instead of the direct fall from the sill to the lower level, the fall is split up into sections of 30-50 ft. in height by a number of partitions forming retaining basins which break the force of the water due to the eddying effect set up. These partitions are comparatively thin, and in order to ascertain whether they would stand up to the pressure of the water, experiments were carried out on small-scale models; and, by using mercury as the test liquid, the same effect was obtained as would be caused by the high pressure of water on the walls of the full-scale dam. According to *La Nature* of Dec. 1, in which the experiments are described, the tests have shown that the walls of the dam as actually designed will have a coefficient of safety of from 4 to 5. The experiments are judged of sufficient importance in France to be supported by generous grants from certain Government departments.

Prize Awards of the Paris Academy of Sciences.

AT the annual public meeting of the Paris Academy of Sciences the prizes and grants awarded in 1927 were announced as follows :

Mathematics.—The Francœur Prize to Georges Cerf, for his work on partial differential equations.

Mechanics. — The Montyon Prize to Dimitri Sensaud de Lavaud, for his work on the steering of motor-cars : the Poncelet Prize to Henri Villat, for his works on the mechanics of fluids.

Astronomy.—The Lalande Prize to Vincent Nechville, for his researches on star streams : the Valz Prize to Lucien d'Azambuja, for his work on sunspots, the solar prominences, and chromosphere : the De Pontécoulant Prize to Emile Paloque, for his work on the analytical theory of the movement of the Trojan planets.

Geography.—The Gay Prize to Henri Humbert, for his work in Madagascar : the Tchihatchef Prize to Jean Delacour and Pierre Jabouille, for their ornithological work in Indo-China.

Navigation.—The prize of six thousand francs between André Courtier (2500 fr.) for his work on hydrographical data and the prediction of tides : Pierre Changeux (2500 fr.) for his general study of the dynamics of ships or apparatus utilised in marine or air navigation : Edouard Davaux, for his "Cours d'electrotechnique" : the Plumey Prize (in equal parts) between Etienne Hugé, for his memoir on the pulverisation and combustion of mazout in marine boilers, and Marcel Gautier, for his memoir on the utilisation of the Diesel motor.

Physics.—The Gaston Planté Prize to Gabriel Foëx, for his work on magnetism : the Hébert Prize to Pierre Sève, for his work on alternating currents : the Henri de Parville Prize to Paul Girault, for his work in electrotechnics : the Hughes Prize to Georges Reboul, for his researches on the radiation of badly conducting bodies through which an electric current is passing : the Pierson-Perrin Prize to Fernand Holweck, for his work on X-rays with wave-lengths between 14 A. and 500 A. : the Clément Félix Prize to Alexandre Dauvillier, to assist him in his researches on X-rays of great wave-length with special reference to their biological properties.

Chemistry.—The Montyon Prize (Unhealthy Trades) to Emile Kohn-Abrest (2500 fr.) for his work on poisonous gases, and an honourable mention (1500 fr.) to Edmond Rolants, for his book, "Les eaux usées" : the Jecker Prize (in equal parts) between Georges Chavannes and André Kling, for the whole of their work : the Cahours Foundation to Clément Duval, for his work on nitrates : the Houzeau Prize to Augustin Damiens, for his work on the existence of bromine in animals and on the phenomena of allotropy.

Mineralogy and Geology.—The Cuvier Prize to Emile Argand, for his work on structural geology, and especially his researches on the Pennine Alps : the Delesse Prize to Charles Jacob, for the whole of his geological work : the Victor Raulin Prize to Fernand Daguin, to assist in the publication of his memoir on the geology of northern Morocco : the Joseph Labbé Prize to André Demay, for his geological work on Pechelbronn petroleum, Carthagena, and Huelva.

Botany.—The Desmazières Prize to V. Likhité, for his book on researches on the development and biology of some Ascomycetes : the Montagne Prize to Adrien Davy de Virville, for his work in experimental morphology relating to the mosses : the de Coincy Prize to Pierre Bugnon, for his botanical work : the Rufz de Lavison Prize to Lucien Plantefol, for his biological study of the moss *Hypnum triquetrum*.

Anatomy and Zoology.—The Da Gama Machado Prize to Henri Neuville, for his work on the skin of the elephant and mammoth : the Savigny Prize to Maurice Langeron, for his pathological researches in Africa, Crete, and the Eastern Mediterranean.

Medicine and Surgery.—Montyon Prizes to Raoul Bensaude (2500 fr.), for his work entitled, "Traité d'endoscopie, rectoscopie, sigmoidoscopie" : to Henri Carré (2500 fr.), for his "Recherches expérimentales sur une ectodermose neurotrope du chien : la maladie des chiens" : to Constantin Levaditi (2500 fr.), for his work entitled "L'herpes et le zona, ectodermoses neurotropes." Honourable mentions (1500 fr.) to Jean Barotte and Achille Urbain, for their memoir "Étude des teignes du cheval et de l'immunité dans les teignes expérimentales" : to Jean Verge, for his experimental researches on a dipthero-variolic affection of birds, and to Christian Zœller, for his researches on diphtheria. A citation to Émile Frache, for his work, "Les fouets et le mouvement des bactéries," and to Gustave Lesbouyries, for his work on the tuberculosis of the domestic carnivora.

The Barbier Prize to André Léri, for his work on affections of the bones and articulations : the Bréant Prize to Charles Dopter and Paulin Vezeaux de Lavergne, for their work on epidemiology : the Godard Prize to René Herpin, for his biological researches on the reproduction and development of some polychætal annelids : the Chaussier Prize to Edmond and Etienne Sergent, for their twenty-five years' work on the study and prophylaxy of paludism in Algiers : the Mège Prize to Félix Ramond, for his book on the diseases of the stomach and duodenum : the Bellion Prize to Jean Rieux, for his work on latent pulmonary tuberculosis ; Grégoire Ichok receives an honourable mention : the Larrey Prize to Jean Jacquemart and Charles Clavelin, for their memoir, the military health service in times of peace and of war : the Argut Prize to André Charles Guillaume, for his work on light radiations in physiology and therapeutics.

Physiology.—The Montyon Prize to Louis Merklen, for his memoir on the rhythm of the heart during muscular activity, especially when due to games : the Pourat Prize to Antoine Magnan, for his work on the mode of flight of birds with application to the construction of aeroplanes : the Philipeaux Prize to Mlle. Eudoxie Bachrach, for the whole of her work in experimental physiology, with an honourable mention to Marc Jacot for his memoir on glycogen, adrenalin, and insulin.

Statistics.—The Montyon Prize to Jean Gérard, for his book on ten years of industrial effort.

History and Philosophy of Science.—The Binoux Prize to Henri Daudin.

Works on Science.—The Henri de Parville Prize to Fernand Monpillard (2000 fr.), for his book, "Macrophotographie et microphotographie," and Mme. Valentine Allorge-Gatin (1000 fr.) for the "Dictionnaire de botanique," by (the late) Ch. L. Gatin.

Medals.—The Berthelot medal to Emile Kohn-Abrest, Clément Duval, and Augustin Damiens.

General Prizes.—The Grand Prize for Physical Sciences to Georges Bohn, for his work in biology and comparative physiology : the Alhumbert Prize to Henri Longchambon, for his researches on triboluminescence : the Lallemand Prize to André Lwoff, for his work on the pigments in Copepods : the Maujean Prize to Raymond Sabouraud, for his work on the cure of ringworm : the Petit d'Ormoy Prize (Mathematical Sciences) to Ernest Vessiot, for the whole of his work : the Petit d'Ormoy Prize (Natural Sciences)

to Lucien Cuénot, for his zoological work: the Le Conte Prize to Alexandre Yersin, for the whole of his work: the Parkin Prize to M. and Mme. Jacques Tréfouel, for their work on certain carbon compounds and their therapeutic action: the Saintour Prize to Stanislas Zaremba, for his work in mathematical analysis: the Lonchampt Prize (in equal parts) between André Liot, for his memoir on the culture of the pyocyanic bacillus in chemically defined media, and Michel Machebœuf, for his researches on the rôle of nickel and cobalt in animals and on the phosphorus compounds of the blood: the Wilde Prize to Jacques Duclaux, for the whole of his work: the Gustave Roux Prize to Jacques Fromaget, for his geological work in Annam: the Thorlet Prize to Adolphe Richard.

Special Foundations.—The Lannelongue Foundation between Mmes. Cusco and Rück: the Hélène Helbronner Prize to Mme. Schrader.

Prizes of the Grandes Écoles.—The Laplace Prize to Marcel Alliot: the L. E. Rivot Prize between Marcel Alliot, André Ligouzat, Raymond Cheradame, and Charles Feyrabend.

Funds for Scientific Research.—The Trémont Foundation to Marcel Jobelot, for his apparatus for the automatic inflation of captive balloons: the Gegner Prize to Francisque Dumont, for his work in geometry: the Hirn Foundation to René Fabre, for his work relating to fluorescence and its applications in analysis and in biology: the Henri Becquerel Foundation to Louis de Broglie, for his work in wave mechanics, atomic structure of matter and radiation: the Charles Bouchard Fund to Gustave Rappin, for his work on cancer and tuberculosis: the Pierre Lafitte Prize to Henri Abraham, for the whole of his work in radio telegraphy: the Roy-Vancouloux Foundation to A. Borrel, for his work on cancer.

Anti-Malarial Measures in Europe.

THE second general report of the Malaria Commission of the League of Nations, recently published, deals with "Principles and Methods of Anti-malarial measures in Europe." The report is divided into three sections. No. 1 gives a summary of the Commission's views on measures for dealing with malaria in Europe; No. 2 is entitled "Arrangements for studying Malaria"; and No. 3, "Prevention and Control of Malaria."

Section 1 is divided into sixteen parts, each followed by a short 'conclusion' of some half-dozen lines or usually less. These conclusions represent the 'average opinion' of the Commission based upon observation and consultation in many European countries. (A map of the study tours is provided.) They have an unexpectedness about them, very soothing to those who have been constantly told but have not entirely believed, that malaria could be, had been, or was being eradicated in all kinds of places and under all kinds of varying conditions from China to Peru, by this or that or the other panacea. Here is the first shock! "When the discovery of the mosquito cycle of the parasite was made, it was almost universally believed that a single simple method had been put within our grasp, capable of application in all malarious districts. Since then nearly three decades have passed, and such a method is still to seek." But the following is still more disturbing. "The history of special 'anti-malarial campaigns' is chiefly a record of exaggerated expectations followed sooner or later by disappointment and abandonment of the work."

Whether we agree completely with these estimates or not, there can scarcely be any doubt in the minds of those who have pondered over the matter, "that the only prospect of real progress lies in the renewed activity in the continuous study of the disease in all its aspects." We well remember the time when it was considered hyper-scientific to urge that anti-mosquito measures should be confined to killing those mosquitoes known to transmit malaria. It was considered to be more 'practical' to destroy all mosquitoes in one great holocaust.

How refreshing the idea that it is not always necessary to deal with malaria by a method arising directly out of the knowledge that the disease is transmitted by mosquitoes, and how sane the advise that "the treatment of malaria-infected persons is one of the most important measures even from the point of view of prevention."

The subject of 'Bonification' is discussed at length. The Italians do not regard large bonifications as an anti-mosquito measure, and they know that such a bonification may increase the abundance of Anopheles in the area reclaimed; but bonification means a better standard of life, and when that is attained, malaria tends, more or less quickly, to lose its importance as a cause of sickness or death. It would take too long to argue here that bonification has been the cause of the disappearance of malaria from England. Bonification, education, is perhaps the fundamental factor in anti-malarial measures. The anti-malarial factor in general schemes of bonification is the change in the conditions of life of the inhabitants. It has been said that "Le remède du paludisme est dans la marmite." It certainly lies in the schools. We welcome this report as a sane corrective to the exaggerated claims that are often made for this or that anti-malarial measure. The third portion of the report discusses various anti-malarial and anti-mosquito measures, such as the use of quinine and larvicides such as Paris green and liquid paraffin.

This second report is as stimulating as the first report issued in 1926. A summary of it by Lieut.-Col. S. P. James will be found in the *British Medical Journal* for Aug. 27, 1927.

Stereoscopic Photographs of Crystal-Structure Models.

A VERY handy little folding stereoscope has been placed on the market by Messrs. Adam Hilger, Ltd., under the name of a 'camerascope,' together with a series of double (stereoscopic) photographs of crystal-structure models, prepared under the direction of Sir William and Prof. W. L. Bragg, to illustrate the more striking and fundamental results of the X-ray analysis of crystals. Both the instrument, when its three hinged parts are folded together (the two outer ones upon the middle basal part), and the forty-one cards on each of which a complementary stereoscopic pair of photographs is printed, fit neatly into a cardboard box so small (5 in. × 4 in. × 1½ in.) as to go conveniently into the coat pocket. As regards the instrument itself, the front plate of the three thin metallic (blackened) parts, which is arranged upright at right angles to the basal part when unfolded, carries the two stereoscopic lenses, and has a hole of suitable shape and size cut out of it to admit the nose; while the corresponding back-plate, also upright when opened out, is the stage and is fitted with suitable grooves and retaining guides for the reception of any one of the picture-cards, which are 4½ in. × 3½ in. in size.

On placing one of the cards in position, and bringing the instrument so close to the face that the lenses are close to the eyes, one sees the model of some crystal-structure or other, or an instrument (X-ray spectroscope, for example)—whatever it is that is photographed on the card—standing out in the three dimensions of space, as if one were looking at the actual object itself. Users of reading spectacles are recommended, and will find it necessary, to retain them, as no adjustment of the lenses is arranged for, the focus provided being that for normal vision.

Of the forty-one cards supplied, thirty-five are stereoscopic pairs of photographs of models, representing the crystal structure of the more important substances which have been satisfactorily analysed by means of the X-ray spectrometer or spectrograph. Among them are rocksalt, fluorspar, diamond, zinc blende, iron pyrites, spinel, calcite, aragonite, ruby or sapphire, graphite, ice, quartz, barytes, beryl, chrysoberyl, lithium potassium sulphate, cæsium chloride, naphthalene, tartaric acid, and racemic acid. Among the rest are stereoscopic photographs of the Bragg X-ray spectrometer, and of the X-ray spectrograph of Dr. Müller, the latter as arranged in three different ways, for the Debye powder method, the Bragg method, and the Laue and rotating crystal methods.

This use of stereoscopic pictures to represent objects, and in particular models of crystal structure, in relief in the three spatial directions, which is the next best thing to seeing the objects themselves, is not new. Prof. P. von Groth, the veteran crystallographer of Munich, in 1921 issued with his book on crystallography ("Elemente der physikalischen und chemischen Krystallographie") just such a series, twenty-five in number, of stereoscopic picture cards, a little larger than those issued by Messrs. Hilger, packed in convenient pockets on the inside of the front and back covers of the book. These Groth photographs can be used quite well with Messrs. Hilger's little stereoscope, provided the size of the cards be somewhat reduced to fit the stage, by cutting away superfluous margins, the photographs themselves being only very slightly larger than the Hilger ones, to fit a stereoscope of ordinary standard size.

The Hilger instrument is wonderfully effective, and should prove both useful and instructive to all who endeavour to follow the results of X-ray crystal analysis, but have not the immediate opportunity at hand of seeing the actual models or instruments themselves.

A. E. H. TUTTON.

University and Educational Intelligence.

HULL.—Mr. T. R. Ferens has given a further sum, of £22,500, to the newly established University College. This brings Mr. Ferens' gifts to the College to about £300,000. He has asked that £20,000 of his latest benefaction should be set aside for endowing a chair.

The foundation stone of the new buildings will be laid on April 28, when the Duke and Duchess of York will visit Hull.

Mr. A. C. Hardy, zoologist to the recent *Discovery* expedition to the Antarctic, will be the first professor of zoology at the University College.

THE first professorship of the geology of fuel (petroleum and coal) at a German technical school has been created at Freiberg in Saxony. The occupant is to be Dr. Otto Stutzer, who has also been elected director of the new fuel institute at the School of Mines.

THE annual report for 1926–27 of the Battersea Polytechnic, of which Mr. G. F. O'Riordan, formerly principal of the Leicester College of Technology, is now principal, shows that the total enrolment during the session was 3019, of whom 449 were full-time students, including 230 (the highest enrolment for many years) in the Training College of Domestic Science Teachers. The number of students preparing for university degrees was 219, and the number of degrees obtained was 37, including two Ph.D. and two M.Sc. degrees. A substantial amount of research work was done by the staff and students.

FROM the Hokkaido Imperial University of Japan we have received a volume published to commemorate the fiftieth anniversary of the founding of the Sapporo Agricultural College in which the University had its origin. The college was established under the guidance of Dr. W. S. Clark, of the Massachusetts State Agricultural College, who came over from America in 1876 for the purpose, and for eight months controlled its administration. For some years the college remained under American tutelage, but by 1893 all foreign guidance had been dispensed with and the professors were all Japanese. The University's indebtedness, however, to the Americans who shaped its beginnings is gratefully recognised, and the memory of Dr. Clark, in particular, is cherished with enthusiasm. It is noteworthy that his influence was strongly tinctured with religion. He introduced the Bible as a medium of literary and ethical instruction, and conducted daily religious exercises. The University comprises now schools of agriculture and forestry, medicine, technology, and fishery; its instructional staff numbers 240, its student enrolment exceeds 2000, its farms cover 15,000 acres, it has 245,000 acres of experimental forest lands, and its budget exceeds three million yen. With the exception of three instructors in English (all from the United States) and two in German, the staff is exclusively Japanese.

IN "Universities in the United States" (University of London Press, price 2*s*.), Dr. Edwin Deller, Academic Registrar of the University of London, describes impressions received in the course of a three-months' tour in the spring of 1926 undertaken by him at the request of the Laura Spelman Rockefeller Memorial trustees. His tour embraced institutions in the east and middle west and in California. His dominant impressions are concerned with the process of popularisation which has been such a marked feature of the recent history of university education in America. The difficulties involved in dealing with the vast multitude of students who come up imperfectly prepared and with no clear objective in mind are, he found, being faced with admirable courage, energy, and resource. He was much struck by the combination of stimulating faith in the universities, with frank recognition of their shortcomings and anxiety to trace these to their sources. He found a general desire to learn from and profit by the experience of other countries. The strongest feature of the American university is the provision for the graduate student. This has already helped to establish the prestige of America in universities in other countries, and promises even greater developments in the near future. In this connexion attention is directed to the tendency observable in some quarters to regard the education of the undergraduate as a task unworthy of the energies of a great university. English experience suggests, Dr. Deller points out, that to bear their best fruit undergraduate and graduate studies flourish best together, but conditions are more favourable in the United States for the experiment of limiting the activities of some universities to graduate work.

Calendar of Customs and Festivals.

January 18.

EPIPHANY AND OTHER OBSERVANCES OF THE GREEK CHURCH.—As the Greek Church retains the Old Style Calendar, Epiphany falls twelve days later than in western Europe. It is a festival held in great regard throughout the Greek Church; but in Rumania the baptism of Jesus Christ is celebrated with special solemnity as one of the most important feasts of the year. It is to be noted that in both ecclesiastical ritual and in popular custom, the observances of this day involve a ceremonial connected with water. In Bukarest, after the Church service a solemn progress, in which the royal family takes part, is made to the River Dambovitza, where, after a service, a gold and enamelled cross is thrown into the river. Men standing by, stripped to the elaborately embroidered shirts which form a characteristic part of the gala national costume, jump into the river, and the one who retrieves the cross receives a present from the king.

In Constantinople a similar procession of dignitaries of the Greek Church goes to "bless the waters of the Bosporus," and a similar religious or semi-religious ceremonial is observed in southern Greece, where it is known as "diving for the cross." Some light is thrown upon the custom when the immersion is involuntary, as in Macedonia, where it is the custom to thrust someone into the water—a river, the sea, or even a pond or well, the victim receiving a reward for his immersion. On emerging from the water he should sprinkle as many of the bystanders as possible with drops of water. The reward is spent on a banquet.

This popular custom suggests a remote origin in a propitiatory offering to the spirit of the waters, while sprinkling the bystanders with the drops of water is in keeping with the belief in the special 'healing efficacy' of the water at this time of the year. Hence also the general desire for baptism at this season. In the Ethiopian Church, all baptisms of the year were reserved for this day. In Rumania, where it is also a specially favoured day for baptism, children baptised at the same time are known as 'brethren of the cross,' and throughout their lives stand in a specially intimate relation one to another. Should one be dying, unless his 'brother' is chained to him and solemnly released by a third person, the 'brother' will also suffer an early death.

EPIPHANY IN MACEDONIA.—Here the twelve days leading up to Epiphany are a period when magical influences are peculiarly potent. On the eve of Epiphany a general cleaning up of the house takes place, and the ashes which have been allowed to accumulate on the hearth are cleared away. With these go the evil influences lurking in the house, and especially the Karkantzari, malicious fiends at night, of human form by day. These beings would appear to be related to the werewolf. No marriages are celebrated while they are about. They may perhaps be credited, therefore, with similar powers to those of the witch who, by 'tying knots,' may cause impotence and render marriage unfavourable at critical seasons.

January 19. (O.S. January 7.)

FEAST OF ST. JOHN THE PRECURSOR AND BAPTIST.—This festival is observed in the Balkans (Macedonia) by a custom analogous to the carnival customs celebrated later in the Ægean. Parties of old men dressed in goat's skin or old clothes, and girt with chains of bells, parade the streets collecting money by terrorising rather than by amusing. Both their attire and the feeling they aim at inspiring would relate them to the awestriking powers of Nature, later symbolised by Pan and his attendants. Milder in form and character are the 'precursors,' each heading a band of eight or ten men, who go from house to house, and are regaled at loaded tables. They then take away everything they have not already consumed in skins and bottles carried for them by boys. In return for their entertainment, the leader improvises highly eulogistic songs on each member of the family.

In Rumania, on the night of Jan. 6 (O.S.), boys obtain from the priest the aspergil, partly composed of basil (a peculiarly 'holy' plant in Balkan belief), used that morning in the Epiphany ceremonial of scattering holy water after the service on bystanders outside the church. They then proceed to visit the houses of the village, and each member of the household is whirled round and round. On the next morning, Jan. 7, they stand at the door of the church and do the same to each one of the congregation, as well as the priest, as they enter. Beyond attributing it to a pagan origin, no explanation has been offered for this custom, but as the solemn canticle of the Epiphany ceremony is sung on entering each house, it is clearly an attempt to extend the sanctifying influence to each member of the community, while the whirling round has all the appearance of a fertility custom.

January 21.

ST. AGNES, ROMAN VIRGIN AND MARTYR, whose chastity was miraculously preserved against all assault, when consigned to the stews of Rome on her refusal to marry the son of the prefect. He, being struck dead for his attempt on her, was restored to life by her prayers. By popular clamour she was condemned to the flames as a witch, but when they refused to consume her she was beheaded on the pyre. Eight days after her martyrdom she appeared to her parents in a company of virgins with a lamb by her side. Hence the lamb is her symbol, and each year in the Basilica to her memory at Rome twin lambs are blessed, and from their wool the pallium of the archbishops is woven.

In view of the history of the saint, it is not surprising that in popular belief her festival, or rather the eve of her festival, should be associated with divination in relation to marriage. Burton, in his "Anatomy of Melancholy," speaks of maids fasting on St. Agnes Eve, and Aubrey gives directions how by sticking pins in a sleeve to the accompaniment of paternosters, a dream of the future partner in marriage may be obtained. The belief was generally prevalent throughout England. A ritual was observed and an invocation addressed to St. Agnes before retiring. Certain precautions had to be observed, such as that no man should kiss the inquirer on that day, and she should wear a clean white shift. In Scotland the custom was that a number of those seeking to know their future husband or wife met at midnight. Each proceeded alone to a certain cornfield, and threw in some grain, repeating a verse invoking the saint. That night the saint granted him or her a vision of the future partner in a mirror.

January 22.

ST. VINCENT'S DAY.—One of the numerous days at about this time of the year associated with weather lore. The return of spring was a matter of special moment to an agricultural or pastoral community. Hence the exhortation to "remember if the sun shine on this day."

Societies and Academies.

CAMBRIDGE.

Philosophical Society, Dec. 5.—**W. H. Mills** and **K. A. C. Elliott**: Molecular dissymmetry dependent on restricted rotation about a single linking. The optically active forms of benzenesulphonyl-8-nitro-1-naphthylglycine. The ordinary criteria which enable the existence of molecular dissymmetry in a compound to be predicted from its structural formula do not indicate that perididerivatives of naphthalene of the type $C_{10}H_6 \left< \begin{matrix} NR_1R_2 \\ NO_2 \end{matrix} \right.$ should be obtainable in enantiomorphous modifications. It has proved possible to demonstrate experimentally that this type of dissymmetry actually exists in the benzenesulphonyl derivative of 8-nitro-1-naphthylglycine.—**F. G. Mann**: Note on the configuration of the tetrammino-platinous complex. The uniplanar configuration was first allotted to the tetrammino-platinous complex by Werner in order to explain the existence of two forms of dichloro-diammino-platinum $[Cl_2Pt(NH_3)_2]$. Reihlen and Nestle, however, consider these two forms to be not isomeric but polymeric, and assign the tetrahedral configuration to the platinous complex. It seems highly probable that certain complex platinous salts have the tetrahedral configuration, and that the configuration of any particular complex salt is determined mainly by the nature of the co-ordinating groups.

COPENHAGEN.

Royal Danish Academy of Science and Letters, Nov. 4.—**P. O. Pedersen**: Composition, pressure, temperature, and electrical conductivity of the air at high altitudes in the light of radio-wave propagation.

Nov. 18.—**Niels Bohr**: The quantum postulate and the recent development of atomic theory. The dualism which characterises the formulation of the quantum theory has received much illumination through the recent great progress of atomic theory. In the present state of science, this dualism would seem unavoidable and may be regarded as a direct expression of the fundamental limitation of the ordinary principles of classical physics postulated by the quantum theory.

Dec. 2.—**Johs. Lindhard**: The elasticity of skeletal muscles. Experiments show that the coefficient of elasticity decreases when the muscle is stimulated.

GENEVA.

Society of Physics and Natural History, Nov. 3.—**R. Wavre**: The heterogeneous fluid mass in rotation and geodesy. The author demonstrates that Stokes's theorem relating to the Newtonian potential of a heterogeneous fluid mass in relative equilibrium $U_{ext} = F(S, \omega = c, M)$ can be extended to all cases where the angular velocity is a function of the distance from the axis, that is to say, to any planet of which the layers of equal density are horizontal at each point.—**W. H. Schopfer**: Physico-chemical researches on some parasites of fresh- and salt-water fishes. The experiments show that the parasites studied have a Δ very near that of the intestinal liquid of their host and also of that of the internal medium of the latter.—**L. Duparc, E. Molly, and A. Borloz**: Birbirite, a new rock. The authors have found in Abyssinia and in Serbia a quartz rock containing on the average 90 per cent. of silica, composed of grains of quartz, sometimes spherolitic, covered with a mass formed of quartz grains and isotropic material.—**M. Gysin and L. Duparc**: The phenomena of magmatic and secondary Uralitisation. The gabbro diorites of the northern Ural show a magmatic transformation of pyroxene into brown hornblende and a secondary transformation of the latter into a blue amphibole.—**A. Schidlof**: The geometrical representation of the mass of a material point in a universe of five dimensions. The author indicates a geometrical interpretation of the great difference which exists between the mass of the proton and that of the electron.—**Raoul Pictet**: Experimental demonstration of the potential of the ether. Its consequences in the physical theory of the properties of vapours and gases. The author completes the account of the subject given in the meeting of Oct. 20.

Nov. 17.—**G. Tiercy**: A new method for determining the form of the light curve of a variable star. The author measures on a photographic plate the lengths of the spectra and the widths of the lines. These two magnitudes are connected by a simple relation which allows of the construction of the light curve of a variable star.—**A. Brun**: The augite and chrysolite of Stromboli. The augites of Stromboli lend themselves to crystallographic measurements if the surface is cleaned by immersing for some seconds in hydrofluoric acid. They contain as inclusions chrysolites of small dimensions not permitting of exact measurement.—**A. Brun**: Change of the parameters of magmatic augite. If the edge (011) $(0\bar{1}\bar{1})$ is taken for the axis of x, y and z remaining the same, the law of Bravais is completely verified (the law connecting the frequency of the faces and their reticular density).—**Gr. Gutzeit**: A colour reaction of the vitasterins. A suitable solution of antimony trichloride and hydroxylamine hydrochloride allows a colorimetric estimation of the vitasterins and appears to permit of a separate estimation of the A and D factors.—**L. Duparc and E. Molly**: An Abyssinian augitite. This rock contains augite and magnetite as phenocrystals in a vitreous mass with grains of magnetite and microlites of augite. It contains 42 per cent. of silica.—**E. Briner and A. Van der Wijk**: The effect of moisture on the peroxidation of oxide of nitrogen. Experiments made with the reactions ammonia and hydrochloric acid, hydrogen and chlorine, oxide of nitrogen and chlorine, propylene and bromine, appear to show that the action of moisture is especially exerted in the formation of heteropolar compounds.—**R. Wavre**: A useful formula for geodesy. Supposing, in a fluid star in permanent movement of rotation, layers of equal density normal at each point to the field of gravity, the mean curvature of the surface at a point can be determined by means of the formula

$$\frac{dg}{dn} = Cg + \Delta Q - 4\pi\epsilon\rho.$$

—**R. Pictet**: A gas cycle transforming into energy the whole of the heat furnished to the cycle. According to the author, it should be possible to realise with the aid of a gas a cycle furnishing the total transformation of the heat utilised into mechanical work.

ROME.

Royal National Academy of the Lincei. Communications received during the vacation.—**A. L. Herrera**: Thermotropism and constants of the colpoids. Like mobile cells and microscopic organisms, colpoids exhibit positive thermotropism, this effect being due to increase in the osmosis, and to increased intensity of the currents on the membrane and of the chemical reactions on the heated side. Moreover, as regards their movements, colpoids are subject to minimum, maximum, and optimum temperatures;

The presence of lactose increases the osmotic pressure and determines the formation of enormous colpoids, which have the shape of horse-shoes and imbibe at their extremities.—**L. Petri**: Further investigations on the application of fluoroscopic analysis to normal and pathogenic vegetable tissues. Contrary to the indications of earlier experiments, the alcoholic extract of chlorophyll, carotin, and xanthophyll obtained from leaves killed by boiling water, always contains part of the photo-luminescent ingredient. The properties of this substance show that it must be placed among the glucosides.—**R. Caccioppoli**: Quadrature of plane and curved surfaces.—**G. Supino**: Influence of perforations on the elasticity of a plate. —**V. Ronchi**: Distortion: a new interpretation of an old experiment.—**F. Ruda**: Explanation of the 'green ray.' Julius has explained the observed long duration of the so-called green ray, in comparison with the theoretical duration, by assuming that, in the neighbourhood of the horizon, the atmosphere exhibits anomalous dispersion of the sun's light for the waves comprised between Fraunhofer's lines E ($526{\cdot}97\,\mu\mu$) and F ($486{\cdot}06\,\mu\mu$). A consequence of this assumption would be a sensible difference between the index of refraction of air devoid of, or poor in, ions and that of air rich in ions. The author's experiments fail to reveal any such difference. —**M. L. Pagliarulo**: Further researches on natural rotatory and refractive dispersion. The rotatory dispersion of monoisoamyl aspartate is distinctly anomalous and of the same type as that of monoethyl aspartate. Between the rotatory and refractive dispersions there exists a close relationship, which is not evident from the dispersion curves themselves, but is made manifest by calculating the finite differences of the indices for successive wave-length intervals and representing these graphically.—**G. Mezzadroli** and **G Gardano**: The formation of formaldehyde and sugars by the action of ultra-violet rays on alkali and alkaline-earth bicarbonates. These bicarbonates are decomposed by ultra-violet rays with velocities which are greatest for the calcium, and least for the sodium salt. The amount of aldehyde obtained is greater from ammonium bicarbonate than from the alkali bicarbonates, but the greatest yield of formaldehyde is furnished by calcium bicarbonate. —**L. Fernandes**: Investigations on sulpho-salts. (4) Certain derivatives of a hypothetical thioacquic acid. Various methods of preparation are available for obtaining parasulphomolybdates of the form $[H_3(MoS_4)_6]^{R'_5}_{H_4}$ which are the sulphur analogues of the paramolybdates. The ammonium compound decomposes readily, but is stable in the presence of ammonia.—**B. Monterosso**: Preliminary observations on the biology of the genus Scytodes (Walck) (Araneæ veræ, Sicariidæ).—**A. Busacca**: Histological changes encountered in the naphthalene cataract when the crystalline fibres are examined in a surviving condition. The first alterations in the crystalline fibres with animals to which naphthalene has been administered orally are intra-cytoplasmic and consist in the disappearance of the more refractive droplets in the cytoplasm of the more peripheral fibres. These droplets increase in number until they occupy the whole fibre, the chondroma at the same time breaking up and disappearing. The changes afterwards extend to the inner fibres.—**G. Testi Dragone**: Contribution to the study of the fluorescence of chlorochrome in ultra-violet rays. When exposed to the influence of ultra-violet rays, chlorochrome exhibits a red fluorescence of various gradations. This fluorescence is obtained *in vitro* only when the chlorochrome is in solution, but it is visible in the living chloroplasts.

Official Publications Received.

BRITISH.

Leeds University. Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing, during the Session 1926-27. Pp. 14. (Leeds.)

Quarterly Journal of the Royal Meteorological Society. Vol. 53, No. 224, October. Pp. 327-467. (London: Edward Stanford, Ltd.) 7*s*. 6*d*.

Journal of the Manchester Geological Association. Edited by Laurance H. Tonks. Vol. 1, Part 1, 1925-6. Pp. 62. (Manchester.) 7*s*. 6*d*.

FOREIGN.

Smithsonian Institution: United States National Museum. Bulletin 100, Vol. 6, Part 4: *Contributions to the Biology of the Philippine Archipelago and adjacent Regions.* Report on the Echinoidea collected by the United States Fisheries Steamer *Albatross* during the Philippine Expedition, 1907–1910. Part 1: *The Cidaridae.* By Theodor Mortensen. Pp. iii+249-312+plates 48-80. (Washington, D.C.: Government Printing Office.) 45 cents.

Department of Commerce: U.S. Coast and Geodetic Survey. Special Publication No. 134: Geodetic Operations in the United States, January 1, 1924, to December 31, 1926. (Report to the Section of Geodesy of the International Geodetic and Geophysical Union, International Research Council.) By William Bowie. Pp. iii+34. (Washington, D.C.: Government Printing Office.)

CATALOGUES, ETC.

Calendar for 1928. (London: British Museum (Natural History).)

Calendar for 1928. (London: *The Chemical Trade Journal and Chemical Engineer.*)

Calendar for 1928. (Newcastle-on-Tyne: C. A. Parsons and Co., Ltd.)

Diary of Societies.

SATURDAY, JANUARY 14.

BRITISH PSYCHOLOGICAL SOCIETY (at Royal Anthropological Institute), at 3.—Dr. C. S. Myers: The Influence of the Menstrual Cycle on Muscular and Mental Efficiency. (An investigation carried out on behalf of the Industrial Fatigue Research Board by S. C. M. Sowton and Dr. C. S. Myers.)—J. W. Cox: Mechanical Aptitude: Its Existence and Measurement.

INSTITUTION OF MECHANICAL ENGINEERS (Bristol Branch) (at Bristol).—Prof. C. J. Hawkes: The Marine Oil-Engine (Thomas Lowe Gray Lecture).

MONDAY, JANUARY 16.

VICTORIA INSTITUTE (at Central Hall, Westminster), at 4.30.—Dr. W. Bell Dawson: The New Testament Era in the Sequence of Prophecy.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—G. M. Lees: The Physical Geography of South-East Arabia.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: A Review of Hunter's Experiments of Growth and Grafting, and the Interpretation of his Results in the Light of Modern Discoveries.

RAILWAY CLUB (at 25 Tothill Street, S.W.), at 7.30.—Lieut.-Col. W. R. Mansfield: Timetables, Old and New.

ROYAL SOCIETY OF ARTS, at 8.—Dr. A. E. Dunstan: The Scientific Foundation of the Refining of Petroleum (Cantor Lecture) (I.).

CHEMICAL INDUSTRY CLUB, at 8.—J. Hill: The City Churches.

HUNTERIAN SOCIETY, at 9.—Dr. H. Kelly: Emergent Gynæcology (Hunterian Lecture).

ROYAL SOCIETY OF MEDICINE (Social Evening), at 9.15.—Dr. Jane Walker: Saints, Medicine, and Surgery.

INSTITUTION OF THE RUBBER INDUSTRY (Sales Section) (at Engineers' Club, Coventry Street).—C. Tullberg: Art of Window Dressing.

INSTITUTE OF BREWING (London Section) (at Charing Cross Hotel).—J. Stewart: Malting Barleys of 1927.

UNIVERSITY OF BIRMINGHAM CHEMICAL SOCIETY (at Birmingham University).—Prof. W. N. Haworth: Presidential Address.

TUESDAY, JANUARY 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—P. R. Coursey: The Development of Dielectrics for Electrical Condensers (I.).

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.

ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at City Hall, Leicester), at 6.45.—A. H. Law and J. P. Chittenden: Higher Steam Pressures and their Application to the Steam Turbine.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at 39 Elmbank Crescent, Glasgow), at 7.—Dr. C. H. Lander: The Fuel Problem.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—Dr. T. Slater Price: A Résumé of Recent Work on the Effect of Adsorbed Ions on the Photo-sensitivity of the Silver Halides.

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Engineering Club, Wolverhampton), at 7.30.—E. A. Watson: The Electrical Characteristics of Spark Gap and Sparking Plugs.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Technical College, Cardiff), at 7.30.—J. Pryde: Vitamins and Diet.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch), at 7.30.—J. Calderwood: Diesel Engine Drive for Generators and other Auxiliary Machinery on Board Ship.

HULL CHEMICAL AND ENGINEERING SOCIETY (at Photographic Society's Rooms, Grey Street, Hull), at 7.45.—F. H. Peck: Hydro-electric Development in Brazil.

BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at Royal Society of Arts), at 8.15.—Dr. C. D. Broad: Main Problems of Ethics.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Prof. R. R. Gates: Amerindian Crosses in Canada.

INSTITUTE OF BREWING (Scottish Section) (at Caledonian Station Hotel, Edinburgh).—C. Ranken and J. R. Bell: Surface of Yeast as a Factor in Fermentation.

MINERALOGICAL SOCIETY.—Dr. L. J. Spencer: Potarite, a New Mineral discovered by the late Sir John Harrison in British Guiana.—Dr. H. V. Ellsworth: A Simple and Accurate Constant-Volume Pyknometer for Specific Gravity Determination.—W. Campbell Smith: The Optical Orientation of Labradorite from County Down (Ireland) determined by the Federov Method.

WEDNESDAY, JANUARY 18.

SOCIETY OF GLASS TECHNOLOGY (at College of Technology, Manchester), at 2.30.—W. W. Warren: *The Design and Operation of Glass Furnaces.*—P. Marson (based on a Paper by Prof. W. E. S. Turner): The Manufacture and Use of Glasshouse Pots.—Prof. W. E. S. Turner: The Refining of Glass.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Growth of Living Tissues under Experimental Conditions and the Bearing of the Knowledge thus obtained on Abnormal Growth of the Human Body.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at 17 Fleet Street), at 5.30.—Eng.-Capt. E. C. Smith: Some Episodes in Early Ocean Steam Navigation.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.30.—H. A. Reed: Appliances for Handling Goods in Ports and Docks (Vernon-Harcourt Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—W. Ellerd-Styles: Large Electric Baking Ovens.

INSTITUTE OF METALS (Swansea Local Section) (at Thomas' Café, Swansea), at 7.—W. T. Griffiths: Some Interesting Properties of Alloys of Nickel.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—G. E. Taylor: Electric Furnaces in Metallurgy.

MANCHESTER GEOGRAPHICAL SOCIETY (at 16 St. Mary's Parsonage, Manchester), at 7.30.—L. M. Butterworth: The Lancashire Glass Industry (Lecture).

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Annual General Meeting, at 7.40.—Presentation of Symons Medal to Prof. H. Hergesell.—Prof. H. Hergesell: The Observation of Clouds with Special Reference to The Safety of Aviation.—Sir Gilbert T. Walker: World Weather.

MERSEYSIDE AQUARIUM SOCIETY (at 1 Falkland Road, Egremont), at 7.30.—Rev. C. E. Y. Kendall: The Paper Aquatic Molluscs.

ROYAL MICROSCOPICAL SOCIETY (Annual Meeting), at 8.—Dr. J. A. Murray: Staining and Structure (Presidential Address).

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. M. Fletcher: Architecture of Provincial France (Lecture).

ROYAL SOCIETY OF ARTS, at 8.—A. H. Barker: Methods of Radiant Heating.

ENTOMOLOGICAL SOCIETY (Annual Meeting), at 8.

FOLK-LORE SOCIETY (at University College), at 8.—Mrs. F. Ayscough: A Calendar of Chinese Household Customs.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Northampton Polytechnic Institute), at 8.15.—W. James: Polishing and Plating.

THURSDAY, JANUARY 19.

ROYAL SOCIETY, at 4.30.—E. S. Horning and A. H. K. Petrie: Enzymatic Function of Mitochondria in the Germination of Cereals.—S. Dickinson: Experiments on the Physiology and Genetics of the Smut Fungi.—P. H. H. Gray: Formation of Indigotin from Indol by Soil Bacteria.—Dr. R. A. Fisher: Triplet Children in Great Britain and Ireland.—Prof. J. W. H. Harrison: (*a*) A Further Induction of Melanism in the Lepidopterous Insect, *Selenia bilunaria* Esp. and its Inheritance; (*b*) Induced Changes in the Pigmentation of the Pupæ of the Butterfly, *Pieris napi* L. and their Inheritance.—*To be read in title only*:—J. Piiper: On the Evolution of the Vertebral Column in Birds illustrated by its Development in Struthio and Larus.—F. G. Gregory and A. S. Horne: A Quantitative Study of the Course of Fungal Invasion of the Apple Fruit and its Bearing on the Nature of Disease Resistance. Parts I. and II.—F. G. Gregory: The Differential Effect of the Ions of Three salt Solutions on the Growth of Potato Plants in Sand Culture.—Sir Kenneth Goadby: Bacterial Proteins.—L. Rapkine and R. Wurmser: On Intracellular Oxidation-Reduction Potential.—Dr. F. W. R. Brambell: *Development and Morphology of the Gonads of the Mouse.* Part II.—Prof. R. C. Punnett: Linkage Groups and Chromosome Number in Lathyrus.

LINNEAN SOCIETY OF LONDON, at 5.—C. V. B. Marquand: On Capt. Kingdon Ward's Botanical Collections from the Eastern Himalaya and Tibet, 1924-25.—F. W. Edwards: Insect Collecting in the Southern Andes.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. F. Thorpe: The Significance of Unsaturation in Carbon Compounds (I.).

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—W. Ellerd-Styles: Large Electric Baking Ovens.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Major W. S. Tucker: The Problem of Noise in Civil Aircraft and Possibilities of its Elimination.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—T. Smith: On Toric Lenses and Canonical Forms in the Theory of Asymmetrical Optical Systems.—Dr. M. Herzberger: Some Remarks on an Extension of the Optical Cosine Law.—Tintometer, Ltd.: Demonstration of the Rosenheim-Schuster Colorimeter.

INSTITUTE OF METALS (Birmingham Local Section) (jointly with Birmingham Metallurgical Society and Staffordshire Iron and Steel Institute) (at Engineers' Club, Birmingham), at 7.—T. H. Turner: Heat Resisting Alloys.

INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) (jointly with Society of Chemical Industry, East of Scotland Section) (at North British Station Hotel, Edinburgh), at 7.30.—Discussion on The Separation of Solids and Fluids.

CHEMICAL SOCIETY, at 8.—Prof. G. T. Morgan and H. Burgess: *cyclo*-Telluropentane.—I. Vogel: Syntheses of Cyclic Compounds. Part II. Racemic and Meso Ethyl $\beta\gamma$-diphenylbutane-$\alpha\alpha\delta\delta$-tetracarboxylate. Synthesis of a Truxinic Acid.—E. H. Farmer, C. D. Lawrence, and Prof. J. F. Thorpe: Properties of Conjugated Compounds. Part IV. The Formation of Isomeric Additive Dibromides from Butadiene.

LANCASTER ASTRONOMICAL AND SCIENTIFIC ASSOCIATION (at Storey Institute, Lancaster), at 8.—G. Dixon: Coal Gas Manufacture.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Chandos Street, W.), at 8.15.—Surg.-Commdr. D. H. C. Given: Some Health Problems of the Singapore Naval Base.

EUGENICS SOCIETY (at Royal Society), at 8.30.—F. C. Bartlett and others: Discussion on Innate Qualities in Social Classes.

INSTITUTION OF MECHANICAL ENGINEERS (Birmingham Branch).—Informal Discussion.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Branch).—L. H. Fry: Some Experimental Results from a Three-Cylinder Compound Locomotive.

FRIDAY, JANUARY 20.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—M. G. Simpson: The Indo-European Telegraph Department.

ASSOCIATION OF ECONOMIC BIOLOGISTS (Annual Meeting) (in Botany Department, Imperial College of Science), at 5.—Presidential Address.

SOCIETY OF MEDICAL OFFICERS OF HEALTH (at 1 Upper Montague Street, W.C.), at 5.—Dr. W. Elliot and Prof. R. H. A. Plimmer: Recent Advances in the Knowledge of Food.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: A *Summary of the Evidence, both Experimental and Clinical, of the* Growth-controlling Functions of the Pituitary Gland.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 6.—G. Fairrie: The Production and Refining of Cane Sugar.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Fifth Report of the Steam-Nozzles Research Committee.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—Dr. R. C. Fox: The Three Cathode Carbon Arc.

WEST CUMBERLAND SOCIETY OF CHEMISTS AND ENGINEERS (at Workington), at 7.—O. T. Jones: The Lubrication of the Automobile.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group Informal Meeting), at 7.—T. H. B. Scott: The Pictorial Aspect of Modern Buildings.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—S. Hopkins: Steam Accumulators.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (jointly with Society of Dyers and Colourists (Manchester Section)) (at Milton Hall, Manchester), at 7.30.—Dr. A. E. Everest and J. A. Wallbrook: Azoic and other Insoluble Colours.

TUBERCULOSIS SOCIETY (at Royal Society of Medicine), at 8.—Dr. G. Jessel, Dr. A. P. Ford, Miss Lewis, and others: Discussion on the Work and Aims of Tuberculosis Care Committee and Kindred Agencies.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Prof. S. Russ, Dr. T. F. Cotton, Dr. Justina Wilson, and others: Discussion on Diathermy in Relation to Circulatory Disturbances, particularly in High Blood Pressure, etc.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir William Bragg: Photo-electricity.

SOCIETY OF DYERS AND COLOURISTS (Scottish Section) (at Glasgow).

SATURDAY, JANUARY 21.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. R. W. Chambers: Some Tudor Biographers (I.).

PHYSIOLOGICAL SOCIETY (in Department of Physiology, King's College).

PUBLIC LECTURES.

FRIDAY, JANUARY 13.

UNIVERSITY COLLEGE, at 5.—C. F. A. Pantin: Comparative Physiology. (Succeeding Lectures on Jan. 20 and 27, Feb. 3, 10, 17, and 24, Mar. 2, 9, and 16.)

MONDAY, JANUARY 16.

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—R. L. Cornell: Poultry Diseases.

TUESDAY, JANUARY 17.

KING'S COLLEGE, at 5.—Dr. J. A. Hewitt: Integration in the Nervous System. (Succeeding Lectures on Jan. 24 and 31, Feb. 7, 14, 21, and 28, Mar. 6.)

WEDNESDAY, JANUARY 18.

UNIVERSITY COLLEGE, at 4.—Prof. A. V. Hill: Muscle. (Succeeding Lectures on Jan. 25, Feb. 1, 8, 15, and 22.)

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.30—Dr. R. Burrows: The Medical Practitioner in relation to the Administration of Justice.

THURSDAY, JANUARY 19.

UNIVERSITY COLLEGE, at 5.—Dr. R. J. Ludford: Cytology in Relation to Physiological Processes. (Succeeding Lectures on Jan. 26, Feb. 2, 9, 16, and 23.)

KING'S COLLEGE, at 5.30.—Dr. F. W. R. Brambell: The Development of Sex, with special reference to Recent Work on Birds and Amphibians. (Succeeding Lectures on Jan. 26, Feb. 2, 9, 16, and Mar. 1.)

SATURDAY, JANUARY 21.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Stone working in Ancient Egypt.

SATURDAY, JANUARY 21, 1928.

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Land Drainage.

THE heavy rainfall and snowstorms of last month, culminating in the overflow of the Thames in London on Jan. 7, with grievous loss of life, has brought vividly before the nation the subject of the control and disposal of surplus water. In Great Britain, the problems, although serious, are not of the same magnitude as elsewhere. The disastrous Mississippi floods of last summer, and the extensive damage done around Bagdad when the Tigris broke its banks about two years ago, are illustrations of a menace the full force of which is happily spared us. In these cases the fundamental cause is the gradual raising of the river bed in its lower reaches by the suspended material brought down from the uplands and deposited when the speed of the current is reduced.

In the absence of measures of control, the river will frequently change its course, and may build up an extensive delta in the estuary. The difficulty is met by dredging, which is rarely able to meet the case completely, especially in extensive river systems, and reliance is placed mainly on embankments or levees for confining the river to its course. The embankments must be raised from time to time to keep pace with the silting up of the river bed, and eventually the normal water level may be several feet above the level of the surrounding land. In such conditions a break in the defences is disastrous, and the longer the catastrophe is in coming, the greater it is. The effect is felt most in the lower reaches of the river, but the causes extend over the full region of the catchment area. Every little stream, every small trickle of surface water, is contributing its small quota of suspended material to the main stream, and the engineer is in reality struggling against Nature's ceaseless modification of the topography of the land over the whole of the drainage area discharging into the river. The battle can never be won; an armed truce is all that can be hoped for, and man's energies are or should be directed towards postponing the evil day.

The necessity for co-ordination in such efforts is self-evident: it is worse than useless for the protection of one part of the area to be carried on as an isolated problem, independent of the conditions in adjacent areas; and yet in Great Britain this piecemeal method is still the rule rather than the exception. For a long time past, the problem of land drainage has been growing steadily more acute, and the enforced neglect during the years of the War brought matters to a head. Attempts were

made in the Land Drainage Acts of 1918 and 1926 to secure improvements in co-ordination and grouping of the multitudinous drainage authorities, each of which is more or less a law unto itself. These acts were not satisfactory, quite apart from the question of lack of funds, and a Royal Commission was appointed in March 1927, with the Right Hon. Lord Bledisloe as chairman, to inquire into the present law and its administration, and to suggest any improvements that would lead to an efficient arterial drainage system without placing undue burdens on any particular section of the community. The Commission was ordered to report as soon as possible, and it has obeyed this instruction with commendable zeal: the Report[1] was issued last month.

The main recommendation is that a catchment area shall be regarded as one unit, and be under the control of its own elected central authority, that shall be responsible for the main channel of the river, the upkeep of which shall be a rating charge on the whole catchment area. The numerous drainage boards existing within any catchment area are to be reorganised and grouped as internal drainage authorities, which will levy their local rates for internal drainage, and be supervised by the catchment authority in order to secure coordination of effort. The Thames is regarded as a special case, and it is recommended that beyond constituting the Conservancy a drainage authority for the whole of the catchment draining into its present area of jurisdiction, no change should be made; the Port of London Authority would therefore continue to exercise control from below Teddington weir to the Crowstone. This suggestion may need modification in view of the recent floods in London.

The recommendations of the Commission are simple, and indeed obvious, but they are none the less sweeping in their effect. They reduce to a logical scheme the confusion that now exists. There are more than 360 drainage authorities of various types in England and Wales, many of them of great age. The earliest appears to be the Commission of Sewers for Romney Marsh, appointed in the reign of Henry III., and it covers the period when the land was settled in more or less isolated and self-supporting communities. Much of the low-lying part of the country, now occupied, was then wastes of marsh or fens that provided, until reclaimed in their turn, a ready and convenient accommodation for the drainage water from the settled areas. The fens of East Anglia provide the best example of this process. Reclamation on an extensive scale was begun in the seventeenth century in spite of the determined opposition of the fenmen, whose attitude can be judged from the following verse of a doggerel poem of the period:

> "The feather'd fools have wings to fly to other nations,
> But we have no such things to help our transportations;
> We must give place (oh, grievous case!) to hornéd beasts and cattle,
> Except that we can all agree to drive them out by battle."

It is not surprising that these difficulties, together with the lack of engineering resources, and the absence of much of the interdependence that now marks British agricultural life, should have resulted in the construction of many independent reclaimed areas, the drainage authorities of which would say, with Chesterton, "I don't care where the water goes, if it doesn't get into"—my land. This very natural attitude was reinforced and protected by the powers granted by law and custom to each area. The recommendations of the Commission, if adopted, will enable the catchment authorities appropriately to modify the constitutions of these areas. Further, the upland districts, the drainage water of which increases the difficulties of dealing with the lowland areas, will be under their jurisdiction.

It is asserted that the drainage of upland agricultural districts by pipe and mole drains has shortened the time taken for this surplus water to reach the main stream. As a result, flood water that formerly slowly percolated by undefined channels is now discharged much more rapidly, and has forced the lowlander to increase his embankment protections and to enlarge the outfall facilities of the main stream.

The claim is undoubtedly correct; large areas were drained in the middle of last century, and except where drains were laid too deep to be of service, the condition of the land was improved. Renewed attention is now being paid to field drainage, and we hope it will be examined not only as a simple technical question of removing surplus water, but also as one of the related aspects of soil physics demanding fuller investigations in the light of recent advances in the theory and practice of this subject.

It is indeed questionable whether drainage alone is the best method of dealing with occasional surplus water. In spite of our adequate and well-distributed rainfall, foreign agriculturists visiting Great

[1] "Report of the Royal Commission on Land Drainage in England and Wales." (Cmd. 2993.) Pp. 60. (London: H.M. Stationery Office, 1927.) 1s. 3d. net.

Britain are surprised at the susceptibility of our crops even to mild droughts; the suggestion is frequently made that our normal cultivation operations do not conserve sufficient soil moisture. The principles underlying these operations are certainly worthy of further study; they reached their present form about 1750, and were based on cheap labour and on horse power. Greatly increased labour costs have altered the situation completely, but the cultivation methods have not undergone any essential modifications to meet the new conditions, in spite of the facilities for mechanical power now available. A full examination of the effects of deeper cultivations, subsoiling, and rotary tillage on the amounts and rate of flow of percolation water, and studies of the influence of mulching on evaporation, should give valuable information on the ability of the soil to hold a greater reserve moisture supply. These problems are essentially physical, and they imply parallel studies of the physical and physico-chemical properties of the finest soil particles, the colloidal nature of which makes the soil differ in many respects from a simple porous material.

There is another aspect of the subject. This fine material is now known to exercise a controlling influence on both the inherent fertility of the soil and its ability to fall into that favourable physical condition known as good tilth. Unfortunately, this material is the most susceptible to removal by erosion and drainage to lower levels, where it silts up and intensifies outfall difficulties. In areas where it can be accumulated, it gives rise, as would be expected, to a very fertile soil. The narrow belt bordering the Nile, the warp-lands of the Humber estuary, and to some extent the polders of Holland, are well-known examples where natural forces or man's intervention have succeeded in saving some of this valuable material for agriculture.

Finally, we may point out that the above problems of drainage, tilth, and fertility are combined with peculiar force in all irrigation areas, and it is encouraging to note that those members of the recent Imperial Agricultural Research Conference most familiar with the practical problems of overseas agriculture were foremost in urging the vital necessity of fundamental research on the soil. The establishment of a Bureau of Soil Science, as suggested at the Conference, would be a distinct aid to such research by collating the results and showing the bearing which soil survey work has on problems of drainage and of irrigation in all parts of the Empire.

The Dolomites of South Tyrol.

Das Grödener-, Fassa- und Enneberggebiet in den Südtiroler Dolomiten: Geologische Beschreibung mit besonderer Berücksichtigung der Überschiebungserscheinungen. Von Dr. Maria M. Ogilvie Gordon. 1 und 2 Teil: *Stratigraphie-Tektonik.* (Abhandlungen der Geologischen Bundesanstalt, Band 24, Heft 1.) Pp. xxiii + 376 + 26 Tafeln. 90*s.* 3 Teil: *Paläontologie.* Mit einem Atlas von 13 Tafeln. (Abhandlungen der Geologischen Bundesanstalt, Band 24, Heft 2.) Pp. 89. 30*s.* (Wien: Geologische Bundesanstalt, 1927.)

THE work under review is one exceptional for its comprehensiveness, and one that marks the conclusion of an enormous amount of labour, both physical and mental, on the part of the author, Dr. Maria Ogilvie Gordon. Begun in youth, under the ægis of two great students, Ferdinand von Richthofen and August Rothpletz, both long since dead, it was completed after she had borne with fortitude the bitter blow that fate had dealt her as a wife, and after she had devoted her energies to her country's cause during the War. By reason of the length of the period over which the work was spread, and the magnitude of the events that encompassed us all during the years of interruption, her earliest work must appear now as objective to her as to the reviewer. It must almost seem not to be her own work, but that of some stranger of a past generation. Yet underlying all her work, from those early days of 1893 up to the present time, one motive may be traced—the endeavour to unravel the tectonic structure of the Dolomites, enormously complicated in reality, albeit described as simple by some; and, on the basis of this work, to solve certain other problems, one of the most important of which is the question, first raised by von Richthofen, and since repeatedly denied or affirmed, as to the coral-reef origin of the gigantic masses of limestone and dolomite. It must, moreover, be mentioned with approbation that the author, in spite of the keenness and originality of her own perception, has adhered to the principle laid down by von Richthofen so to present her observations that they remain available for other interpretations. This remark is especially applicable to the work now under review.

The volume comprises an almost overpowering wealth of detailed observations concerning the stratigraphy, the tectonics, and the palæontology of the area studied. Nobody will ever think of starting work upon this area without availing

himself of this colossal archive of observations, while he who also knows the actual mountaineering difficulties that face the worker in the Dolomites cannot but express his wonder at the energy, the courage, and the spirit of the author.

The first section of the work, consisting of 169 large quarto pages, is devoted to stratigraphy. It begins with a comparatively short description of the Permian (Bellerophon limestone and quartz-porphyry). The several stages of the Trias are, on the other hand, most exhaustively portrayed. The old division of the Werfen beds into a lower series (Seis beds) and an upper series (Campil beds) is retained, but the conglomerate of Richthofen is referred to the Lower Muschelkalk, so that, in this respect, the classification differs from that of Wittenburg. Numerous detailed profiles are given, both for the strata of this series and for those of higher horizons.

In the Upper Anisian stage the occurrence of *Diplopora annulatissima* Pia at numerous localities is described. The Lower Buchenstein beds of Mojsisovics are here included. The Buchenstein beds *sensu stricto* (*Protrachyceras reitzi* and *P. longobardicum* zones) and the Wengen beds (*P. archelaus* zone) are grouped together as the Ladinian stage. The eruptive rocks of this age receive very exhaustive treatment. The author concludes from her observations that, during the period of deposition of the Upper Buchenstein beds, differential movements of the earth's crust occurred along the northern margin of an anticlinal flexure or elevated zone with a W.N.W.-E.S.E. trend, while erosion and re-deposition of the limestone and dolomite sediments occurred. Lavas and tuffs were erupted from the fissures that were developed in the sunken northern section. This process did not occur continuously, but at intervals. Hence along the border zone between the two facies the volcanic rocks sometimes predominated, and sometimes the limestones and dolomites. This is the true reason for the extremely complicated differences in facies met with in the area.

During the period of the Wengen beds, the eruptive activity decreased only slightly, eruption taking place along the same structural lines as during the Buchenstein period. Both for this and for palæontological reasons, the author unites the Wengen with the Buchenstein beds, and separates from them the so-called Pachycardia tuffs.

The St. Cassian and Raibl beds are grouped together as Carnian, since the author has been able to show, in the so-called Upper St. Cassian beds, the close connexion between the horizons above and below, thereby demonstrating the absence of any gap in the history of the marine faunas. In the Raibl beds also a very sudden change in facies is demonstrated. Each subdivision of that series of strata can be shown to pass laterally from a calcareous or sandy facies into dolomite.

Next follows a section bringing together all the available information bearing on the coral-reef theory. The author is in favour of the view, developed by the present reviewer, that the chief builders of the great calcareous masses were not corals but calcareous algæ. She proves conclusively that the reef-like appearance of many of the present-day dolomite mountains is due primarily to later tectonic movements, even if it has depended also on facies differences.

The tectonics are dealt with in a most thorough manner. This section of the work is made all the clearer by the inclusion of a map on the scale of 1 : 100,000, showing the tectonic lines, two large charts of profiles, a geological map of the Enneberg district on the scale of 1 : 25,000, a geological map of the Schlern district (1 : 25,000), including, to the north, the Gröden Valley, and to the south-east, the upper portion of the Fassa Valley as far as the western slopes of the Marmolata, and a small map of the Rodella district (1 : 12,500), with two special profiles.

In the space of a short review it is impossible to deal in full with the author's interesting and detailed observations. The most important result is the demonstration of the existence of two series of tectonic movements; these occurred at different periods and acted in different directions. The older had a general W.N.W. trend, the younger an N.N.E. trend. The result was a sort of interference, and a tendency to produce a turning movement of mountain masses. For this turning movement the author uses the term 'torsion.' Many might deny the propriety of this use of the term. To the reviewer the actual term used seems to matter less than the facts observed; and there appears to him to be no doubt that the statements of Dr. Gordon in this connexion are trustworthy and deserving of the greatest respect, even if one differs in their interpretation.

Overthrusting also was connected with this phase of earth movements, and on this subject the present work contains a mass of important observations. It is true that this overthrusting was not on the same scale as that of the large Alpine nappes. Nevertheless, it is not to be underestimated, as Cacciamali's studies in the Alps of Lombardy have also taught us.

The author has rendered especial service by the clear manner in which she has described the tectonic rifts to which the considerable volcanic activity of Triassic times was due.

In the palæontological volume, a large number of known fossil species as well as a few new forms are figured on thirteen plates and carefully described in the text. The new species are *Allorisma depressa*, *Avicula stachii*, *Gymnocodium nodosum*, *Pecten nicolensis*, *Myophoria elliptica*, *Leda minuta*, *Thecosmilia norica*, *Elysastræa parvula*, and *Milleporidium fassani*. The chief importance of this section lies in the fact that the horizons of the fossils are accurately determined, while new localities and horizons are recorded for various algæ and hydrozoa, and investigations are made into the structure of these organisms. The author has found in the Bellerophon limestone at various localities the algæ *Mizzia velebitana* and *M. yabei*, hitherto known only from the Upper Carboniferous of Dalmatia and Japan, as well as *Vermiporella velebitana*.

The whole work is sumptuously got up and excellently illustrated. It is a credit to the Vienna Bundesanstalt. Together with the earlier works of the author it forms a monument in the field of Alpine geology upon which both special and general geologists, professional or not, may look with pride and satisfaction.

WILHELM SALOMON-CALVI.[1]

Biology before Darwin.

(1) *De Linné à Jussieu : Méthodes de la classification et idée de série en botanique et en zoologie* (1740–1790). Par Dr. Henri Daudin. (Études d'histoire des sciences naturelles, 1.) Pp. v + 264. (Paris : Félix Alcan, n.d.) 20 francs.

(2) *Cuvier et Lamarck : Les classes zoologiques et l'idée de série animale* (1790–1830). Par Dr. Henri Daudin. (Études d'histoire des sciences naturelles, 2.) 2 vols. Vol. 1. Pp. xvii + 460. Vol. 2. Pp. 338. (Paris : Félix Alcan, 1926.) 60 francs.

WE are not familiar with the name of Dr. Henri Daudin, of Bordeaux, as a working biologist, but however that may be, he has, in the above treatise, produced a history of modern biology which it would be inexcusable to overlook. His original intention was to discuss the historical aspects of the works of Darwin and the evolutionary school, but he has instead traced the development of systematic biology during the immediate pre-evolutionary period, and has hence preferred to devote his attention to causes rather than to effects.

Dr. Daudin divides his work into two sections, the first of which deals with the years 1740–1790, which he regards as introductory to his main or critical period extending from the latter date to 1830. There is something to be said for this division. The years in the neighbourhood of 1790 were certainly critical. They stand at the onset of that sudden burst of research activity which culminated in the 'thirties and thence rapidly declined. Thus Dr. Daudin's final date is also a significant one. On the other hand, to stop at 1830 results in including the early and less productive years of a large number of distinguished workers, ranging back from Stannius and Michael Sars to Dufour. It would have been more logical and instructive to have extended the limit to 1840, or at least to 1835, so as to include the first years of the decline.

Before 1790, research was neither intensive nor coherent. The old school, including O. F. Müller, Spallanzani, the Hunters, Meckel, Camper, Bonnet, Daubenton, Ellis, Lyonet, Buffon, and Linnæus, representing all the earlier phases of descriptive and speculative biology, was slowly preparing the way for the emergence of Cuvier, whose work covers the whole of the very important period from 1790 to 1830, of which it may be said to constitute the foundation. It is not easy to explain fully the sudden display of activity at the beginning of Cuvierian times. The publications of Buffon, and to a lesser extent those of Bonnet and Spallanzani, had aroused a definite and widespread interest in the investigation of animals, and must have exerted some influence on the extent and trend of contemporary inquiry. Dr. Daudin's earlier date of 1740 may be justified as a more or less natural boundary between the methods and traditions of the seventeenth century and those of the pre-Cuvierian school.

The works under review embrace a prolific period, the adequate investigation of which involves the examination of piles of literature. This has naturally occupied the leisure of the author for many years, and the result is a serious contribution to the subject based on original authorities. There are, however, several omissions within the limits Dr. Daudin has laid down for himself, and some of them are of first-rate importance. Indeed the author almost confines himself to the work of the French school, which is fully and carefully debated,

[1] Translated by L. R. Cox.

but no history of the period can be said to be in any sense complete which omits discussion of the publications of Roesel, Meckel, Hunter, Spallanzani, the second Monro, Bojanus, and Straus—to mention only a few of the more important names. A further criticism of the author's bibliographical methods is that wrong editions are frequently quoted, and translations are used instead of the originals. Contemporary translations are helpful as evidence of how an author was interpreted in his own time; but they are often misleading, and it is never safe to assume that the translation accurately conveys the meaning of the original text. We have, on the contrary, at times encountered wide differences between the two. It is necessary, however, to make allowances for a writer in the provinces, far removed from the National Library—probably almost the only French library which could provide him with all the literature he needed.

The history of animal classification before Darwin receives special and admirable treatment in these volumes. Dr. Daudin attaches considerable importance, and rightly so, to this aspect of the subject, because the constant striving after an acceptable classification must sooner or later lead to a natural classification, or in other words to the recognition of evolution. The only guarantee of the reality of a group is that its members should constitute a harmonious whole, with which members of other groups are out of tune. The intuition which introduced the word 'family' into pre-evolutionary classification carries with it a prophetic recognition of the doctrine of common descent.

The fact that the biological catalogues of the seventeenth century were already crystallising into natural groups before the time of Darwin can only be regarded as the unconscious growth of the idea of descent, and many pre-Darwinian naturalists must certainly be credited with this 'intellectual perception.' In the domain of morphology the recognition that, for example, the abomasum of the compound stomach is the only part homologous with the stomach of other mammals is a comparable result. Thus, as Daudin points out, the truth was in Lamarck even before he became a conscious transformist. The steady and unobtrusive work on classification and comparative anatomy did more to precipitate the coming of evolution than all the crazy rhetoric of the so-called philosophers of the Geoffroy school—"plus hardis que solidement informés."

We may be permitted to regret that historians of science are not occasionally tempted to apply the knowledge which they so laboriously acquire. Who better than the historian could tackle the epidemics of callow speculation which afflict us from time to time, and check the exuberance and tyranny of the latest fashion in research. We are called upon to accept, on pain of excommunication, creeds and dogmas which we regard with vigorous misgivings. The modern speculator excuses his vice on the ground that it is better to have a bad theory than no theory at all. History not only gives little support to this ingenuous claim, but even cries out aloud against it. An unsound hypothesis, should it gain general acceptance, hangs like a millstone round the necks of contemporary workers. It is easy to show that a doctrine like the preformation theory in embryology, or the vertebral theory of the skull, not only retards the advance of science, but also may cruelly oppress a sound observer who has the genius to see through its absurdities and the courage to expose them.

Progress in science is the result of faithful observation combined with the generalisations of those rare individuals who are born to this difficult task. The historian can smile at the modern worker who holds the speculations of Oken and Geoffroy in contempt, but lacks the imagination to suspect that a future generation may be mildly amused at his own magnificent system. On matters such as this the historian should have much wholesome and weighty advice to offer. Why does he not produce it?

The Validity of Modern Physics.

The Logic of Modern Physics. By Prof. P. W. Bridgman. Pp. xiv+228. (New York: The Macmillan Co., 1927.) 10*s.* 6*d.* net.

THE author of the latest discussion of the foundations of physics, Prof. P. W. Bridgman, of Harvard University, is a highly distinguished experimenter in a branch of physics with a peculiarly difficult technique, most of which he has developed himself, while his experimental work has repeatedly been greatly aided by his capacity for doing his own incidental theory. His main attitude in the present work may be called a qualified phenomenalism; that is, apart from the material objects of ordinary observation, he is prepared to admit other concepts, but anxious to keep their number down to a minimum. His

test of the validity of a concept is that the old facts co-ordinated must outnumber the new assumptions made. The fundamental analysis in terms of sensations is not attempted, but the view is consistently maintained that a physical magnitude is defined by the operations that measure it and not by any prior considerations. The opening discussion of the meaning of length, in application to atomic and electronic distances on one hand, and stellar distances on the other, where the ordinary methods based on measuring scales are useless for opposite reasons, brings out extremely well the nature of the logical problems involved. On this point of view it is simply meaningless to assert or deny a physical proposition without some means of verifying it experimentally; thus the statement that space on a small scale is Euclidean is meaningless.

The rejection of unobservable entities until he is forced to accept them leads Bridgman to accept action at a distance, and to reject the ether, while with the latter goes the physical reality of the electric field. But the point assumes a knowledge of what we mean by physical reality in this connexion. Bridgman seems to know what it means, and not to believe in it. So far as I can tell, the situation is that measurement of the forces on electric charges and magnetic poles gives the values of the electric and magnetic forces experimentally wherever we like to find them, and that these vectors satisfy Maxwell's differential equations. If the possibility of measurement is enough to determine physical reality, the electric field is as real as distance.

The notion of action at a distance, on the other hand, seems to mean that the field is determinate when we know the neighbouring charges and magnets, and is independent of the intervening medium. But actually it depends on the dielectric constant and permeability of this medium, which is therefore highly relevant. The reviewer's own point of view is that the differential form of the laws is more general and, except in the simplest cases, more fundamental in knowledge than the integrated form, and involves direct reference to intervening places. Consequently, while having no use for the ether, I should accept the field and reject action at a distance when they are defined so as to convey any meaning to me.

In a later part of the book Bridgman discusses problems of time and relativity. From his phenomenalist point of view he is led to reject the notion of light at any places except those where it is emitted or absorbed, because all means of testing its presence at intermediate places involve either diverting or destroying it. Thus light as a thing travelling with a finite velocity disappears. With it goes Einstein's definition of simultaneity; the velocity of light is made infinite by "setting a distant clock on zero at the instant it receives a light signal flashed from our clock at its zero." In this way we arrange for the light to spend no time on the way in going; but if we fix a mirror at the distant clock the light spends twice the accepted time on the way back, and the trouble about observing the returning beam is as acute as ever.

This seems to be a case where pure phenomenalism is impracticable. The phenomenalism of Mach and Karl Pearson was a reaction against the realist and mechanist attitude of the older physics, expressed especially in such concepts as absolute position and the elastic solid ether. Accepted physical laws had to be re-examined to find out how far they were demanded by the data; mere consistency with the data was no longer enough. The results were seen in improved understanding of essentials and attention to formal properties instead of models, and cleared the way for such positive advances as the theory of relativity and the modern quantum theory. But a critical attitude towards fundamentals does not mean that we must deny the existence of anything we cannot perceive directly. It is true that light cannot be perceived in transit; but if we therefore deny its existence we immediately get into worse difficulties.

The author gives a discussion of the value of mathematical methods, appreciating both the utility and the danger of their ability to carry us far beyond the original data. Later he gives an extended account of the validity of the postulate that physical laws are formally simple. He has thus given all the preliminaries to an analysis of the validity of physical laws in terms of probability, but he does not attempt such an analysis or mention what progress has been made by other writers.

Prof. Bridgman's points are always well made and his style is attractive. His acute, though at times too far-reaching criticism is the best example known to the reviewer of both the benefits and the drawbacks of the phenomenalist attitude, and his work can be strongly recommended to the attention of those interested in the foundations of science.

HAROLD JEFFREYS.

Our Bookshelf.

Meteorological Office : Air Ministry. British Rainfall, 1926 : the Sixty-sixth Annual Volume of the British Rainfall Organisation. Report on the Distribution of Rain in Space and Time over the British Isles during the Year 1926 as recorded by about 5000 Observers in Great Britain and Ireland. (M.O. 295.) Issued by the Authority of the Meteorological Committee. Pp. xv + 293. (London : H.M. Stationery Office, 1927.) 15*s.* net.

THE sixty-sixth volume of "British Rainfall," which deals with the year 1926, follows the lines of earlier volumes and is mainly statistical. There are tables and diagrams giving the total rainfall in each month, and for the whole year. The monthly totals are for nearly four hundred stations evenly distributed over the British Isles, while the annual totals are for nearly five thousand stations. The monthly evaporation from a free water surface, and the amount of rain percolating through depths of twenty, forty, and sixty inches of soil, in relation to the rainfall of each month, appear for a dozen stations. Covering as they do a variety of soils, these figures provide information of considerable horticultural interest. The annual rainfall statistics, on the other hand, continue to constitute indispensable information for engineering firms dealing with water-supply. An interesting analysis of heavy falls of rain in short periods is given (pp. 44-54). It includes figures for 1926 as well as for previous years. Falls of an inch in ten minutes have apparently occurred on several occasions, though not in 1926, and there is one instance of a quarter of an inch descending in a minute and a half.

To the general student of meteorology, mere statistics, especially when they refer to one meteorological element only, are of limited interest, and for this reason analyses of individual occasions of exceptional rain, illustrated by synoptic charts, such as are given for the severe and widespread thunderstorms of July 17-18, and for the heavy cyclonic rains of Nov. 4–5, are welcome additions.

It is interesting to note that for the British Isles as a whole, 1926 was rather a wet year, and was the fifth in succession to have a total equal to or greater than the average—the longest run of wet years experienced since 1875–83. The year 1927, it may be observed, will be an addition to this run. In distribution the rainfall of 1926 was very erratic, including the wettest January since 1877, the wettest November since 1870, and the driest December since 1870, when comparable statistics first became available.

How we Behave : an Introduction to Psychology. By Prof. A. E. Heath. Pp. vi + 90. (London : Longmans, Green and Co., Ltd., 1927.) Cloth, 2*s.* ; paper, 1*s.*

AMIDST the mass of psychological works that emanate from the printing presses at the present time, this little book deserves more than a passing notice. It is one of an admirable series designed, in the words of the prospectus, "to meet a widespread demand from working-class students for inexpensive introductory books on subjects studied in elementary classes," and published under the auspices of the Workers' Educational Association. The present work fully keeps up the high standard set by others in the series. It is, indeed, remarkable with what success Prof. Heath has tackled the task, that one would have been inclined to pronounce impossible, of giving an adequate introduction to psychology within the limits of ninety small pages. It is of course intended as an introduction and not a complete survey of the subject, and it is a merit of the work that it constantly suggests further questions in a way which cannot fail to stimulate the student to carry on his inquiries. The general scope of the work is sufficiently indicated by the chapter headings: "The Nature and Aim of Psychology," "The Subject Matter of Psychology," "The Development of Animal Behaviour," "The Development of Human Behaviour, (1) Towards a more Unified Response of the Self as a Whole, (2) Towards Completer Adjustment to the Full Realities of the Environment."

Prof. Heath studies the working of the mind from a dynamic point of view, and emphasises the element of conation or 'striving' in mental life. If he ever expands what he has to say here into a fuller work, one would welcome more detailed discussion of the relation of this 'striving' to consciousness, a point on which, while interesting and suggestive, he does not seem perfectly explicit. The only general criticism, if it is a criticism, that one could suggest, is that the student who begins on this work might get the impression that psychology is always a delightfully interesting and amusing study, a dream from which he would be likely to have a rude awakening when he went on to the works of some other authors. G. C. FIELD.

Fūrie Kyūsū oyobi Sekibun Ron, being a Japanese translation of H. S. Carslaw's "Introduction to the Theory of Fourier's Series and Integrals." Translated by G. Takemae. Pp. xii + 482. (Tōkyō : Uchida Rōkakuho, 1927.) 8 yen.

DURING the last fifteen years or so, several important books on physics and mathematics have been translated into Japanese. To the list of these is now added the book under notice. It is translated with accuracy into a clear and simple Japanese. In the preface the translator describes the difficulties which he had to cope with in bringing the book to the stage of publication, occasioned by the great earthquake of 1922 and his long illness in following years. Both the translator and the publishers must indeed be congratulated on their admirable work in translating and publishing in such a clear and well-printed form this excellent book by Prof. Carslaw.

The translation will no doubt prove useful to Japanese students of physico-mathematical and technological science. One fears, however, that the translator may not receive due reward for his labours. All Japanese university science students

are able to read English well enough to understand the explanations of a technical book, and it is unnecessary for them to resort to translations. Especially is it so with a book on mathematics. Moreover, the reading of foreign books in the languages of the originals is to be encouraged, as later on it will be necessary for many of them to read original papers in foreign languages as well as in Japanese.

Nevertheless, the present translation will be very welcome to students who cannot go through a systematic course of study, either of their special subject or of the language in which that special subject is written. Furthermore, in the present translation are included various important alterations and corrections due to Prof. Carslaw, thus rendering the translation more up-to-date than the original work. S. YOSHITAKE.

The Magneto Manual. By H. R. Langman. (Lockwood's Manuals.) Pp. x + 221. (London: Crosby Lockwood and Son, 1927.) 7*s*. 6*d*. net.

IN practically every motor-car the ignition of the explosive mixture is effected by means of an electric spark produced by a small generating device called a magneto. During recent years considerable advances have been made in the design of these generators, and they are now thoroughly trustworthy. It is advisable, however, that every driver of a car should have some knowledge of the timing and setting of magnetos and of their necessary adjustments. He will find much that is useful to him in this book. Luckily, the permanent magnets of magnetos now normally retain their magnetic properties for many years. This is due mainly to the great advances that have been made in the manufacture of magnetic steels and to improved methods of magnetising them.

Heat and vibration, however, have a demagnetising effect even on the best magnets. It sometimes happens, therefore, that the magnet becomes weak and the functioning of the device becomes uncertain. The pull of the magnet can be easily tested by placing a soft iron keeper across the poles and by means of a spring balance measuring the pull required to displace it. A good-sized magnet when new can easily support a weight of at least sixteen pounds. The author gives some useful and convenient methods of testing and remagnetising the particular type of magnetos used in Ford cars, many of which are running in Great Britain. A list of questions is given at the end of the book, and this will enable the student to test his knowledge.

Land Tenure and Agricultural Production in the Tropics (being a Discussion on the Influence of the Land Policy on Development in Tropical Countries). By Dr. H. Martin Leake. Pp. ix + 139. (Cambridge: W. Heffer and Sons, Ltd., 1927.) 7*s*. 6*d*. net.

DR. LEAKE has had practical experience of tropical agriculture as Director of Agriculture in India and as Principal of the Imperial College of Tropical Agriculture in Trinidad. In discussing these vital problems, therefore, he has a first-hand knowledge of the facts in certain areas. It must not be thought, however, that he takes a restricted view of the subject, and while he recognises the importance of local knowledge of conditions, and has been at pains to make himself acquainted with these conditions, he argues on lines which aim at elucidating general principles modifiable in their application to specific cases.

How far Dr. Leake has been successful may perhaps best be judged from his very valuable and suggestive appendix on land tenure in tropical Africa, which is reprinted from the *Empire Cotton Growing Review*. He there suggests a triple partnership which would seem to merit a trial, though the position which is assigned to the chief is perhaps open to question. It is also doubtful how far it would be generally applicable even in East Africa, where it would seem best adapted to conditions among certain tribes only. With Dr. Leake's plea for increased agricultural education, his readers will find themselves in hearty agreement.

Psychology and the Soldier. By F. C. Bartlett. Pp. viii + 224. (Cambridge: At the University Press, 1927.) 7*s*. 6*d*. net.

IT is a difficult matter to discuss the practical application of psychology in a manner that appeals to the novice without offending the expert, but in this book Mr. Bartlett has succeeded admirably. Although he addresses himself primarily to the student of military affairs, his discussion is also of interest to the general reader. Problems of mental and physical fitness, tests for general ability and for special aptitudes, the effects of practice, the study of fatigue, and allied topics, are discussed simply and with appropriate illustrative detail. The sections dealing with leadership, discipline, and morale, and with the mental disorders of warfare, are, however, more attractive because more expressive of the author himself. Such a combination of sound psychology and simple exposition deserves a larger audience than the students to whom it was originally addressed.

An Introduction to Psychology. By Prof. John J. B. Morgan and Prof. A. R. Gilliland. Pp. xi + 319. (New York: The Macmillan Co., 1927.) 7*s*. net.

THE suggestion that courses in elementary psychology to high school pupils will be of value is decidedly novel, but, when we consider the character of American high schools, not so ill-advised as might at first sight appear. In this text-book the authors have aimed at giving concrete expression to the idea. The work has been efficiently done and the book will doubtless meet the needs of those who require a formal text for class purposes. Interest in the 'parlour tricks' of experimental psychology is of course easily secured, and the authors have not overlooked this. The usual topics, such as the nervous system, habit, sensations, attention, learning, memory, etc., are included, but the treatment is very simple and is concerned chiefly with facts. Questions and references are given at the end of each chapter.

Letters to the Editor.

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Pleochroic Haloes and the Age of the Earth.[1]

IN several communications, including one in NATURE (vol. 109, p. 480, 1922), Joly has directed attention to discrepancies between the position of the innermost ring of pleochroic haloes due to uranium and the accepted ionisation curve of the α-particles of uranium. Since the range of the α-particles which produce the haloes by ionisation processes is related to the velocity of decay of the disintegrating substance by Geiger and Nuttall's law, Joly concludes that uranium may have disintegrated more rapidly at one time than it does to-day, or that in early geological times a more rapidly disintegrating uranium isotope may have existed, the ionisation curve of which is no longer accessible to observation, owing to the fact that the isotope has decayed completely in the later geological epochs.

Objections to these conclusions have been raised, particularly by O. Hahn in his book "Was lehrt uns die Radioaktivität über die Geschichte der Erde?" (Berlin, 1926, pp. 55-56). Hahn assumes that the position of the innermost uranium ring is by no means anomalous, but that it indicates the true current range of the α-particles. From this it follows, of course, that the Geiger-Nuttall relation no longer holds valid for extremely long half-value periods.

Since no similar discrepancies are observed in the case of thorium haloes, Hahn's explanation raises difficulties, which can, however, be avoided if we assume the following causes to be operative in the production of the anomalies.

The range of an α-particle depends not only on the velocity of disintegration of the radioactive substance, but also on the physical constants of the medium into which the α-particle penetrates. Changes in the cohesion properties of the medium can call forth deviations in the range, without the intervention of accompanying changes in the rate of disintegration. Mügge's observations show that radioactive disintegration can produce isotropy in minerals, loosening of the crystal lattice, and alterations in cohesion (*Nachrichten der Gesellschaft der Wissenschaften*, Göttingen, 1922, Math.-Phys. Klasse, p. 110). Such processes must also take place within pleochroic haloes, particularly in the central portion, where for geometrical reasons the action of the α-particles is concentrated. In the region of the innermost uranium ring the effect must be particularly strong, for in this zone the α-ray absorption shows a maximum value, as is indicated by the integral ionisation curve of uranium, which possesses a steep peak in this position.

We must, therefore, conclude that the coloration of the mineral is accompanied by an alteration in its cohesion properties, with a corresponding increase in the range of the α-particles. This increase will be revealed especially in the *innermost* uranium ring; it will probably remain outside the limits of measurement for the remaining rings. On the basis of this assumption, the history of a uranium halo will be somewhat as follows:

The innermost ring first develops at the normal distance from the nuclear inclusion. With advancing development, and corresponding to the increased range, the outer periphery of the halo advances in a radial direction, whereby the part of the ring directed towards the centre is no longer darkened to the same extent as previously and soon is lost in the general brown coloration of the inner parts of the halo. The outer radius of the innermost halo thus increases in the course of time, exactly as in Joly's observations. The changes in cohesion which it is necessary to assume to explain these alterations of the radii are but very small.

That an analogous phenomenon has not hitherto been found with thorium haloes is, in my opinion, due to the fact that the integral ionisation curve of thorium is not so steep as that for uranium, but is much more evenly distributed. In particular, no marked maximum of absorption of the α-rays coincides with the innermost rings, as in the case of uranium. Changes in the cohesion properties of the mineral containing the halo are thus smaller, and above all more uniform, for thorium haloes than for uranium haloes. Corresponding anomalies in the radii of the haloes are therefore much more difficult to detect. In the elucidation of this question, however, it is very desirable that accurate observations in this matter should be carried out, and that in this connexion attention should be directed to a possible dependence of the position of the innermost halo on the physical and chemical nature or condition of the containing medium.

The explanation I have given of the anomalies in the uranium haloes invalidates Joly's assumption of the existence of uranium isotopes with abnormally high disintegration rates in early geological time, and hence the conclusions as to the calculation of geological ages which Joly has drawn from this work appear unjustified.

FRANZ LOTZE.

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[1] Translated by Dr. R. W. Lawson.

The Nature and Function of Golgi Bodies.

"Youth is, we all know, somewhat reckless in assertion, and when we are juvenile and curly, we take a pride in sarcasm and invective."—BENJAMIN DISRAELI.

THE opening sentence of Prof. Gatenby's letter (NATURE, Jan. 7, pp. 11 and 12) raised in me hope that at last we should be given some kind of indication of the function of the Golgi bodies, by one who has apparently devoted himself to them entirely. On reading through his letter I find that he makes no suggestion as to function, and that the only definite destiny attributed to them is that they form the acrosome of the sperm. As, however, we are also told that the Golgi bodies are "as universal as the nucleus itself" in animal cells, this cannot be their only destiny; and as this assertion claims no more than that the Golgi bodies give rise to a specific structure in a particular group of highly specialised cells, which in a certain sense can scarcely be regarded as part of the body of the animal or plant, we are still left in ignorance as to what Prof. Gatenby believes is the function and destiny generally, of what he calls "this intra-cellular organella."

I suppose that the most modest of men would not, in ordinary circumstances, be displeased if he were told that he had had part in a scientific discovery. Prof. Gatenby's style is such that when he writes, "It was really Moore and Walker who discovered the 'Golgi apparatus' in animal spermatogenesis!" I am not sure whether he gives this as his own or someone else's opinion. In either event the opinion is mistaken, and the mistake does not please me. The particular vesicles described in the paper of which I was part author ("The Meiotic Process in Mammalia," Univ. Press, Liverpool, 1906) were described by Benda in 1896, by Baumgartner in 1902 and 1904, by others

later, and again by me in 1925 (*Proc. Roy. Soc.*, B, vol. 98). Their behaviour under the action of staining and fixing reagents is entirely different from that attributed to Golgi bodies by Prof. Gatenby. In fact, when the methods he recommends for the demonstration of Golgi bodies are used, only a distorted image of the later stages can be traced, even by one familiar with these structures in properly preserved material.

It is curious and suggestive that these vesicles, which can be traced through three cell generations, which are described as going to form the cap of the sperm, and are best demonstrated by those methods of fixation regarded as least likely to distort the structure of the cell long before Golgi bodies became fashionable, should be those which are now claimed as the Golgi bodies which can be seen in the living cell. The true Golgi body, according to Prof. Gatenby, is not demonstrable in fixed material if acetic acid is used, and the material requires subsequent treatment for a week or two in osmic acid, or the use of some other drastic method such as those, the use of which is deplored by many histologists, necessary in the case of some preparations of nervous tissues; deplored because, though they are requisite for the particular purpose in view, they distort the structures to be examined. I see no reason, therefore, for calling a structure which is best demonstrated by the use of a fixative containing a considerable percentage of acetic acid and by rigidly avoiding the methods recommended by Prof. Gatenby, a Golgi body; particularly as its history and destiny were more clearly shown by other investigators many years before he published his first paper upon the subject.

With regard to the rest of what Prof. Gatenby calls Golgi bodies, I am sorry that he did not give any reasons for his condemnation of my paper (*Proc. Roy. Soc.*, **101**; 1927). His assertion that I have been asleep for thirty years I can scarcely regard as bearing upon the validity of my observations. Nor do I see that their truth is affected by my failure to quote papers by a botanist on "mitochondria *which even divided*."

The observations referred to were briefly as follows. If mixtures containing proteid, peptone, albumose lipins, and other substances found in cells, are treated with a fixative that does not contain acetic acid, structures indistinguishable from the 'Golgi bodies' may be demonstrated if the preparation is dealt with according to Prof. Gatenby's osmic acid method. Moreover, if minute globules of fat are introduced into the solutions, some of the 'Golgi bodies' take up 'a juxta-nuclear position' just as do some of the 'Golgi bodies' in the cell. They do not appear if the lipins are omitted from the mixture. If acetic acid is used in the fixative, the 'Golgi bodies' do not appear either in my mixtures or in the cells. Now all cells, animal and vegetable, contain lipins, chiefly lecithin and kephalin, therefore it would be very surprising if these bodies did not appear in the cells just as they do in the mixtures.

How are Prof. Gatenby's assertions supported? Evidently from his letter there is much disagreement even among the adherents of the Golgi body. But he quotes "the leading English workers" as believing certain things about them. Who are the leading English workers? Prof. Gatenby's style of writing again makes me doubtful as to his exact meaning, but I rather gather from his letter that he means himself, Dr. Ludford, Dr. Brambell, and Miss Shana King. Surely there are some others! But later on in his courteous criticism when he says, "If Prof. Bose expects other cytologists to accept the view . . . , he is much mistaken," he appears to consider himself justified in speaking for cytologists in general, so perhaps these really are our leaders.

There is one request I would venture to make of Prof. Gatenby, and that is that he would cease to use the word 'inclusions' in describing all structures contained in the cell or even in the cytoplasm! I hope he means something different from what the word may be interpreted as meaning when he uses it thus. The invention of a new word, or trying to give a new meaning to an old word, is always regrettable, though the former proceeding is sometimes unavoidable.

"He strikes no coin, 'tis true, but coins new phrases,
And vends them forth as knaves vend gilded counters,
Which wise men scorn, and fools accept in payment."
(Old Play, quoted by Sir Walter Scott, chap. xv. "The Monastery.")

CHARLES WALKER.

The University, Liverpool,
Jan. 10.

A Dark Space in High-frequency Discharges.

KIRCHNER (*Ann. d. Phys.*, **77**, 287; 1925), Gill and Donalson (*Phil. Mag.*, **2**, 129; 1925), and Wood and Loomis (NATURE, Oct. 8, 1927) have shown that a glow discharge can be produced in vacuum tubes at very low pressures, provided the exciting current has a frequency of the order of 4×10^7.

Some experiments were carried out by me in which a 17 cm. spherical bulb, fitted with both internal and external electrodes, was excited at low pressures by a short-wave oscillation generator having a frequency of $3 \cdot 8 \times 10^7$. Discharges of about equal brightness were obtained with either pair of electrodes.

When the internal electrodes (made of sheet aluminium 3 cm. × 3 cm.) were used, a well-defined dark space appeared surrounding each electrode. This dark space had the appearance of the well-known Crookes's dark space but differed decidedly in thickness. When the pressure was such that a 25,000-volt transformer produced a 12 cm. Crookes's dark space, this new dark space had a thickness of only 2 cm. The thickness of this new dark space proved to be more or less inversely proportional to the pressure, for on decreasing the pressure, the thickness increased to about 3·5 cm. At the minimum pressure used, the transformer produced no trace of a discharge in the tube. The dark space could also be seen when the tube was excited by means of the external electrodes.

According to Kirchner, the high-frequency discharge results from a to-and-fro motion of electrons in the rapidly alternating field, the distance between electrodes necessarily being greater than the amplitude of the to-and-fro motion of the electrons. On this hypothesis a dark region near the electrodes is to be expected, for if the mean position of the electron is less than half its amplitude of oscillation from an electrode, the electron will be removed from the field by the electrode. To account for the sharp boundary of the dark space, one must recall that the strength of the electric field in these high-frequency discharges is not large, so that only in the vicinity of its mean position will the electron have sufficient energy to excite radiation. It is probable that the change with pressure is due to an increase in potential, for lowering the pressure decreases the number of available electrons, and if we consider the to-and-fro motion of the electrons as a kind of displacement current, decreasing the number of electrons will change the potential across the tube. SINCLAIR SMITH.

Mount Wilson Observatory,
Dec. 20, 1927.

Temperature and Salinity Observations in the Gulf of Aden.

MY letter on the observations of the outflow from the Red Sea, made by H.M. Surveying Ship *Ormonde* during the spring of 1927 (NATURE, Oct. 8, 1927, p. 512), and the account of the oceanographical work of the Italian Surveying Ship *Ammiraglio Magnaghi* in the same area during the spring of 1924 ("Camp. idrografica nel Mar Rosso della *R.N. Ammiraglio Magnaghi*, 1923, 1924." *Ricerche di oceanografia fisica*. Parts I. and IV.), were published independently and almost simultaneously. Prof. Vercelli has now sent me the drawing reproduced here (Fig. 1) with an

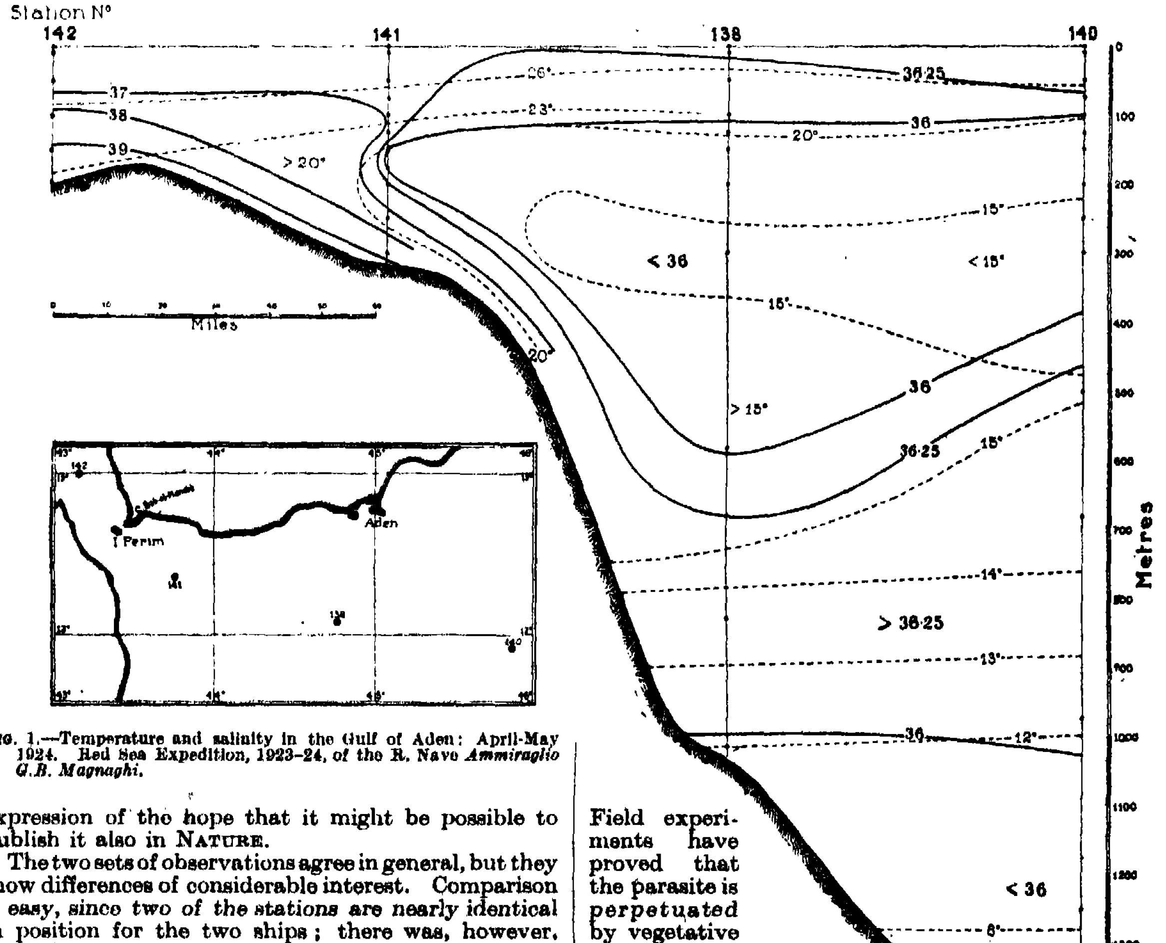

FIG. 1.—Temperature and salinity in the Gulf of Aden: April-May 1924. Red Sea Expedition, 1923–24, of the R. Nave *Ammiraglio G.B. Magnaghi*.

expression of the hope that it might be possible to publish it also in NATURE.

The two sets of observations agree in general, but they show differences of considerable interest. Comparison is easy, since two of the stations are nearly identical in position for the two ships; there was, however, no Italian station so far east as the British station E.

The *Ormonde's* station B lies seven miles nearly due south of the Italian station 141. At the former the salinity was 37·8 on the bottom in 370 m., as compared with 38·8 in the smaller depth of 300 m. at 141. Again, at D the *Ormonde's* maximum salinity was 37·54, at 1000 m., against 36·44 at 830 m. at the Italian station 138, which lies two miles farther northward and ten miles to the westward. The *Ormonde* sounded 1300 m. here, with water of a decidedly oceanic character, 35·76 salinity, at 1200 m.; the *Ammiraglio Magnaghi* found only 1015 m., so it is possible that the distance between the two stations was more than ten miles.

The differences support Prof. Vercelli's contention that the tidal currents in the western part of the Gulf of Aden extend to great depths.

DONALD J. MATTHEWS.
5 Holly Bush Lane, Harpenden, Herts, Dec. 19.

Disease of Grasses caused by *Epichloe typhina*.

THE Ascomycete fungus, *Epichloe typhina*, has been recorded on eight species of Gramineæ in the neighbourhood of Aberystwyth during the past seven years. Although not a parasite of general economic importance in the district, the fungus has been decidedly destructive at the Station, entailing the loss of some valuable breeding plants. An investigation relative to the biology of the fungus started in 1922 has given some interesting results.

Epichloe typhina is found to possess a slender intercellular mycelium, which permeates the stems and leaves of infected plants at all periods of the year. Field experiments have proved that the parasite is perpetuated by vegetative propagation of the host plant.

The research has centred for the most part in the disease on *Festuca rubra*, a species which first aroused the interest of the writer by showing the conidial stage on exserted panicles. In most grasses the fungus fills the spaces between successive leaves of the fertile shoot and holds the panicle a prisoner.

Seed collected from diseased specimens of *Festuca rubra* has produced consistently a high percentage of infected plants. Visible symptoms of attack, namely, the formation of conidia external to the host, were not developed until the second or third year of growth, but microscopic examination of seedlings revealed the characteristic mycelium at the growing point and in the leaves. Some plants which remained barren for three successive years also revealed mycelium in the vegetative organs.

Mycelium similar to that found in other parts of the plant has been traced in the floral organs and in the ripe seed. So far mycelium has not been absent from any seed examined from an infected plant.

The mycelium occurs as scattered strands in the pales and pericarp, but it is most abundant immediately outside the aleurone layer and between the endosperm and the scutellun. The mycelium does not appear to penetrate the cells. It has been traced within the tissues of the embryo itself, and in the first leaf of seedlings grown from infected seed under aseptic conditions.

The cytological relationship of the host and parasite as revealed under the microscope does not betoken any decided parasitic tendency on the part of the fungus, but an examination of the seed produced by infected plants gave definite statistical evidence of the adverse influence of the parasite.

The invasion of *Festuca rubra* by *Epichloe typhina* and its transmission by the seed are of particular interest in comparison with the endotrophic fungus of the genus Lolium investigated by Freeman and by McLellan.[1] Certain points of difference, notably the intracellular mycelium of the Lolium fungus, and its more thorough invasion of the seed, make it unwise in the present state of knowledge to push the comparison too far. Another parallel might be drawn between the behaviour of *Epichloe typhina* and the mycorrhizal fungus of Calluna described by Rayner.[1]

A further point of interest arising out of the present studies is the discovery of a fungus, in the roots of *Dactylis glomerata*, *Alopecurus pratensis*, and *Festuca rubra*. The fungus has an intracellular mycelium of the Phycomycete type and resembles that recently described in the mycorrhiza of various plants including wheat, *Holcus mollis*, *Festuca ovina*, and the genus Lolium.[1] In my opinion this fungus has no genetic connexion with *Epichloe typhina*.

KATHLEEN SAMPSON.

Welsh Plant-Breeding Station,
Aberystwyth, Dec. 14.

[1] References to the original papers on these topics may be found in the recent book by Dr. M. C. Rayner, entitled "Mycorrhiza, an Account of Non-pathogenic Infection by Fungi in Vascular Plants and Bryophytes," *New Phytologist Reprint*, No. 15, 1927. The references are too numerous to print here.

Activation of Hydrogen by Electric Discharge.

IN a recent paper, Mr. G. A. Elliott (*Trans. Faraday Soc.*, **23**, 60; 1927) describes experiments on active hydrogen in an ozoniser. The activation was determined as usual by leading the active hydrogen over solid sulphur (which was placed very near to the discharge tube).

A mechanism of activation is herewith proposed which does not need such hypothetical species as H_3 (see F. Paneth, etc., *Zeit. f. El. Ch.*, **33**, 102; 1927) and only involves ions and electrons. If the stream of hydrogen leaving the discharge tube carries ions (H^+_2, H^+, or both) and electrons, due to the fact that they have not all recombined, then the electrons may readily combine with the sulphur atoms, because the latter have a decided affinity for electrons. Sir J. J. Thomson uses this idea to explain certain phenomena in the electrodeless discharge in gases (*Phil. Mag.* [7], **4**, 1153 and 1157; 1927). The next step in the ozoniser reaction is then a simple ionic combination (see S. C. Lind, "Chemical Effects of Alpha Particles and Electrons." Second edition, Jan. 1928, Chemical Catalog Co., New York) between H^+ and S^- with the resultant production of H_2S. With the sulphur placed close to the discharge it is very likely that it is under an electric field due to leakage, and it is not necessary then to regard a slow rate of recombination of gas ions as essential.

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Oxfordshire Flowers and the Plot Memorial Windows.

In NATURE of May 28, 1927, p. 798, in the excellent account of the unveiling of the Wren-Ashmole-Plot Memorial Windows at Oxford, it is said that "the surrounding wreath is of two Oxfordshire flowers which Plot was the first to recognise as new to the British flora"—*Viola palustris* and *Geranium dissectum*.

I have dealt with these in my Oxfordshire Flora (lxxvii) and quote Morison's remark upon the Viola. He says (*Pl. Hist. Un. Ox.*, iii. 475, 1680): "Detecta fuit a Jacobo Bobert decennio abhinc"; moreover, it is doubtless Parkinson's ("Theatrum," 755, 1640) *Viola rubra striata Eboracensis*. So, too, with *Geranium dissectum*, Morison does not give Plot, but Bobart as its discoverer. It was actually included in Thomas Johnson's "Catalogue of Kentish Plants," published in 1629. So that neither of the two plants selected to appear in the wreath were actually new to Britain.

Plot, however, did discover a new species of elm (*Ulmus Plotii* Dr.) as well as *Potentilla procumbens*, *Sagina apetala*, and *Eleocharis acicularis*, the two latter not very adaptable for depiction in a floral wreath. The viola, however, and geranium are both figured in his History.

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Experimental Measurement of the Surface Tension of Solids.

IN previous publications I have shown that the surface tension of solids can be determined experimentally by methods which do not involve any hypothesis as to molecular structure. As there is evidence that the structure of rock salt is more complicated than it appears at first sight, I devised a method which enables the molecular forces to be determined in a direct way. The method is limited to a certain range of values and is not applicable when the substances used act on each other; I have determined the surface tension of glass and rock salt. Now I find that this method, described in the *Phil. Mag.*, June 1926 and Oct. 1927, suitably modified, can be also used for many other substances and some metals in particular. Thus it is possible to determine the surface tension of antimony, bismuth, lead, tin, aluminium, cadmium, and zinc. For metals with higher surface tension, certain adjustment of physical properties is still necessary, and this will be done in due course.

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AN unfortunate error has crept into the last paragraph of my article (NATURE, Dec. 31, 1927, p. 969). 125 pengö (not penzö) approximately equals, not 14*s.* 4*d.*, but £4 4*s.*, and 25 pengö is about 16*s.* 8*d.* Since the article was written in Budapest, I am at a loss to account for the error, and I apologise for having overlooked it in proof.

F. A. BATHER.

Light and Sight.

By Sir JOHN PARSONS, F.R.S.

AN opportunity for exemplifying one aspect of the relationship between physics and physiology, namely, that of the physical stimulus to a sense organ and the physiological response, was afforded by the Tyndall Lectures upon "Light and Sight," delivered by me at the Royal Institution on Nov. 1, 8, and 15. John Tyndall, in addition to being a physicist, drifted into biology, and by his experiments on spontaneous generation may be regarded as a pioneer in bacteriology. He was also a philosopher. He himself expressed his indebtedness to three men—Carlyle, Emerson, and Fichte. "These three unscientific men," he said, "made me a practical scientific worker." His philosophy led him strongly to support the pioneers of the evolutionary theory—Darwin and Wallace, Herbert Spencer and Huxley. Specially strongly did he support that canon of scientific discipline which was so ably enunciated by Huxley and rather unfortunately branded by him with the contentious name, agnosticism. Here Tyndall was overshadowed by his great contemporaries, and the immense effect of his Belfast address is liable to be overlooked by the historians of science.

The essence of the agnostic creed was a judicial suspicion of authority and the cultivation of suspension of judgment in regard to matters which are not yet susceptible of rigorous scientific proof. It cannot be doubted that the rise of the theory of relativity and the deductions therefrom have led to a weakening of scientific discipline and a too facile acceptance of plausible speculations. A reversion to the stricter canon of Tyndall and Huxley would be beneficial to all branches of science, and not least to physics, where hypotheses as to atomic structure, the constitution and life history of the stars, etc., are asseverated as facts with all the adamantine validity of the laws of the Medes and Persians. As Sir Arthur Keith has recently said, "The unfortunate position is that in this world there are men who will not be satisfied with not knowing"—an ambiguous remark which, however, as meant, embodies a great truth.

Our consciousness of the world around us is derived from impressions conveyed to our sense organs, of which the most important for us are the organs of vision. The integrated results of our sensory impressions are perceptions, which thus originate in the absorption of energy in various forms by the sense organs and its transformation into physiological impulses which are conveyed by sensory nerves to the brain.

In considering the radiant energy emitted by sources of light, such as the sun and artificial illuminants, and its distribution throughout their spectra, it is interesting to note that the human eye has become specially adapted to sunlight, as shown by the fact that the brightest part of the spectrum, as seen by the light-adapted eye, coincides more or less accurately with the summit of the curve of radiant energy.

As Helmholtz long ago pointed out, the eye *shows many defects as an optical instrument.* The refracting surfaces are not accurately spherical; they are not accurately centred on the optic axis; they are not completely homogeneous and therefore give rise to irregular astigmatism, or completely transparent; the cornea and lens are not free from spherical or from chromatic aberration. Hence Helmholtz's oft-repeated dictum that if an optician delivered so faulty an instrument it would be justifiable to return it to the maker. Even Homer sometimes nods, and it is regrettable that Helmholtz should have uttered so unjust a sarcasm. For the true criterion of the eye as an organ of vision is its biological utility, *i.e.* its capacity to fulfil its manifold functions in the interests of the individual and ultimately of the race. An instrument approximately a sphere of 11 mm. radius, which combines the advantages of being a camera with automatic adjustment from infinity to a distance of 3 or 4 inches and unparalleled range of sensitivity, an efficient photometer, colorimeter, kaleidoscope, stereoscope, and range-finder cannot be regarded as inefficient.

The criterion of visual acuity is the capacity to distinguish two points of light as separate, *i.e.* the *minimum separabile.* This depends on the resolving power of the eye and the fineness of grain of the screen upon which the image is formed, *i.e.* the neuroepithelium of the retina. Experimental observations showing a minimum visual angle of 40″ of arc coincide well with the mean diameter of the foveal cones, 3μ. But contour discrimination, with a minimum visual angle of 10″, or even binocularly of 2″ (Andersen and Weymouth), is much less easy to explain. As shown by Hartridge, the key to the problem is found in the *difference* of illumination which is perceptible to cone vision. It is a striking example of the law that all perception is perception of change.

It can be safely stated that there is no form of sensory discrimination which is so highly developed as that of contours; and it is noteworthy that it has been employed empirically by physicists in the vernier. When the vernier method is inapplicable, as in photometry, the error of experiment is greatly increased. It is well for physicists to remember that the accuracy of their measurements depends upon a biological foundation (see NATURE, 110, 824; 1922).

The bearing of these facts on the physiology and psychology of reading elicits many interesting conclusions. The defects of the optical apparatus lead to diffusion images, and cause irradiation, whereby the image of a dark object is encroached upon by the surrounding white. Irradiation in print is largely counteracted by the use of serifs and by careful design of the letters and spaces. Thus, the interspace between round letters like *o* and *e* should be less than that between square letters. Moreover, the significant parts of letters are usually

in the upper half, so that a line of print can be easily read if the lower halves of the letters are covered, but is illegible if the upper halves are covered.

The eye is not only automatically adjustable to distances, but also its sensitivity is automatically adjusted to the amount of light entering it. The sensitivity of the retina increases enormously in dark adaptation, and scotopic or twilight vision differs in many respects from photopic vision. Evidence derived from physiological and pathological observations supports the view that the rods are responsible for scotopic, the cones chiefly for photopic vision. This is the so-called duplicity theory. Thus, the rod-free area of the macula is night-blind, as was long ago discovered by astronomers, and it is generally held that the Purkinje phenomenon is absent at the fovea. Further, the rate at which the eyes become adapted to dim light varies somewhat in normal people, and there are diseased conditions in which it is very slow or almost absent. Such people are night-blind. They are practically incapacitated in dull lights, and cannot get about after dark. In one rare group the eyes appear to be otherwise normal and the disease is transmitted from one generation to another. The most famous and most extensive pedigree of any diseased condition is that of some congenitally night-blind people in the Montpellier district in the south of France. The pedigree was started by Cunier in 1838 and brought up-to-date in 1907 by Nettleship. It consists of ten generations of 2121 persons, 135 of whom were night-blind. Much commoner is the night-blindness associated with the disease of the retina called retinitis pigmentosa.

An interesting antithesis to night-blindness is found in the rare cases of congenital total colour-blindness. For the normal sighted the colourless grey spectrum of scotopic vision becomes suffused with all the colours of the rainbow as the intensity of the light is increased. For the totally colour-blind, although the brightness increases under these conditions, no colours are seen. Moreover, there is no shift of the maximum brightness from the green to the yellow region of the spectrum, such as occurs in the normal.

On the duplicity theory, the congenital night-blind may be regarded as having only cone vision, and the totally colour-blind only rod vision. There are, however, difficulties in accepting this simple explanation.

The discovery of the visual purple indicates forcibly that the first stage in the energetics of the retina is photo-chemical. It is associated with electrical changes of great complexity; and whereas Adrian has shown that the electrical changes in the optic nerve are in all respects like those in an ordinary nerve under excitation, the correlation of these changes with those of the more complex retina has yet to be elucidated.

Stimulation of the retina by an instantaneous flash of light elicits two facts—the persistence of the visual impression for an appreciable time beyond that of stimulation, and the recurrence of vision. The latter is due to the pulsatile nature of the sensory response. It accounts for such peculiar phenomena as 'Bidwell's ghost,' Charpentier's bands, and so on. One of the most striking phenomena is the production of a colour sensation by pure black and white stimulation, as in Benham's top; and this has recently been partially explained by Piéron on the same principle.

The relations of these scientific observations on light and sight to such practical problems as the illuminations of rooms, factories, art galleries, etc., and the hygiene of vision in relation to flickering lights, the cinema, etc., is full of interest, but also often very obscure. The investigation of such problems is the chief work of the Physiology of Vision Committee of the Medical Research Council.

The Second Danish-Icelandic Expedition to Iceland, 1927.

By Dr. NIELS NIELSEN, Copenhagen.

OUR knowledge of the interior of Iceland is of quite recent date and still in part very incomplete, even to the point that there are districts which may be said to be utterly unknown to science. This applies both to topography and to geographical and geological conditions. The reason is that it is very difficult to push into the highlands of the interior, because different difficulties, each of which requires to be met by a special technique on the part of the traveller, combine to present obstacles to his passage as well as to his closer scientific investigation of the country.

In a purely practical way the coast districts have been known ever since the country was first inhabited, that is, for about a thousand years, and similarly certain tracks through the inner highlands, which one may suppose were considerably better known seven or eight hundred years ago than they were in the eighteenth and nineteenth centuries. Meanwhile, the last fifty years have made great changes in our knowledge of this region, inasmuch as a great advance has been made in the scientific investigation of the highlands, and at the same time in a practical knowledge of the country. This advance is due to a considerable number of able and energetic men of science and travellers, among whom one may name Winkler (1858), Preyer and Zirkel (1860), Keilhack (1883), Watts's various expeditions in the 'seventies, and Biziker (1900). Above all, one must mention the great work carried out by the distinguished Icelandic investigator, Thorvaldur Thoroddsen, who in the last two decades of the nineteenth century travelled over a very great extent both of the highlands and of the coast districts, and published numerous papers on the geography and geology of Iceland. We further owe to Thoroddsen a number of excellent handbooks which are among the most important aids in Icelandic exploration. Since 1898, when Thoroddsen's journeys ended, the work has been continued by

German, British, Icelandic, and Danish men of science, who have all contributed to our knowledge of the peculiar natural conditions of the interior of Iceland. During the War, Icelandic investigation came almost to a complete standstill, but since then a number of investigators have made journeys into the country, and the results are beginning to appear in various journals.

One link in the series of these resumed investigations of Iceland is contributed by the journeys accomplished in the years 1924 and 1927 under the name of the First and Second Danish-Icelandic Expeditions, under the leadership of the author of this article and the Icelander Palmi Hannesson. The costs of these expeditions were provided by the Danish-Icelandic Confederation Fund and the Danish Carlsberg Fund. With regard to the expedition of 1924, the reader may be referred to the articles already published,[1] but in what now follows a short synopsis will be given of the work accomplished in the expedition of 1927.

Fig. 1.—Surface of lava-gravel near Fiskivötn, Iceland. The storms, joined with the great porosity of the surface, make vegetation very scarce. In the foreground may be seen a little stunted Armeria.

The main lines of the plan were to push from the district near Hecla towards the western part of the great ice-field of Vatnajökull and to make investigations in the ice-free country west of the ice-field and its western part, the intention being to explore westward until contact was established with the districts south of Hofsjökull explored in 1924.[2] That has now been done, and the plan proved on the whole to be workable with the means and the man-power which were at our disposal.

The participators in the scientific work were Steinthor Sigurdsson, Palmi Hannesson, and Niels Nielsen. They were accompanied by a non-scientific colleague, an Icelandic schoolmaster, Sigurdur Jonsson. The work lasted from the beginning of July until the middle of September, and from July 18 to Sept. 3 the expedition was cut off from all connexion with the inhabited district except that the Danish minister in Iceland, Fr. de Fontenay, was from July 30 to Aug. 5 the guest of the expedition and took part in the work.

By far the greatest part of the highlands of Iceland is extremely deficient in vegetation and may be described as desert; but this differs very much, as great parts are covered with ice the whole year through, especially the higher altitudes of the plateaux, which embrace most of the country and in many places extend right down to the coast. The parts of the highlands which are free from snow in summer are for the most part very sparingly overgrown, and it is only at long intervals that one comes upon oases. These conditions completely govern the technique of travel in Iceland, which is based on the use of Icelandic ponies, because it is only with their help that one is able to overcome the obstacles presented by ice-fields, lava-fields, barren stretches of sand and gravel, and, not least, the great number of rivers springing from the margins of the ice-fields.

On long journeys in country free from snow it is impossible to transport fodder for the horses,[3] because a horse can only carry fodder for himself to last about ten days, so that one must depend on the few and scattered oases already mentioned. The explorations of 1927 set out from two such oases near Fiskivötn and Illugaver, both known before. On these spots we established a base whence the work was carried on, partly on horseback, partly on foot, partly by the setting up of small intermediate stations in the desert tracts around.

The equipment consisted of tents, with watertight floors, sleeping-bags of lamb-skin, and vegetable provisions for nine weeks: on the other hand, the supply of meat was quite small, the intention being to furnish the expedition with animal food by hunting and fishing. We succeeded, thanks especially to our catches of trout, in getting what we needed. For transport of men and goods, seventeen horses were employed, of which, however, immediately after our arrival at Base No. 1, four had to be sent back to the inhabited district, because there was not grass to feed them all. So the number of our horses was properly thirteen. The scientific equipment consisted, *inter alia*, of a complete outfit for mapping and astronomical determination of position (wireless receivers for

[1] *Geografisk Tidsskrift*, Copenhagen, 1924; Niels Nielsen: "Der Vulkanismus am Hvitárvatn und Hofsjökull auf Island." Meddelser fra Dansk Geologisk Forening, Copenhagen, 1927.

[2] Niels Nielsen: "Plan til en Ekspedition til den vestlige Del af Vatnajökull og tilgrænsende Egne i Centralisland." *Geografisk Tidsskrift*, Copenhagen, 1927.

[3] Conditions are quite different when one has to do with ice-tracts and can employ sledges drawn by horses; cf. J. P. Koch's journey over the inland ice of Greenland with Icelandic horses, 1912–13.

determining time and for meteorological intelligence), apparatus for meteorological observations, and a set of instruments for limnological work. We carried, besides, a good photographic equipment, both the usual plates and cinema-films.

Those who took part in the scientific work worked to some extent collectively and to some extent singly. Thus the cartographical work was mainly carried out by Sigurdsson, the limnological, as also the zoological and botanical investigations, were made by Hannesson, while I mainly occupied myself with geomorphological inquiries, especially concerning the morphology of vulcanism and tectonics. But collective work was much needed both for practical and for scientific reasons.

The results of the investigation can naturally not appear in their completed form until later, and then will probably be published as articles in journals in a widely used language, but a short survey of the materials collected can be given at once.

1. The results obtained give a series of new lights on topographical facts in the country west of Vatnajökull and the western part of that ice-mass; and on the basis of the triangulation carried out for the whole district and the detailed measurements carried out in certain cases, it will be possible to make a general survey map of the whole district and a map to smaller scale of different areas of especial geographical or geological interest. The working sketches already made show that the chief topographical lines, mountains, rivers, ice-margins, seashores, run essentially otherwise than has been hitherto supposed, and of a great part of the district it is certain that it was never before travelled in, far less mapped out.

2. The biological, and more especially the limnological, material will probably contribute to an understanding of the rigorous conditions under which animals and plants subsist in these regions, which may be described as the border-regions of the diffusion of life on the earth. A special investigation has been taken in hand of some peculiar lakes in the neighbourhood of ice-margins, which are marked by an extraordinarily rich fauna and flora, though its richness relates only to the number of individuals, not of species. Only two species of fish are found, namely, one of stickleback and one of trout, but by way of compensation the fish were very well-grown and fat; the trout weighed up to 4 kilograms. Another special research has been made into the peculiar plant-world which is found at times in the immediate vicinity of the ice-margin, and here forms such large and continuous oases that one can feed a small number of horses there for some days, a plant-world existing amid a number of concurring circumstances of a remarkable kind.

3. The geographical-geological material is very extensive and various in character. Of the topographical part, mention has already been made. In addition, there are numerous observations concerning volcanic action, which has been very violent and varied, in this part of the country. One finds, for example, typical fissure-eruptions with a great production of lava which has formed lava-fields covering many hundreds of kilometres. Again, we have single volcanoes with a mixed formation of the same type as Vesuvius, while the excrescences found at fissure-eruptions a e

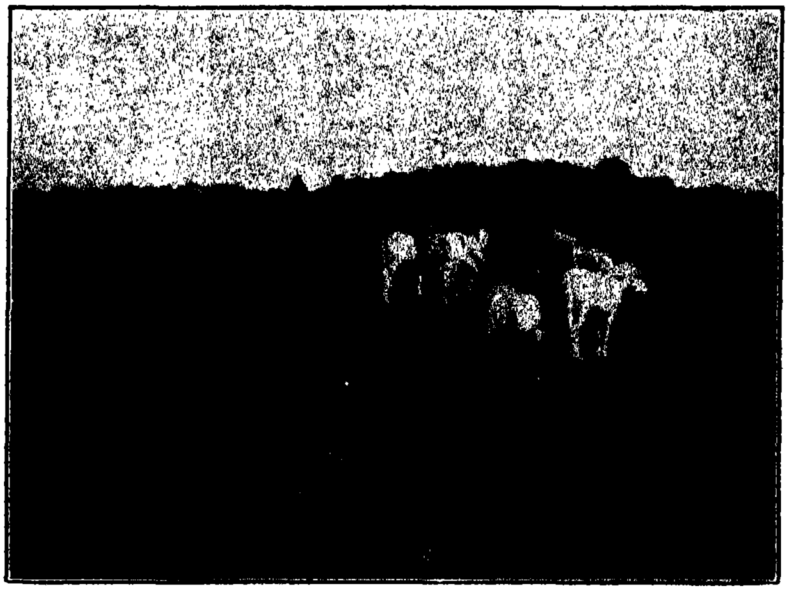

FIG. 2.—In the lava-fields immediately west of Vatnajökull. The horses are standing on an old lava-stream of somewhat loose sand, while the two men behind are walking on quite recent lava which is very difficult to cross. The demarcation of the two streams is seen quite clearly.

so slight that they are difficult to find. In one of the volcanic zones the explosive activity has been very great and has led to the formation of a number of craters or 'Maarer' of many different types. The volcanic activity can be followed from the later period of the ice age down to the present day—the last outbreak which can be dated with certainty took place in 1913. Consequent on the volcanic phenomena, many fumaroles and hot springs are found.

The country west of Vatnajökull is further remarkable for being a very disturbed country in a tectonic sense. A great part of the region is broken up by earthquakes. The displacements have especially taken place along lines running in the direction S.W.—N.E. and have divided the country into a number of ridges with intervening depressions. Some of these displacements go back to the ice age, while others are quite recent, in any case not more than some few thousand years old.

As a third factor in landscape-formation one may mention the ice, which has many times spread from the neighbouring Vatnajökull over the whole country, and the effect of which, both in earlier times and in modern times, has been the subject of study.

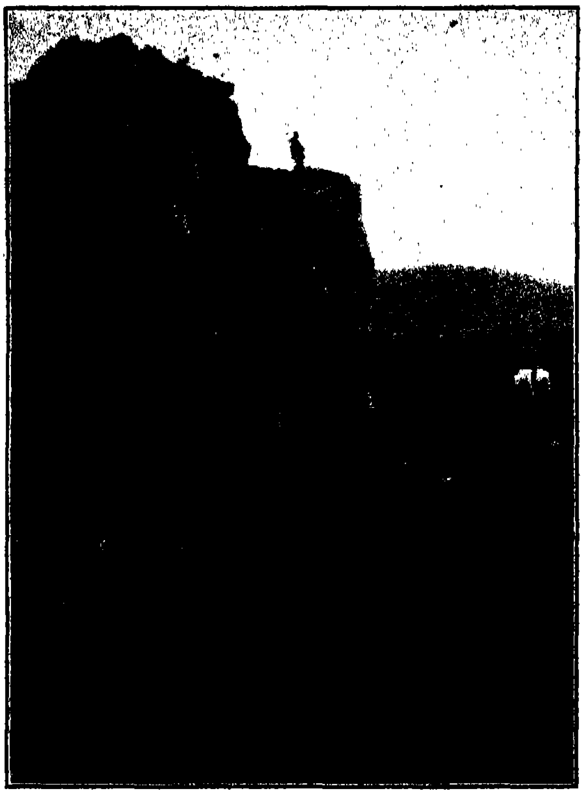

FIG. 3.—An earthquake-rift in the lava-fields west of Vatnajökull.

In this landscape, the origin of which, as has been stated, must be referred to three different sets of factors, a whole series of transforming forces are at work at this moment, and some of these have been specially investigated, because the conditions here in certain respects are abnormal. A very special rôle, for example, is played by the wind, the erosive power of which is very violent and is the cause of production of frightful sandstorms, which in their strength remind one of those that take place in the great desert regions of Asia and Africa. Another very real factor in erosion is the snow, which, together with the masses of water set free by its melting, greatly contributes to the transformation of the landscape. The reason why the above-mentioned factors play so great a part in this work, and can be studied with comparative ease, is that nearly the whole district is deficient in surface streams. Apart from the great rivers of melted ice, one finds only a few short streams, since the whole surface consists of very porous kinds of rock which absorb water with avidity and carry it underground a great distance until it emerges as springs of surprising abundance.

The expedition has met with great kindness and support on many sides both in Iceland and in Denmark, the conditions of work have on the whole been good, and the work has been carried out without serious misfortune to man or beast.

Obituary.

PROF. P. H. VON GROTH, FOR. MEM. R.S.

GEHEIMRAT PAUL HEINRICH RITTER VON GROTH, who died on Dec. 2, 1927, was born on June 23, 1843, at Magdeburg. His father was a portrait painter. His early academic studies were pursued first at the Bergakademie at Freiberg (1862–65) and then at the University of Berlin (1865–67), where he obtained his Ph.D. degree in 1868. He was successively assistant in the Department of Physics in the University (1868–70), reader of mineralogy and geology at the Bergakademie in Berlin (1870–72), and in 1872 was appointed professor in the newly constituted University of Strasbourg, where he remained for eleven years until his promotion to the chair at Munich. It was during Groth's tenure of office at Munich that the most important work of his life was accomplished. In 1874 he published his "Tabellarische Übersicht der einfachen Mineralien"—a comprehensive list of the mineral kingdom, containing not only a systematic classification of species, but also a critical survey of views on their chemical composition; subsequent editions with much new material appeared in 1882, 1889, 1898, and were followed in 1921 by a new survey, "Mineralogische Tabellen," in conjunction with Mieleitner. In 1876 he published his famous "Physikalische Krystallographie," a most readable and suggestive treatise which was for many generations of teachers and students an attractive introduction to a science that had previously been presented in a very unattractive form. Sir Lazarus Fletcher has recorded the fact that he was led to take up the study of the subject by happening to see a copy of the book in that year. Subsequent enlarged and revised editions appeared in 1885, 1895, 1905.

In 1877, Groth started the first volume of the *Zeitschrift für Krystallographie und Mineralogie*, which became universally known as Groth's *Zeitschrift*. This he edited with great skill for thirty-nine years, enlisting the co-operation of a large number of mineralogists from all countries; it was conspicuous for its international character and for the value not only of the original papers, but also of the abstracts which it contained. In a memoir which appeared shortly before his death in the *Zeitschrift*, he gave an account of its inception and a history of its progress during the period of his editorship. The fiftieth volume (1923) was a

(Continued on p. 107.)

Supplement to NATURE

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On the Rotation of the Earth and Astronomical Time.

By W. DE SITTER, University of Leyden.

ABSOLUTE TIME AND PRACTICAL MEASURES OF TIME.

NEWTON'S "Principia" begins with the definitions of some technical terms, such as 'mass,' 'force,' etc. Newton then continues as follows :

"Nam Tempus, Spatium, Locum et Motum, ut omnibus notissima, non definio. Notandum tamen, quod vulgus quantitates hasce non aliter quam ex relatione ad sensibilia concipiat. Et inde oriuntur praejudicia quaedam, quibus tollendis convenit easdem in absolutas et relativas, veras et apparentes, mathematicas et vulgares distingui.

"I. Tempus Absolutum, verum, et mathematicum, in se et natura sua absque relatione ad externum quodvis, aequabiliter fluit, alioque nomine dicitur Duratio : Relativum, apparens, et vulgare est sensibilis et externa quaevis Durationis per motum mensura (seu accurata seu inaequabilis) qua vulgus vice veri temporis utitur, ut Hora, Dies, Mensis, Annus."

The few words which Newton puts in parentheses contain the great problem : How are we to decide whether a given measure of time is accurate or not ? We measure time by different 'motions,' of the sand in an hour-glass, of the hands of a clock (hours), of the earth on its axis (day), of the moon round the earth (month), the earth round the sun (year), or others. If these different methods do not give the same result, *and they do not*, how are we to know which is to be preferred, which is the best approximation to the true, absolute, mathematical time ?

It is one of the fundamental characteristics of natural science that we never get beyond an *approximation*, and this for two reasons. The first of these is that the motions that we use for measuring time must be observed, and all observations are affected by errors, and can never be absolutely accurate. The other is that Nature never offers us simple and undivided phenomena, or 'motions,' to observe, but always infinitely complex compounds of many different phenomena. Each simple phenomenon can be described mathematically in terms of the accepted fundamental laws of Nature ; to interpret the complex phenomena of daily experience we must analyse them into their simple components, isolate these, and from each separately draw our conclusions. We can never be sure that we have carried this analysis to its full exhaustion and have isolated one single simple phenomenon, to which we can apply our mathematics. We might, indeed, take a different point of view and argue that the phenomena of Nature are simple, and that it is we who introduce the complication, forced to do so by the limitations of our power of mind and our mathematics, which do not allow us to grasp the sublime simplicity of Nature otherwise than by the devious route of first splitting it up into partial aspects, so chosen that we can master them by our mathematics, and then recombining these to an approximate representation of the whole. However this may be, we cannot but use the only means at out disposal, and if the truth be one and simple, we can only comprehend it as a synthesis of many constituent truths.

The simple constituent motions into which we decompose the actual phenomena are described in terms of the laws of mechanics and the time. This time, which is thus the 'independent variable' of our differential equations, or laws of Nature, is Newton's mathematical (or true, or absolute) time. Once the observable quantities have been expressed mathematically in terms of the time, it is very easy inversely to derive the time from the observed values of these quantities.

In our choice between different motions used to measure time, or, as we may say, between different 'clocks,' we are thus guided by two considerations : which can be most accurately observed, and which 'runs' most accurately, that is, which represents the best approximation to an isolated simple phenomenon of which we know the laws.

Astronomical Time.

The standard clock, to which all other measures of time are referred for comparison, is the rotating earth. In fact, we know of no other motion which is so purely representative of an isolated simple phenomenon, so free from 'perturbations.' The time measured by the *rotation* of the earth has for immemorial ages been used by astronomers as their standard of reference. It is called *astronomical time*.

The motions of the other heavenly bodies can, of course, also be used as a measure of time. Their mathematical expression in terms of the time is less simple, and the determination of the time from the observed motions thus demands a greater amount of computation. Also they cannot be observed with the same accuracy, the motions being slower and the bodies far away. But within the limits of uncertainty, they all ought to give the same time; that is, the ratio of the day and the month, and of the day and the year, ought to be constant through all ages, after due allowance has been made for known perturbations.

Time measured by the Moon: The Secular Acceleration.

These ratios, however, are *not* constant. The great astronomer Halley discovered that the month, measured in astronomical time, is continually getting shorter. Whether, measured in the true or mathematical time, the month gets shorter or the day longer, or both change, we have no means of saying: we only know that the number of days in a month is becoming smaller. The change is very minute: if it continues at the same rate, it will take 250 million years for this number to diminish by one unit. The length of the month at the present time diminishes by $\frac{1}{35}$ of a second per century; in other words, the motion of the moon referred to astronomical time is accelerated.

When two clocks do not show the same time, the difference may be constant, or it may be variable. If it increases or diminishes regularly, the two clocks have different *rates*; one of the clocks, say A, loses time as compared with the other, say M; or one hour of A is longer than one hour of M. If also the difference of the rates is not constant, but changes regularly with the time, then one of the clocks is *accelerated* with regard to the other, and the other is retarded with reference to the first. If we call T the time as read from clock A and t that given by clock M, the three cases considered are represented by the following mathematical formulæ:

$$(1)\ t-T=a,$$
$$(2)\ t-T=a+bT,$$
$$(3)\ t-T=a+bT+cT^2.$$

The formula (3) represents the case of the earth and moon, used as our clocks A and M. The time as derived from the moon's observed longitude is not uniform as compared with astronomical time, but contains a term $20^s \times T^2$, if T is expressed in units of a century. This is technically known as the *secular acceleration* of the moon's motion. It was discovered by Halley, who found that he needed it in order to represent by one formula the modern observations as well as eclipses observed by the ancient Babylonians and by the Arabian astronomer Albategnius (ninth century A.D.).

The presence of this term proves that our simple theory of the motion of the moon, taking account of no other forces than the general attraction by Newton's law, is incomplete. Consequently, either some minute gravitational effect has been overlooked in elaborating this theory, or some other cause must be acting in addition to it. Newton[1] suggested that this other cause might be a slow increase of the mass of the earth by the addition to it of the "vapours escaping from the atmospheres of the sun and the stars and the tails of comets, which by their gravity fall down into the atmosphere of the earth and the other planets and may there be condensed and converted into water and watery vapours, and subsequently by slow heating be changed by and by into salts and sulphurs, and tinctures and mire, and mud and clay, and sand and stones, and corals and other terrestrial substances."

We now know that this cause—which in modern language we would call the fall of meteorites—is real, but incapable of explaining even a very small fraction of the observed acceleration. Tobias Mayer, in the middle of the eighteenth century, was the first to suggest that the change might not be primarily in the month, but in the day, the rotation of the earth being retarded by the friction of the tides. This suggestion, however, does not appear to have attracted any attention at the time. Laplace, in 1787, found a perturbation by the gravitational influence of the planets on the motion of the moon, which had been hitherto overlooked. According to his computations, this would be just sufficient to explain the observed acceleration of the moon's motion, the day not being affected. If this were so, there would be no discrepancy; the two clocks would be in perfect agreement. Adams,

[1] "Principia," Book III., just before the *Scholium Generale*.

however, in 1853, carried Laplace's computations to a further order of approximation and found that this cause explains little more than one-half of the observed acceleration, giving in fact a term $11^s \times T^2$. There thus remained unexplained about $9^s \times T^2$.

FLUCTUATIONS OF THE MOON'S LONGITUDE.

This, however, is not the only unexplained discrepancy in the moon's motion. In addition to it, the moon shows irregular deviations from its path as prescribed by theory. It is sometimes in advance of its theoretical position and sometimes it is left behind. The difference can run up to 15 or 16 seconds of arc. In other words, since the moon takes about two seconds of time over one second of arc, the time shown by the 'clock *M*' may occasionally be about half a minute slow or fast on astronomical time. These irregularities, called *fluctuations*, were discovered by Newcomb. He suspected them already in 1875, but it was only in 1903 that he published an entirely convincing proof of their reality. Before about 1630 the observations are too inaccurate to enable any conclusions to be drawn. At that time the moon was about 30 seconds slow on astronomical time. About 1670 it began to gain, so that in 1720 it had made up its arrears. It then continued to gain, and was nearly 30 seconds in advance by 1785. Then it started to lose again, being caught up by the theoretical moon in 1865, and left behind more and more until about 1900, when it started to gain again. It has, however, only succeeded in diminishing its arrears from about 30 seconds in 1900 to about 18 in 1918, and has lost again in the last few years, being some 23 seconds slow at the present time.

It should be understood that these fluctuations are additional to the secular acceleration, and they are of a very different nature. The secular acceleration is a steady increase of the rate of the lunar 'clock.' If it is graphically represented by plotting on co-ordinate paper the deviations of the moon's observed position from the theoretical one, the resulting curve is a parabola. If the change of the rate is not uniform, then the curve will differ from a simple parabola, but it will always be a smooth curve with a continuous curvature and without any sharp bends. The fluctuations, on the other hand, show a very different character. When plotted on co-ordinate paper, they have the appearance of a series of straight lines with sharp bends where two lines meet. Thus from the appearance of the observed deviations we would be inclined *a priori* to ascribe them to two different causes.

It has already been remarked that the observations prove only that there is a difference between the time as shown by the two 'clocks' *A* and *M*, but do not enable us to decide which of the two is correct. There is, however, one crucial test, which is very obvious, though not so very easily applied. If the clock *A* is in error, that is, if the astronomical time differs from the mathematical time, then not only the moon, but all the other heavenly bodies as well, must show deviations from their theoretical motions. Now the moon is not only our nearest neighbour, in consequence of which the observations of its position are more accurate than those of other bodies, but it also moves much more quickly than most others, so that the irregularities run up to a larger amount in the same time. The consequence of this is that irregularities in the moon's motion have been discovered earlier than in the motions of other bodies.

THE SUN AND THE PLANETS.

It was only in 1906, about two centuries after Halley's discovery of the secular acceleration of the moon, that Cowell detected a secular acceleration in the longitude of the sun. His result has been confirmed by later researches, and it has also been found that the planet Mercury, which can be very accurately observed on the occasions of its transits across the sun's disc, shows a similar acceleration. The most recent discussions lead to a secular acceleration of the longitudes of the sun and Mercury corresponding to a term $40^s \times T^2$, *i.e.* about 4·4 times as much as the unexplained acceleration of the moon. If this is ascribed to a retardation of astronomical time, *i.e.* of the rotation of the earth, then the corresponding lengthening of the day is $\frac{1}{480}$th of a second per century. On the other hand, several astronomers have found fluctuations similar to those of the moon in the longitudes of the sun, Mercury, and Venus. Brown was the first who produced strong evidence of this (in 1914), and lately many investigations have established the similarity of these fluctuations with those of the moon beyond any reasonable doubt. Whenever the moon is losing on astronomical time, the sun and planets are also losing, and when the moon is gaining, the sun and planets are also gaining. Thus, for example, from 1876 to 1897 the moon lost about 15 seconds, and from 1897 to 1918 it gained about 11 seconds. The sun and planets have in these intervals lost 19 seconds and gained 14 seconds respectively, and similarly for other intervals, the moon's loss or gain being always about four-fifths of those of the sun and planets.

All this points to the astronomical time, that is, to the rotating earth, as the chief offender, in complicity, however, with the moon. We are thus confronted with the question how a change in the rate of rotation of the earth, that is, in the length of the day, can be explained, and with the further question whether the cause which produces this change can also affect the motion of the moon. The problem certainly looks forbidding enough.

If we return to our representation by 'clocks,' we have now *three* clocks: A, the rotating earth, giving astronomical time; M, the moon; and S, the sun and planets. The sun and the planets Mercury and Venus are treated as *one* clock, S, since they agree amongst each other within the limits of accuracy of the observations, but they do not agree with M. The observations of the other planets are not sufficiently accurate to be used for comparison. There is, in fact, a fourth clock, J, namely, the satellites of Jupiter, of which accurate observations exist. This, however, does not agree with either M or S.

The problems which are raised by this further disagreement are so complicated that I will leave them out of consideration in this article. We will restrict ourselves to the three clocks A, M, and S. We find that both M and S are uniformly accelerated with regard to A, and the acceleration of M is between a quarter and a fifth (0·23) of that of S. Further, both are losing or gaining simultaneously, at irregular intervals, the loss or gain of M being four-fifths of that of S. We can, however, choose any other clock as our standard of reference instead of A. If we choose S—and I may say here at once that our final conclusion will be that S keeps true mathematical time—then our observational data are that both A and M are uniformly retarded, the retardation of M being between three-quarters and four-fifths (0·77) of that of A, and further, both A and M are alternately gaining and losing simultaneously, the gain or loss of M being one-fifth of that of A. It should be kept in mind that this division of the observed phenomena in two classes, the uniform retardation and the alternate gain and loss, is introduced by us in order to prepare them for mathematical treatment. In Nature there is only *one* phenomenon, the sum of the two, and our mode of cutting it up may be very unnatural.

It is, however, necessary to cut up our problem into simpler ones, because our mathematics would not otherwise be able to deal with it. Mathematics, after all, is only a device to relieve us from thinking, as one of my astronomical friends likes to say. We may compare it to the motor-car, which is a device to relieve us from walking. We will make a free use of this convenient vehicle, but we will thereby unavoidably lose a little of the intimacy with the landscape which the pedestrian enjoys.

Two Possible Explanations.

Amongst all the causes that have been imagined for a change in the rate of rotation of the earth, there are only two which can stand the test of critical scrutiny. These are: first, changes in the size or shape of the earth, or the distribution of mass inside the earth, leading to a change of the moment of inertia with reference to the axis of rotation; and second, tidal friction.

The first cause can act both ways: when the moment of inertia is increased, the rotation becomes slower; when it is diminished, quicker. The motion of the moon is not affected. If the changes of the moment of inertia take place discontinuously, the rate during the intervals between the changes is constant: the graphical representation of the longitudes of the heavenly bodies will be just such a series of straight lines as we found characteristic of the *fluctuations*. The only difficulty is that the moon should show exactly the same fluctuations as the sun and the planets, and not four-fifths of them, as it does. In other words, this cause affects our 'clock A' only; it should leave M just as true to mathematical time as S.

The second cause can only retard, and never accelerate. If the tidal friction remains constant throughout the ages, the retardation must be uniform, and we shall get a representation by a parabola, as observed in the secular acceleration; if it is not uniform, but changes from time to time, we shall get a series of parabolas, but they will still form a smooth curve, without sharp bends. A characteristic difference of this cause from the first is that it does influence the moon's motion. The tidal wave is caused by the attraction of the moon, and inversely it must attract the moon, thus creating a tendency to accelerate its motion. This causes the moon, by centrifugal force, to recede from the earth, and thereby, in accordance with Kepler's third law, its period of revolution is increased, *i.e.* the 'clock M' is retarded. When the moon is nearest the earth, at its perigee, the tides are higher and the ensuing force is greater than the average; consequently, the distance increases more than the average, and by the time it has arrived at the opposite end of its orbit, the apogee, it has swung farther out. Here the force is less than the average, the outward tendency is less, and the moon recedes

less than the average. The consequence is that the difference between the greatest and least distances is enhanced: the eccentricity is increased.[2] To convert this qualitative reasoning into a quantitative one, that is, to calculate the exact amount of increase of the mean distance and the eccentricity, it would be necessary to have a detailed knowledge of the forces acting.

The forces acting in the tidal friction are extremely complicated. It has been proved that neither the tides in the body of the earth, nor those in the great oceans, can produce enough friction to explain even a very small part of the observed retardation. The effective friction occurs in the shallow seas and narrow straits, such as the English Channel, the Straits of Malacca, the Bering Sea, and others. The tidal current runs up these straits or shallow seas from the ocean, and spends part of its energy in friction against the coasts and the bottom. The energy thus dissipated (which is, of course, converted into other forms of energy, for example, by a small rise of temperature of the water) is taken from the rotation of the earth, which is thus always retarded, whether the current happens to run against the rotation, or with it as in the case of the English Channel. The reaction on the moon takes place by the intermediary of the mutual attraction of the moon and the small secondary waves set up from the areas of dissipation as centres. Jeffreys has calculated the amount of energy thus taken from the rotation per second, and finds that those shallow seas in which the currents are known with sufficient accuracy to make the computation possible, explain about one-third of the observed retardation. If we reflect that more than two-thirds of this is contributed by the Bering Sea alone, and that there are many more shallow seas not included in his investigation, especially in the polar regions (for example, to the north of Asia), where presumably the friction is increased by the presence of ice, it does become very probable that this is the true explanation of the retardation of the rotation of the earth and of astronomical time. We may also remark that it is scarcely to be expected that the friction will be exactly the same throughout all time. It is thus natural to suppose the retardation to be variable. The observed secular acceleration is, from this point of view, the average over the last 20 or 25 centuries, but there may have been oscillations.

Can the variability of the secular acceleration be invoked to explain the fluctuations? To begin with, as has already been pointed out, it will never give rise to sharp bends such as occur in the observed fluctuations. But there is a much more cogent reason why it can only explain a relatively small part of the fluctuations. Friction can, of course, never *accelerate* the rotation; it must always retard it. Now the fluctuations consist of alternate retardations and accelerations, and sometimes the accelerations are larger than the retardation of tidal friction, so that the total effect is an acceleration. This circumstance sets a limit to the fraction of the fluctuations which can be due to the variability of tidal friction. Certainly not more than one-half of the observed fluctuations could be explained in this way.

Effect of Tidal Friction.

So far we have considered the effect on the rotation of the earth. We have also seen that the mean distance of the moon must be increased, and consequently its mean motion diminished, and that its eccentricity will probably also be increased. To calculate the retardation of the moon and the increase of its eccentricity corresponding to a given retardation of the earth, we would have to follow step by step the play of the forces in the small secondary tidal waves produced by the friction in the shallow seas. Here the ground becomes too difficult even for the mathematical motor-car. We must take a flying machine to cross over this jungle and land us safely at the other side. Such devices, which can lift us from the solid ground of actual computation to bring us by a short cut to some remote point without taking any notice of the intervening country, are provided by the 'general principles' of theoretical mechanics. The machine that we use in this case is called the 'principle of conservation of angular momentum.' If the earth's rotation is slowed down, the angular momentum of the system earth–moon is diminished, and the moon must make up for that by increasing its own angular momentum, which it can do by increasing its mean distance, by increasing its velocity of revolution (mean motion) or by diminishing its eccentricity. The increase of the mean distance is the most effective of these means, and it is the one that the moon will choose. It entails a decrease of the mean motion, and the exact balance between these two effects is determined by Kepler's third law. We have seen that probably the eccentricity will also be increased, and consequently the mean distance has to be increased more than if the eccentricity remained constant. How much more, the general principle cannot tell us.

[2] This explanation of the increase of the eccentricity is borrowed from Darwin, to whom it was suggested by Lord Kelvin. It is, as Darwin remarks, not a rigorous reasoning, but still it is sufficient to make an increase of the eccentricity appear more probable than a decrease.

If the eccentricity did not change, the increase of the mean distance would be such as to make the retardation of the moon's motion two-thirds (0·67) of that of the rotation of the earth. We know by observation the retardation of the rotation and we can thus easily calculate the increase of mean distance for constant eccentricity. On the other hand, we also know the actual retardation of the moon's motion, and therefore, by Kepler's third law, the actual increase of its mean distance. The excess of this over the computed value must be what is needed to compensate the increase of the eccentricity. In this way we find that to the observed ratio of 0·77 of the retardation of the moon and that of the earth, corresponds an increase of the eccentricity of the moon's orbit by one fifty-millionth, or one three-millionth of itself, per century. This, of course, is an extremely minute quantity. It can never be detected by direct observations, and can, so far as I can see, have no influence on any other observable phenomenon, but it is sufficient to increase the ratio just mentioned from 0·67 to 0·77.

Changes of the Earth's Moment of Inertia.

We return to the consideration of the first cause. How can the moment of inertia of the earth be changed? The change must be due to some displacement of mass on the surface or in the inside of the earth. But the displacements needed to explain the observed changes of rate are enormous. In 1918 the length of the day changed suddenly, or at least within a very short interval of time, from $\frac{1}{650}$th of a second longer to $\frac{1}{540}$th shorter than the average, a shortening of one twenty-five millionth of its length. If the whole of the Central Asian Highlands, from the Himalaya to the Kuen-lun mountains (both included), had at that time been sunk into the earth, their mean height being reduced to sea-level, the resulting shortening of the day would have been only one hundred millionth of its length, or one-fourth of what is required. This example shows that it is hopeless to look for local displacements of mass as an explanation of the observed changes. If, however, the displacements are world-wide, they need not be so large. A uniform shrinkage of the whole earth, decreasing its radius by about 5 inches, would be sufficient to produce the shortening of the day which happened in 1918. Even this would be rather a crude way of producing the required effect. It can be attained by a very slight adjustment of the shape of the layers of equal density in the inside of the earth, of which the effect on the dimensions of the outer surface need not exceed a fraction of a millimetre. But in any case the origin of the change must be in the deeper layers, and it must be of a world-wide, and not of a local, character.

This, then, must be the explanation of the sudden changes of rate of our 'clock A,' which are revealed by the fluctuations in the observed motion of the moon, the sun, and the planets. There is, in this case, no change of angular momentum: the rate of rotation adjusts itself instantly to the altered size or shape of the earth, so that the angular momentum of the earth by itself remains constant, and no call is made on the moon for any compensation. The true length of the month is not affected; the 'clock M' is not concerned at all.

Combination of the Effect of the Two Causes.

We found, however, that the clock M *does* show real fluctuations to the extent of one-fifth of those of the clock A. Now it must be remembered, as has already been remarked above, that the splitting up of the total deviation from uniformity into a uniform retardation—of which about four-fifths is transferred to the moon—and fluctuations—in which the moon takes no part—that this division into two parts is entirely artificial. If the retardation is not uniform, it can explain a part of the fluctuations (not more than one-half, as we have seen), and of this part four-fifths will be transferred to the moon. Our conclusion is thus that three-quarters of the fluctuations in astronomical time are produced by changes of the size and shape of the earth, and one-quarter by variability of the coefficient of tidal friction. Four-fifths of this quarter, or one-fifth of the whole, is then transferred to the moon.

Thus all observed phenomena are satisfactorily explained by the simultaneous action of two causes. It should be remarked that the two causes are entirely independent of each other, acting at different times. But we can only observe the sum of their separate effects.

The word 'satisfactorily' perhaps requires some qualification. When do we call an explanation satisfactory? If we are satisfied when it shows how the observed phenomena follow naturally from causes which we know are acting, or at least are possible, then the explanation here offered is satisfactory. But if we require that the explanation will enable us to *predict* the phenomena for the future, or even for the present or the past, *i.e.* to assert that they must of necessity occur or have occurred, and to calculate their amount from known data, then the explanation is very unsatisfactory indeed, for if it is true, then the phenomena

are essentially *unpredictable*. We have no means of saying when a new change of the size or shape of the earth may happen, or in what direction or how large its effect will be, nor can we predict when the coefficient of tidal friction will change, or by how much.

The accompanying diagram (Fig. 1) gives a representation of the observed facts compared with the explanation. For the interval of nearly three centuries from 1637 to 1927, seven changes in the rate of rotation and two in the rate of retardation have been assumed. These are sufficient to represent the observations, with only very few exceptions, within their limits of uncertainty. Of course,

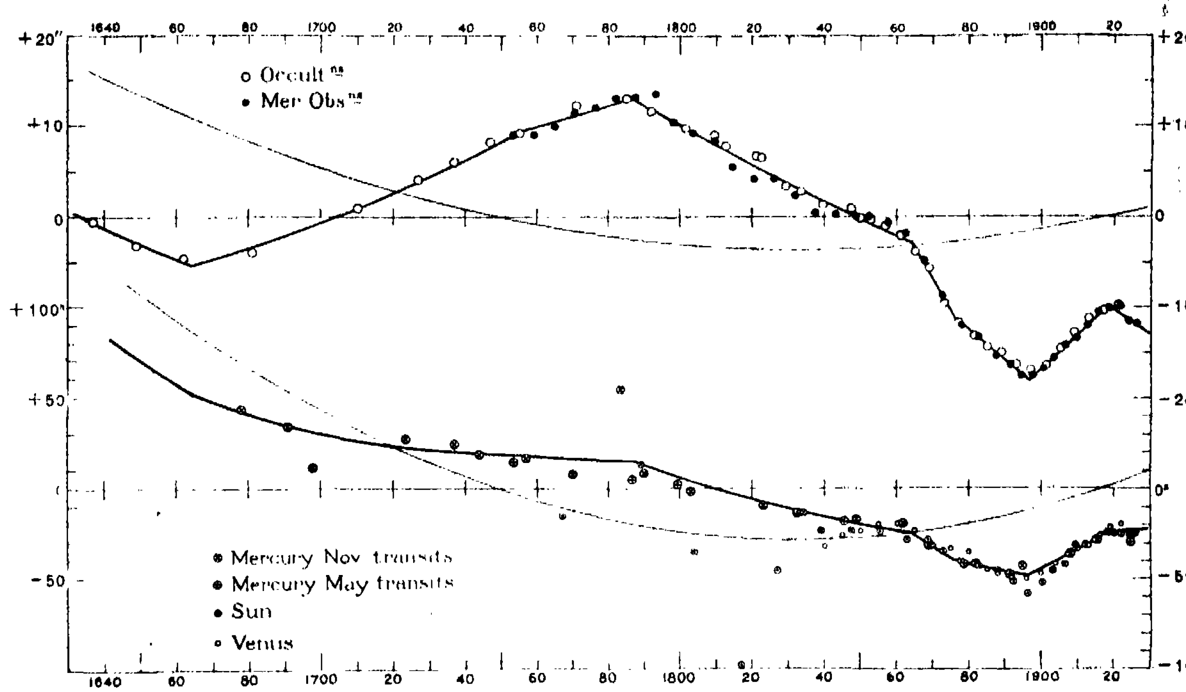

FIG. 1.—SECULAR ACCELERATIONS AND FLUCTUATIONS IN THE LONGITUDES OF THE MOON, THE SUN, VENUS, AND MERCURY.

The curves represent the combined action of two causes (A) and (B). The cause (A) consists in changes of the size or shape of the earth or the distribution of mass inside the earth. It produces discontinuous changes in the length of the day. The adopted excesses $\Delta\tau$ of the length of the day over its average value are:

(A)	Before 1664	$\Delta\tau = 0^s{\cdot}00000$
	from 1664 to 1755	$+0{\cdot}00134$
	„ 1755 „ 1786	$+0{\cdot}00089$
	„ 1786 „ 1864	$-0{\cdot}00091$
	„ 1864 „ 1876	$-0{\cdot}00357$
	„ 1876 „ 1897	$-0{\cdot}00186$
	„ 1897 „ 1918	$+0{\cdot}00153$
	after 1918	$-0{\cdot}00186$

The cause (B) is the retardation by tidal friction. It produces a continuous lengthening of the day, of which the adopted amounts are:

(B)	Before 1745	$d\tau/dt = +0^s{\cdot}0024$ per century
	from 1745 to 1870	$+0{\cdot}0013$ „
	after 1870	$+0{\cdot}0037$ „

The average over the last 25 centuries is an increase of $+0^s{\cdot}0022$ per century.

The upper curve is (A) + 0·23 (B), and the lower one is (A) + (B). Against the upper curve are plotted the observed deviations of the moon's longitude from its purely gravitational value, computed with astronomical time as independent variable. Against the lower curve are similarly plotted the observed deviations of the sun, Venus, and the transits of Mercury. A scale of seconds of arc is added to the upper curve, and a scale of seconds of time to the lower one. This latter thus gives the correction that must be applied to astronomical time in order to reduce it to uniform (or 'absolute') time.

The lower curve has been drawn on a smaller scale than the upper one, corresponding to the smaller accuracy of the observations of the sun and planets compared with those of the moon. In forming a judgment of the deviations, it should be borne in mind that the older observations are far less accurate than the modern ones; especially, the observations of the sun previous to about 1835 (the date of Airy's accession to Greenwich) are very untrustworthy. Of the modern observations, only those of the sun of 1896·5 and 1900·5 deviate more than would be expected by the accidental errors of observation. Of the transits of Mercury, that of November 1782, which was almost a grazing transit, and very difficult to observe, is the only one showing a serious deviation from the curve.

The thin lines are the secular accelerations. The null-line has been so adjusted as to make these zero for 1750·0 and 1917·1.

there have probably been many more smaller changes, the effects of which are indistinguishable from the unavoidable errors of the observations.[3]

Mechanical Clocks.

One further point I should like just to touch upon. We have throughout spoken of the 'clocks' A, M, and S, representing the rotating earth, the moon, and the sun and planets respectively. But what about clocks in the accepted sense of the word? Can a mechanical clock be expected to keep mathematical time, that is, can it be considered as a sufficiently approximate realisation of one simple natural phenomenon, obeying one definite law without sensible perturbations? Before the application of the pendulum to clocks by Huygens, no timekeeper could be relied upon for more than a few hours. Even in the end of the eighteenth century, mechanical clocks were still so much distrusted that the regular astronomical practice was to make a 'determination of time,' that is, to take a reading of the standard clock A, before and after every observation of which it was essential that the time should be known accurately. The manufacture of precise clocks made great strides in the nineteenth century, but still, not many years ago, astronomers used to get rather uneasy when, as a consequence of bad weather, they had to rely on their clocks for any length of time, say a week or a fortnight. The invention of the free pendulum clocks has suddenly altered the aspect of the problem. One of these clocks has been left entirely to itself, being, however, kept under rigorous control, at the Observatory at Greenwich during the greater part of a year, and its rate has been absolutely invariable (apart from a very slight retardation due to a slow lengthening of its pendulum by sagging to the extent of, if I remember rightly, something like a fifth of a micron per month). It looks as if this clock could be depended on to keep time within a few hundredths of a second for a period measured in years instead of weeks.

Can, then, these wonderful clocks, if this expectation should turn out to be confirmed, be of use as a control on the uniformity of astronomical time, like the clocks M and S? Can the handiwork of man compete with the heavenly bodies? That depends on *which* time it will keep; and this, unfortunately, we are unable to tell. If the attraction of the earth remains constant, the clock will keep mathematical time. The change of gravity by the change of centrifugal force in consequence of the change of the rate of rotation of the earth is too small to be taken into consideration. It is, however, scarcely to be expected that the readjustments of masses in the bowels of the earth, which alter the earth's moment of inertia, will have no effect on its attraction. But how this effect will be we cannot say; it might happen to be negligible; it might by some improbable accidental coincidence be such as to make the clock keep astronomical time instead of mathematical time: it cannot be predicted.

It seems probable that such a change of rate as occurred in the rotation of the earth in 1897 and in 1918 would be shown unmistakably by the free pendulum clock. We must expect, then, that these clocks will show discontinuities in their rates at the same epochs as the earth. They will probably *not* be the *same* discontinuities, but of the same order of magnitude, and the comparison of the pendulum with the earth may perhaps help us a little towards the understanding of the causes which produce these changes.

[3] This article was in print before the recent transit of Mercury of Nov. 10, 1927. The observed times of this transit, so far as they have been published, appear to confirm the 'prediction' by the formulæ on which Fig. 1 is based. It has generally been observed from 20 to 40 seconds too early, the formula giving 20^s·8. Evidently no considerable sudden change of the moment of inertia has yet occurred since the one in 1918.—W. de S.

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Festband in honour of his eightieth birthday and contained papers by many of his old pupils, representing twelve countries.

In 1878, Groth's "Catalogue of the Strasbourg Collection" not only showed how active he had been in getting together an important teaching collection in six years, but also served as a model for future mineral catalogues. His reputation as the foremost teacher of mineralogy and crystallography had been firmly established when, in 1883, he was transferred to Munich as professor of mineralogy and Director of the State Collection. His department at Strasbourg had been remarkable for its international character; young men from all the countries of the world, who were destined to be the professors of the next generation, flocked to his laboratory; and at Munich the new department preserved the same character. Here again he built up a great collection and inspired a remarkable succession of researchers; a guide to the collection appeared in 1891, an introduction to the study of precious stones in 1887, an introduction to chemical crystallography in 1904, the elements of physical and chemical crystallography in 1921. But his energies were mainly concentrated on a sequel to his life's work in the form of a vast book of reference—a complete dictionary of the physical and chemical characters of crystallisable substances—mainly based upon the material contained in fifty-five volumes of the *Zeitschrift*. "Chemische Krystallographie" appeared in five volumes between 1906 and 1919, and is an invaluable work of reference.

A life so strenuously devoted to teaching, to the writing of treatises and text-books, to the organisation of university departments, to the inspiration of students, and to the supervision of their investigations, left little time for research. Except through the work of his pupils, the name of Groth is not associated with any great discovery. But he was always occupied in welcoming and in fostering new ideas, and he always had problems for his students to work out. At the beginning of his career he made a striking study of changes of form in the crystal produced by the substitution of one element or radicle for another, especially among organic compounds, and introduced the term 'morphotropy' for this effect; it guided his masterly studies on the composition of minerals; and the connexion between chemical composition and crystalline form was always his chief interest. The avidity with which he absorbed the new experimental work and theories about crystal structure in his old age is evidenced by his latest publications.

Devotion to academic duties and to the *Zeitschrift* left comparatively little time for travel, but Groth made mineralogical expeditions in France and Italy. In 1904 he visited England for the British Association meeting and made a tour in Wales. In Great Britain his position in the scientific world was fully appreciated fifty years ago when he was elected an honorary member of the Mineralogical Society. He was afterwards elected foreign correspondent (1895) and foreign member (1900) of the Geological Society (and received its Wollaston Medal in 1908), and foreign member of the Royal Society in 1911. He received the Hon. Sc.D. degree from Cambridge in 1904.

The present writer has a vivid recollection of Groth as an active young professor at Strasbourg in 1881; energetic and busy with his class and his collection, but always accessible and ready to help and inspire the little group of eager research students who worked in his laboratory. He always impressed them as a strenuous worker, a great teacher, and a most genial, sympathetic, and loyal friend. H. A. M.

MR. THOMAS BAIRD.

A TRAGEDY on the Cairngorms has deprived the University of Glasgow of two brilliant and promising men, of whom one, Thomas Baird, was on the staff of the Geological Department. He attracted attention early in his geology course by his quickness as an observer, his intellectual ability, and his enthusiasm as a student. His early death at the age of twenty-two years has prevented him completing any of the research work on which he had entered, but he had done enough to give promise of great success. He has recorded some sections exposed in the foundations of the new buildings of the National Bank, and described the glacial sands there interbedded with the boulder clays. He had begun the investigation of volcanic necks at Yieldshields Hill, near Carluke, and was working out their inclusions with some help from Dr. Tyrrell.

Baird's special interest was in mountain structure, and he was studying some Dalradian rocks in the Grampians to the east of Kinloch Rannoch, of which the correlation is in doubt. Mr. Baird's interest in mountain geology led him to take every opportunity of training as a mountaineer. He had made some winter ascents and gained experience in ice-climbing. It was his ambition ultimately to explore some of the Asiatic mountain ranges of which the structure is still unravelled.

With this end in view, Baird arranged the recent excursion to the Cairngorms in order to gain further experience of mountaineering under winter conditions. He and his companion, Hugh Barrie, a medical student and graceful poet, were both thoroughly competent for the expedition. They appear to have spent three nights at the Corrour bothy between Ben Macdhui and Cairn Toul, and from such clues as are available they probably gained the summit of Braeriach on the return route to Aviemore on Sunday, Jan. 1. Some accident must have happened there, for Baird's left hand was injured as if he had caught hold of some rock or rough ice. He probably exhausted himself either in the effort to help Barrie to shelter, or, as appears more likely, when trying to find his comrade after their separation by the accident. Baird had reached the floor of Glen Eunach, and there, caught in a furious blizzard, collapsed on the roadside a few hundred yards from a hut. He was found next morning, but died before help could arrive from Aviemore.

News and Views.

IN a supplement to this issue we publish an article by Prof. de Sitter in which a comparison is made of the time as determined by the rotation of the earth, the revolution of the moon round the earth, and of the inner planets round the sun. The application of the theory of gravitation and the laws of motion to the various bodies shows that equal intervals of time determined by one body are not exactly equal according to the others. The application of the laws of dynamics is complicated by the fact that the earth is not a rigid body and that tidal friction is slowly decreasing the rate of the earth's rotation and at the same time that of the moon's revolution. It is not possible to compute the numerical coefficient exactly, but work by Jeffreys on the tidal friction in narrow seas gives a coefficient of the right order of magnitude. Prof. de Sitter finds that the observations are best explained if the coefficient for the three intervals, before 1745, 1745–1870, after 1870, are approximately in the ratio 2 : 1 : 3. It is, however, difficult to explain why the coefficient should have altered to this extent. Tidal friction can only slow down the earth's rotation, while observations of the moon and planets indicate that at times this rotation is accelerated. This can only be done by reduction of the earth's moment of inertia. Prof. de Sitter finds that the reduction of the whole mountain range of Central Asia to sea-level would have produced only one-quarter of the change in the length of the day which observations of the moon indicate took place in the year 1918, but that an alteration of the earth's radius by five inches would suffice. Both explanations almost appear to call for observable effects on the earth itself.

EXPRESSED in time, observations of the moon indicate that the earth's period of rotation altered by 0·00339 sec. either suddenly or in the course of a few months in the year 1918. This means that the earth's rate of rotation altered by approximately 1 part in 25 millions. Prof. de Sitter raises the question whether this is sufficiently large to be tested by an actual clock. The free pendulum clock, Shortt 3, installed at Greenwich, has shown a great advance on all previous clocks; for example, its daily rate has remained constant for more than six months to the order of 0·001 sec., except for a secular term which altered the daily rate by 0·032 sec. in 100 days. This coefficient, as well as the rate, has to be determined from astronomical observations. It corresponds to a slow lengthening of the invar rod and is probably decreasing with time. The clock has, however, a rather large temperature coefficient, namely, about 0·007 sec. daily per 1° C. The cause of this is unknown, but it may be due to the impulse varying with the temperature and consequently changing the arc of vibration. To produce a change of 0·007 sec. in the daily rate the semi-arc, at present about 55′, has to alter only 10″, a quantity too small to be observed accurately with the Greenwich clocks, but possible with later ones.

THE election of Prof. D'Arcy W. Thompson as president of the Classical Association for this year calls for the congratulations of his scientific friends. Not all men of science are devoid of some tincture of letters, as the pages of NATURE testify, but it is sometimes hinted that it is not hard to pass for a scholar in their company. Prof. Thompson's election shows, however, that he is esteemed as a scholar by literary men. He is, indeed, peculiarly fitted to link the older with the newer humanities. His contributions to the history of Greek science—his "Glossary of Greek Birds," his translation of Aristotle's "Historia Animalium," and his Herbert Spencer Lecture on "Aristotle as a Biologist," to name only a few—are well known and valued. On the other hand, he brings to his scientific work not only a polished style but also a sense of the historic background of knowledge which illuminates even the pages of reports on fishery statistics. His "Growth and Form" showed that he could handle and correlate, as few men can, the results of research in the most diverse branches of modern science. Prof. Thompson's love for the classic literatures is inherited, and those who have read the "Daydreams of a Schoolmaster" will know how it would have gratified the author could he have seen his son in the position to which he has just been elected.

AN article from the *Times* correspondent at Delhi, in the issue of Jan. 12, conveys the welcome news that a great new meteorological observatory at Poona is to be brought into use this summer, thus carrying into effect a scheme proposed in 1924 for transferring the headquarters of the Indian weather department thither from Simla. The difficulties that have led to the transfer are not limited to the tropics. On one hand, it is vital that the routine work of daily forecasting and of administration shall be well carried on, for it is on performance of these tasks that revenue depends, and with that the chance of scientific progress. Further, there is a material gain of efficiency if the staff can be collected into the same station, facilitating co-operation as well as access to laboratories and libraries. There is, therefore, a tendency for the ablest men to gravitate to headquarters. But Simla cannot employ kites because winds are too light, or instrument-carrying balloons because of the wild mountain regions in which they would be lost: so experimental examination of the physical processes of weather can scarcely be effected there, and bringing up an officer from a provincial observatory very seriously reduces his chance of advancing knowledge and of keeping in living contact with science. The remedy adopted by the department in India has been to give up the advantage of being at the seat of government and to transfer its headquarters to Poona, where upper air work is possible and monsoon conditions, unlike those of the western Himalayas, are representative of India. Poona has the further advantages of a good climate and of proximity to Bombay, so that closer relationships can be maintained with shipping and commercial interests.

THE *Times* correspondent says, however, that the object of the new observatory is "special research

work with a view to elaborate and accurate forecasting of the south-west monsoon." Also "The Meteorological Department . . . is now able regularly to forecast in mid-October the quantity of rainfall in Northern India in the next five months. The indications are given to within a fraction of an inch, and during twelve years wherever the system has been followed it has never proved fallacious." On reading this surprising account, it is natural to inquire into the recent success of the method, and we find Mr. Field in his forecast of Jan. 6 last, after rightly deprecating undue confidence, saying that the high-level winds were "about normal in character." The total actual precipitation, as described on June 27, was, however, not normal but "in moderate defect." Again, in the previous year the high-level winds were "stronger than usual"; and the total actual precipitation was not in excess as it should have been, but "in slight defect." In spite of this lack of perfection, we are convinced that upper-air data promise to be of great value for seasonal forecasting after twenty or thirty years of data have been accumulated; but friends of the department should lay stress on the value of the upper-air work done at Poona for aerial navigation and daily forecasting, rather than arouse expectations of an early revolution in methods of seasonal prediction. Confidence in long-range forecasts can only be built up slowly, and is more easily lost than won.

THE award of the Progress Medal of the Royal Photographic Society to Dr. S. E. Sheppard in recognition of his researches and publications, which have resulted in important advances in the science of photography, will be generally welcomed. Dr. Sheppard is still, in the modern sense, a young man, whose name first came into prominence in connexion with the extended series of researches in photographic subjects, carried out in conjunction with Dr. Mees. The results were published in the *Photographic Journal*, in the *Proceedings of the Royal Society*, and in the *Journal of the Chemical Society*, and were then collected, together with additional work, and published in 1907 as a book entitled "Investigations on the Theory of the Photographic Process." Dr. Sheppard is also the author of the volume on "Photochemistry" in the series of text-books on physical chemistry edited by Sir William Ramsay. Dr. Sheppard was elected to an 1851 Exhibition research scholarship and proceeded to Germany for further study. Shortly after returning to England he was offered a position in the Research Laboratories of the Eastman Kodak Company, Rochester, N.Y.

SINCE taking up his duties at Rochester, where he is assistant director of research, Dr. Sheppard has been responsible for researches covering many phases of the photographic process, which culminated comparatively recently in his important discovery of the rôle played by sulphur compounds contained in gelatin in conferring sensitivity on the silver halide grain. In addition to the books already mentioned, Dr. Sheppard has been responsible for two others, namely, "The Silver Bromide Grain of Photographic Emulsions," and "Gelatin in Photography," vol. 1, published by the Eastman Kodak Company, and has done valuable work in connexion with the electro-deposition of rubber. Previous recipients of the Progress Medal have included Sir William Abney, Dr. J. M. Eder, Prof. Gabriel Lippmann, Ferdinand Hurter and Vero C. Driffield (jointly), Mr. Alfred Watkins, A. Lumière et ses fils, Dr. C. E. K. Mees, Mr. William B. Ferguson, and the present president of the Royal Photographic Society, Mr. F. F. Renwick.

ON Tuesday, Mar. 20, H.M. the King will open the eastern block of the new buildings of the Science Museum at South Kensington. First formed in 1856, the collections have occupied various buildings, but now for the first time they are shown in one designed for this purpose, though about a quarter of the collections still remain in buildings which were originally constructed for the exhibition of 1862. In 1898 Parliament voted £800,000 for completing the Science and Art Buildings at South Kensington, and in 1908 the Victoria and Albert Museum was opened by H.M. King Edward VII. As nothing had so far been done for the science collections, a number of men eminent in science and in technical industry strongly urged the need for action in the matter. Sir Henry Roscoe headed a deputation fully representative of science and its applications, which was sympathetically received by the President of the Board of Education, and in the following year the President appointed a committee, of which Sir Hugh Bell was chairman, to inquire into the Science Museum and to report upon its needs. This Committee recommended that new buildings should be erected on the existing site, which should ultimately extend from Exhibition Road to Queen's Gate.

IT is the eastern block, the first instalment of this scheme recommended by the Committee, which is to be opened in March, doubling the exhibition area of the Museum. Though the space available is still considerably less than that which the Committee laid down as being immediately needed, it has made it possible to develop the collections extensively, and to improve very greatly the setting out and exhibition of them. The result of this is reflected in the greatly increased numbers of visitors, of whom more than 709,000 visited the Museum during 1927 as compared with 450,000 in 1925. The new galleries are exceptionally well lighted, and the provision of compressed air and electricity in each gallery makes it possible to show objects in motion or specially illuminated at any point in the Museum.

IN February 1927 the Government of Queensland appointed a Land Settlement Advisory Board of three members, with the powers of a Royal Commission, to inquire into and report upon various questions in connexion with the administration of land leased for grazing sheep in Central and Western Queensland, and "generally what action should be taken by the Government to further develop the wool industry in Queensland." In the Board's report, which has been presented by the Premier to the Queensland Parliament, it is stated that the total number of sheep in

Queensland remained almost the same (20 millions) between 1891 and 1925, in spite of the fact that in the same period the population of the State increased by 109 per cent. and the railway mileage by 165 per cent. Owing to the severe drought that has prevailed over much of the sheep country since 1925, it is estimated that the number of sheep is now only 14 millions. Since, during the last five years, wool constituted 60 per cent. of the State's exports, it is obvious that the prosperity of the industry is of vital importance to Queensland.

THOUGH none of the members of the Board were scientific men, it is gratifying to find that a section of the report is devoted to the advocacy of scientific research. It is stated that "the valuable results obtainable from the practical application of science to industry have already been demonstrated sufficiently in Queensland to urge all authorities to further efforts. The banana bunchy-top investigations and the chemical and biological agencies for prickly pear destruction are instances of scientific endeavour of first-rate importance to this State. In each of these investigations the scientists of the University of Queensland played their part. Another field of endeavour is now presented to scientists in stemming the annual wastage in the wool industry." Among the problems which are mentioned as requiring scientific investigation are the provision of suitable stock licks for different types of country, the effect of artificial feeding on wool production, the effect of different grasses on the quality of the wool, the varying mineral and protein contents of pastures on the different geological types of country, the effect of overstocking on natural grasses, particularly as regards their re-growth, and the prevention of losses due to blow-fly, worms, and other parasites and diseases. It is stated that the Premier of Queensland has offered to the Commonwealth Council for Scientific and Industrial Research an area of about 25,000 acres of land in Central Queensland, free of rent for any term desired, to be held in trust as a central scientific station for investigations on the above and kindred subjects, and the hope is expressed that the offer will be accepted either in whole or in part.

WITHIN a fortnight from the date of his first dispatch on the season's work at Ur, Mr. Woolley is able to chronicle in the *Times* of Jan. 12 a further discovery of almost sensational interest which throws an entirely new light upon the customs and religious beliefs of the Sumerians. Although the body of the king has not been found in the Royal Tomb now being excavated, as probably it was plundered at an early date, a large number of objects interred at the time of the burial for his use have been unearthed. Among these are a harp, largely composed of wood, the form of which has been recovered by the use of plaster to fill up the cavities left by the decay of the wood; a chariot, on the rein ring of the pole of which was a wonderfully realistically executed donkey in silver; a gaming board; a clothes' chest; and piles of copper bowls and tumblers. The remarkable feature of the burial, however, is that, scattered among these relics are the remains of the king's attendants, evidently lying as they fell when sacrificed for his service in the next world. The harper is crouched near his harp, two asses lie at the chariot pole, and with them their three grooms; and by the clothes' chest is an officer of rank, as shown by his ornaments, possibly the Keeper of the Royal Robes, and other attendants. In a trench lie thirteen bodies, of which two are those of children, the rest women, no doubt the members of the Royal Harem. Mr. Woolley is of the opinion that this form of burial, accompanied by the sacrifice of the Court attendants, must be regarded as a survival, as there are no evidences of similar sacrifices to be found in the graves of common people.

ON Feb. 14 the Royal College of Surgeons of England celebrates the bicentenary of John Hunter, who may be described as the patron saint of the College. Hunter left one of the most remarkable collections of anatomical preparations and natural history specimens ever assembled by one man. In 1800, seven years after his death, this collection was purchased by Government and handed over to the College of Surgeons in trust. The Hunterian Collection forms the basis of the great museum now housed by the College in the south side of Lincoln's Inn Fields, but the additions made under a long line of conservators, which includes Owen, Quekett, and Flower, now overshadow the original collection. There is a doubt as to the exact date of Hunter's birth, but as he celebrated it on Feb. 14 the Hunterian oration given in his memory every alternate year has always been given in the theatre of the College on this date. On the present occasion the oration is to be delivered by Sir Holburt Waring, surgeon to St. Bartholomew's Hospital, and a former Vice-Chancellor of the University of London. A lecture on the "London Homes of the Hunters" will be given by Mr. G. C. Peachey. A special exhibition of specimens will illustrate John Hunter's chief discoveries. Visitors will also have an opportunity of examining his portraits, busts, published works, manuscripts, and personal relics.

IN a letter to the Editor, Prof. Henry J. Spooner discusses our comment in the issue of Dec. 24, p. 928, on his paper in the *Society of Industrial Engineers' Bulletin* (vol. 9, No. 9), in which he stated that the economic loss through the effects of noise is estimated at £50,000,000. We asked how this figure was obtained. Prof. Spooner states that men of affairs "have their capacity for clear thinking without a doubt perceptibly weakened by the incessant if unconscious strain upon the nervous system" caused by noise, and he says he has had countless letters from mental workers explaining how their health and work suffer through working in a noise. Such remarks, though true as personal expressions of opinion, do not, however, constitute scientific proof. The one piece of research quoted, that of Dr. Laird, would seem to be suggestive rather than conclusive. The control group is always necessary. If one has a personal interview with all the workers in and near a noisy room and inquires about noise among other

conditions of work, one does not get a uniform reaction; some dislike it, some are indifferent, some prefer it. There are heads of departments, creative workers of all kinds, as well as the actual noise producers, who are frankly surprised at the idea of their work being affected by noise. To say it must be unconsciously affected is again opinion, not evidence. In the interests of those who either are, or think they are, detrimentally affected, let us minimise noise, but the proof of its effect is not easy.

GAS undertakings deserve more publicity than is usually accorded them concerning the extent and intricacy of the organisations necessary to maintain an unfailing service of their chief products, and to provide an important supply of the great number of other materials in everyday industrial demand. The consumer's end of the pipe-line is so easily manipulated, day or night, in war and peace, strike or lock-out, with the same anticipated result, that it is not surprising that public attention should be focussed more frequently on cost than on supply. For use on the occasion of the visit of the Science Masters' Association to the Chief Offices, the Central Store, and the Fulham Works of the Gas Light and Coke Company on Jan. 6, the Company prepared an illustrated brochure giving a short account of its activities, and briefly describing the sections visited.

THE Gas Light and Coke Company received its charter so long ago as 1812; its authorised capital is now more than £40,000,000, its employment roll about 20,000, and its area of supply to 1,250,000 consumers is 265 square miles, extending from Windsor Great Park to some miles east of Epping Forest. Every year some 2½ million tons of coal—mostly borne direct by the Company's own fleet—are required. Of the thirteen works, those at Beckton are responsible for the output of about 40 per cent. of the gas produced, whilst those at Fulham, which are probably the oldest in London, are now representative of the most modern practice in gas-works construction, having a capacity (shortly to be largely increased) of 17½ million cubic feet of 500 B.Th.U. quality (*i.e.* 87,500 therms) a day, and treating 900 tons of coal daily on an area of 30 acres. Usually 40,000 tons of coal is held in stock at Fulham; the coal gas, maintained at a constant quality with water-gas of variable composition, is conveyed by means of more than 100 miles of high-pressure mains (at pressures of the order of 3 lb. per sq. in.) to convenient storage centres, and thence in 3700 miles of supply mains at pressures of about 4 in. water gauge. The brochure gives an account also of the housing of the experimental plant and the various research laboratories; it describes the training and welfare work, and refers to the measures which have been taken to give effect to a spirit of copartnership which exists between the Company and its employees.

DR. J. STEPHENSON, lecturer in natural history in the University of Edinburgh, has been appointed editor of the "Fauna of British India" series in succession to the late Sir Arthur Shipley.

DR. EDWARD RAY WEIDLEIN, Director of the Mellon Institute of Industrial Research, University of Pittsburgh, has been re-elected president of the American Institute of Chemical Engineers and will therefore serve in this office during 1928.

DR. MAX WOLF, Director of Heidelberg Observatory, distinguished especially for his originality and activity in observational astronomy, has been elected an honorary member of the American Astronomical Society. The constitution of the Society permits the election of one honorary member at each annual meeting, but no election has been made since 1924.

AT a meeting of the Quekett Microscopical Club, held on Jan. 10, Mr. E. M. Nelson, Dr. A. Mann, and Dr. Karl Viets were elected honorary members. Mr. Nelson was president of the Quekett Club from 1893 until 1895, and also president of the Royal Microscopical Society from 1897 until 1899. He is the author of numerous papers dealing chiefly with the practical optics of the microscope and microscopical technique, which have appeared in the *Journal of the Royal Microscopical Society*, the *Journal of the Quekett Club*, and in the *English Mechanic*. Dr. Mann, of Washington, D.C., is well known as an authority on Diatoms; and Dr. Viets, of Bremen, has done a large amount of original work on the Hydracarina and Halacaridæ.

THE British Empire Cancer Campaign announces an international convention on cancer research to be held under its auspices in London next July. Of the value of such international meetings, especially on the personal side, there can be little doubt, though there seem to have been rather many lately on this particular topic, and the amount of time which those who are actively engaged in cancer research can profitably spend in travelling to meetings across the world obviously has its limits. In this case we are glad to note that none of the considerable expense of the convention will fall on the funds of the Campaign, owing to a generous donation from Sir Richard Garton.

THE Gold Medal of the Royal Astronomical Society has been awarded to Prof. R. A. Sampson, Astronomer Royal for Scotland, for his theory of the four great satellites of Jupiter. This extensive work is contained in three separate memoirs in the *Harvard Annals* and the *Memoirs of the Royal Astronomical Society*. With the tables to which the theory is reduced, it completes a self-consistent revision of the whole problem of the four great satellites. A bronze (Jackson-Gwilt) Medal has been awarded (1) to Dr. W. H. Steavenson, for his work on faint variable stars and on the Herschel instruments; and (2) to Mr. W. Reid, of Cape Town, for his discovery of six new comets.

THE seventh International Congress of Photography will be held in London on July 9–14, under the auspices of the Royal Photographic Society. There will be three sections: (1) scientific and technical, (2) pictorial photography, (3) bibliography and record work; the scientific and technical section will

be further subdivided into groups dealing with theoretical aspects, photographic practice, scientific applications of photography, and industrial and special applications. Papers for the Congress, accompanied by abstracts, both in duplicate and typewritten, must be submitted to the honorary secretary to the organising committee, Dr. W. Clark, The Science Museum, South Kensington, London, S.W.7, before June 1.

AN exhibition indicating the possible utilisation of Overseas Empire timbers in industry will be held at the Exhibition Pavilion of the Imperial Institute, South Kensington, on Feb. 3–April 30. This exhibition is the second of a series arranged to direct attention to specific resources of the Empire, with the object of increasing the usage of Empire raw materials in Great Britain. Samples of selected timbers from some of the Dominions and Colonies will be shown in conjunction with the articles which can be made from them. An important feature will consist of exhibits illustrating the work carried out at the Imperial Forestry Institute, University of Oxford; the Forest Products Research Laboratory (Department of Scientific and Industrial Research) at Princes Risborough; and at the Imperial Institute.

THE council of the Geological Society has this year made the following awards: Wollaston Medal to Dr. D. H. Scott, lately honorary keeper of the Jodrell Laboratory, Royal Botanic Gardens, Kew, in recognition of the value of his researches in fossil botany; Murchison Medal to Dr. J. J. Sederholm, Director of the Geological Commission of Finland, in recognition of his researches in petrology, especially of the granites and gneisses of the pre-Cambrian complex of Fennoscandia; a Lyell Medal to Prof. S. H. Reynolds, C. Wills professor of geology in the University of Bristol, in recognition of the value of his researches in the stratigraphy of the Palæozoic rocks, and in vertebrate palæontology; a second Lyell Medal to Dr. W. D. Lang, keeper of the Department of Geology in the British Museum, for his researches in stratigraphy and palæontology, especially with reference to the Bryozoa; the Wollaston Donation Fund to Mr. James Wright, for his researches on the Crinoidea of the Carboniferous Limestone of Scotland; the Murchison Geological Fund to Dr. George Slater, in recognition of the value of his researches in glaciology; and the Lyell Geological Fund to Mr. Ben Lightfoot, for his researches on the economic geology of Southern Rhodesia.

THE natives of Teheran (Persia) have discovered a new, if rather primitive, method of making ice in the winter months and storing it for summer use, according to a writer in *La Nature* for Jan. 1. Long ponds, running east and west, are dug in the earth and filled with water. Due to the slight night frost, a very thin coating of ice forms. The next night this ice is watered, and the layer of ice increases, until it gradually attains a thickness of about 16 inches. The ponds are protected on the south side by high earth walls to prevent the sun getting to the ponds even at its maximum elevation. The ice thus formed is broken up and stored in blocks in large galleries dug in the earth and separated into compartments, broken ice being placed between each block. When the summer comes, the ice blocks are broken up and retailed in small portions. The insulation provided by the storage galleries is stated to be sufficient to keep the ice without appreciable loss for two years.

FROM the *Report* for 1926 of the Museums of the Brooklyn Institute (N.Y.), we learn that the Children's Museum has obtained the full-time services of a scout instructor. He gave one day each week to the instruction of the Boy Scouts in their summer camp. More than 6000 Boy and Girl Scouts prepared in the Museum for their tests in nature study. Scout captains use the exhibits for demonstrations. This is only one of many lines along which this little Museum does admirable work in promoting a love of Nature among young people of all classes.

THE January issue of the *Journal of the Institution of Electrical Engineers* contains three "Progress Reviews," namely, "Electricity in Mines," by J. A. B. Horsley; "Co-operative Research in 1927," by E. B. Wedmore; and "Electrical Standardization, 1927," by P. Good. These reviews can be obtained in pamphlet form (1*s*. each) from the Secretary of the Institution.

MESSRS. Baird and Tatlock (London) Ltd., of 14-15 Cross Street, Hatton Garden, London, E.C.1, have issued a new edition of vol. 1 (Chemistry) of their Standard Catalogue of Scientific Apparatus. This work—it is a work of no small merit scientifically, commercially, and artistically—is intended to be used in conjunction with the other volumes of the Standard Catalogue, namely, vol. 2, Physiology; vol. 3, Biological Sciences; and vol. 4, Physics. The volume just issued is subdivided into nine separate sections, covering respectively laboratory fittings, general equipment, general chemical apparatus, physical chemistry, industrial chemistry (two sections), meteorology, books, and chemicals. The preface is dated October 1927, so that although such a catalogue of between eleven and twelve hundred large pages must of necessity take months to prepare, the prices which are quoted have yet had but little time in which to undergo their inevitable fluctuations. The illustrations are particularly good, and this fact, together with the comprehensiveness with which the whole publication has been conceived, makes the catalogue a noteworthy addition to the library of any educational institution or industrial laboratory in which experimental chemistry and the allied sciences are pursued. Descriptive paragraphs concerning the operation of the more complex and less well-known pieces of apparatus are a welcome feature. These paragraphs sometimes attain almost monographic proportions; the article on the theory and use of the polariscope, for example, consists of two closely printed pages, with diagrams, and even a reference to a paper in the *Berichte*, whilst that on the determination of hydrogen ion concentration covers three pages. Many new pieces of apparatus not hitherto catalogued are included; even more recent additions to the

chemist's armoury will be dealt with from time to time in separate leaflets. The whole publication is adequately indexed, with cross-references to the companion volumes.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A gas engineer and general manager under the Rotherham Corporation—The Town Clerk, Rotherham (Jan. 25). An inspector under the Ministry of Agriculture and Fisheries for the purposes of the Diseases of Animals Acts, 1894–1925—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (Jan. 30). Assistant Veterinary Inspectors under the Surrey County Council to carry out duties under the several Acts and Orders relating to (1) Milk and Dairies; (2) Diseases of Animals; and (3) such other veterinary duties as the Council may require—The Clerk of the County Council, County Hall, Kingston-on-Thames (Jan. 30). A junior scientific officer under the directorate of scientific research of the Air Ministry primarily for work in the engine research department of the Royal Aircraft Establishment, South Farnborough—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (Feb. 11, quoting A.256). A lecturer in mycology at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 14 Trinity Square, E.C.3 (April 1). A senior lecturer in physical and inorganic chemistry in the University of Melbourne—The Registrar, The University, Melbourne, Victoria (April 23). A principal of the Australian School of Forestry, Federal Capital Territory, Canberra—The Secretary, Department of Home and Territories, Canberra, Australia (April 30). An additional lecturer in zoology at the Ceylon University College, Colombo—The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, Whitehall, S.W.1. An assistant bacteriologist at the Wellcome Bureau of Scientific Research—The Secretary, Wellcome Bureau of Scientific Research, 26 Endsleigh Gardens, W.C.1. A technical laboratory assistant at the Millport Marine Station of the Scottish Marine Biological Association—The Secretary, S.M.B.A., 88 Bath Street, Glasgow. Teachers of Siamese and of Tibetan at the School of Oriental Studies—The Secretary, School of Oriental Studies, Finsbury Circus, E.C.2.

ERRATUM.—A correspondent points out that the late Mr. W. H. Dines was at Corpus Christi College, Cambridge, and not at Christ's College, as was stated in our issue of Jan. 14, p. 65.

Our Astronomical Column.

LARGE METEOR ON JAN. 9, 11^{h} P.M.—Mr. W. F. Denning writes: "This very large meteor was seen by an observer when motoring about 6 miles east of *Birmingham*. The terminal portion of its flight was from near the star Sirius vertically to the horizon. The object was much brighter than Venus at its best, and the nucleus threw off a dense train of sparks at the end. The same meteor was noticed from Ilford, Essex, where the path was recorded as moving from just below Rigel and κ Orionis in a direction towards the western horizon. It was very brilliant, and gave an outburst of sparkling material.

"Further observations will probably come to hand, but it appears that the fireball must have radiated from near the bright star Sirius and that its height was about 63 to 20 miles over a line directed from south to north over the English Channel to its finishing stage over Hampshire. Further data are, however, desirable, particularly from observers near the south coast of England."

THE RECENT GREAT COMET.—Many reports are coming to hand from America and elsewhere, that show what an extremely fine comet this must have been. Its magnitude rose at least to -6; some estimates make it -10. Its tail was at least 8° long: it would doubtless have been more if it could have been seen on a dark sky.

Dr. Slipher reports in a *Daily Science News Bulletin*, issued by Science Service, Washington, that its spectrum was continuous, with no bright lines, indicating that the light was mostly reflected sunlight; but an appreciable amount of lower temperature radiation was present. The nucleus was small, and varied from a circular to an elongated shape. Jets and envelopes were present on the sunward side of the nucleus.

The spectroscope indicated a motion of recession from the earth of 60 miles a second (exact time of observation not stated). The actual rate of recession between Dec. 20 and 21 was 54½ miles a second, which is a good agreement.

The following orbit by Dr. A. C. D. Crommelin is from a combination of observations ranging from Dec. 3 to 20:

$$\begin{array}{lll} T & \text{1927 Dec. 18·008 U.T.} & \\ \omega & 46°\ 9·7' & \\ \Omega & 76\ \ 25·2 & \Big\}\ 1927·0 \\ i & 85\ \ 27·2 & \\ \log q & 9·2365 & \end{array}$$

The earliest known observation of this comet (a day before that of Mr. Skjellerup) was obtained by Mrs. K. Botes at Fraserburg, Cape Province, on the morning of Dec. 2. She slept on a verandah facing south-east and observed the comet from her bed. It was low in the south-east about dawn. Other independent discoverers were Mr. Ross Fitchet at Grahamstown, Dec. 5; Mr. Maristany at La Plata, Dec. 6; Mr. Chidambara Iyer, Kodaikanal, Dec. 15.

Dr. A. C. D. Crommelin has deduced the following elliptical orbit of comet Schwassmann-Wachmann from Bergedorf observations on Nov. 15, Dec. 4 and 28.

$$\begin{array}{llll} T & \text{1925 May 10·9230 U.T.} & & \\ \omega & 359°\ 56'\ 13·7'' & & \log a\ \ 0·8090646 \\ \Omega & 322\ \ 35\ \ \ 2·2 & \Big\}\ 1927·0 & \log q\ \ 0·7403755 \\ i & 9\ \ 25\ \ 37·0 & & \log n\ \ 2·3364097 \\ \phi & 8\ \ 24\ \ 43·0 & & \text{Period 16·35298 years.} \end{array}$$

The orbit lies wholly between those of Jupiter and Saturn; the comet has the largest perihelion distance and the smallest eccentricity of any known comet. In consequence of the small eccentricity, the date of perihelion is difficult to determine and is still very uncertain.

Research Items.

ANTHROPOMETRY IN FORMOSA.—A valuable addition to our knowledge of the aborigines of Formosa is made by Akira Matsumura and Etsuzu Miyauchi in a contribution to the *Proceedings of the Imperial Academy of Tokyo*, vol. 3, in which they give a summary of anthropometric measurements carried out by them under government auspices. The subjects measured were all men between the ages of twenty-three and forty-five years. The present communication deals with stature, cephalic index, and nasal index only. With the exception of the Ami, who inhabit the plain on the south-eastern coast, and the Yami, who live on the island of Botel Tobago, all the tribes belong to the central mountainous area. In stature the mean descends in the order Ami, Tayal, Vunam, Paiwan; in head-form the index in ascending order is Ami, Tayal and Vunam, Paiwan; nasal index, again ascending, Tayal, Paiwan, Ami. Generally speaking, proceeding from north to south, the mountain tribes become lower in stature, broader in the head and wider in the nose; but the Ami of the south-eastern plain have the greatest stature and are the most dolichocephalic and chamæprosopic of all the aborigines. Comparing them with the Philippine Islanders, the aborigines of Formosa resemble closely the Bontoc and Tagai tribes. The ranges of the means are: stature, 157·14 (Paiwan) to 165·14 (Ami); cephalic index, 76·42 (Ami) to 81·30 (Paiwan); nasal index, 75·78 (Tayal) to 86·15 (Ami).

PHILIPPINE SEA-URCHINS.—No. 100 of the *Bulletin of the United States National Museum* consists of Dr. Th. Mortensen's report on the Cidaridæ collected by the *Albatross* during the Philippine expedition of 1907–10. The delay has enabled the author to utilise the knowledge and experience gained on his own later expeditions to the Pacific and the Malay Archipelago. The cidarid sea-urchins here described fall into ten genera, of which Rhopalocidaris, with club-shaped secondary spines, and Psilocidaris, with slender primary and secondary spines, are new. Cyrtocidaris also is founded as a new subgenus of Goniocidaris. Psilocidaris links this form with Aporocidaris, of which the affinities were previously obscure. Of the twenty-seven species and varieties described, six species and seven varieties are new, but, though the descriptions and figures are worthy of his reputation, Dr. Mortensen leaves to some future worker the task of constructing diagnoses. The number of cidarid species now known from the Malayan and Philippine seas exceeds forty, and since many are represented by single specimens, the number of species will doubtless be increased. This is in strong contrast with the eight or possibly ten from the West Indies and the three or four from the whole of the north-east Atlantic. Collectors are warned against pickling echinoids with crinoids, since the pigment from the latter stains the other contents of the jar.

A NEW ECTOPARASITIC TREMATODE.—A new species of Epibdella was found on fishes in the New York Aquarium. It had been introduced into the tanks by a Pacific puffer (*Spheroides annulatus*) from Southern California, but the eyes of the spade fish (*Chætodipterus faber*) and of various species of angel fishes (Angelichthys and Pomacanthus) became infected. The Pacific puffers have eyelids which can be closed over the eyes, so that the worms can adhere within the conjunctival sac, and several worms may be present therein, but fewer are found on the eyes of the other fishes. The cornea of infected fish is pierced, and in about three weeks the eye is destroyed. The largest worms are about 5 mm. long and 3 mm. wide. Dr. G. A. MacCallum (*Zoopathologica*, Sc. Contribs. New York Zool. Soc. on the Diseases of Animals, vol. 1, No. 8, 1927) gives a description, with figures, of the external features and internal structure and of the eggs, and points out how this new species of Epibdella differs from those previously described.

BIOLOGICAL SIGNIFICANCE OF MYCORRHIZÆ.—Present-day opinion on the significance of mycorrhizæ veers all the way from a belief in the truly symbiotic nature of the association of the root and fungus concerned to an investing of the fungus with a purely parasitic rôle. Recent contributions to the subject come from Kôki Masui (*Memoirs of the College of Science, Kyoto Imperial University*, Series B, vol. 3, No. 2) and Lewis Knudson (*New Phytologist*, vol. 26, No. 5). After a detailed investigation of the ectotropic mycorrhizæ of woody plants, Masui defines two groups of mycorrhizal fungi: obligate forms such as *Hydnum affine, Cantharellus floccosus, Polyporus leucomelas, Armillaria caligata*, and facultative forms such as Boleti. He considers the former group as being truly parasitic, the latter group as 'hemi-symbiotic.' From microchemical observations Masui concludes that the growing points of normal roots contain large amounts of amino-acids and sugar, but these nutrients are gradually depleted by the fungi, until, in old mycorrhizæ, no nutrients are found in the root tissues. This may explain to a large extent the inhibition of root growth after infection. The roots, which still contain tolerable amounts of these nutrients, can grow further, pushing aside the fungoid mantle. On the other hand, the facultative mycorrhizæ formers supply a larger amount of phosphorus to the host plant than the uninfected root can normally absorb, whereas in the obligate ones the relation is just the opposite. Prof. Knudson severely criticises Constantin's idea of obligate symbiosis in the case of orchid mycorrhizæ. The work of the former clearly shows the dependence of the orchid embryo on soluble organic matter, and the investigations indicate that the capacity for synthesising food is lacking in the embryo. Given suitable organic food material and a hydrogen ion concentration in the medium sufficient to retain the iron in solution, orchid seeds germinate asymbiotically. The orchid fungus may be useful in making insoluble food material available for the root and in regulating the hydrogen ion concentration of the medium. Constancy of association of orchid root and fungus is taken as merely indicating the wide distribution of the orchid fungi and the readiness with which the orchid embryo and root can become infected.

POST-GLACIAL MOLLUSCA OF GENEVA.—Starting with a study of the hitherto much neglected post-glacial deposits of the Geneva basin, Dr. Jules Favre found that their elucidation required a thorough knowledge of the recent molluscan fauna of the area; and having attained this, he has now embodied the results of his researches in a most valuable monograph on "Les Mollusques post-glaciaires et actuels du basin de Genève" (*Mém. Soc. Phys. Hist. Nat. Genève*, vol. 40, fasc. 3). The greater part of the work (which runs to more than 260 pages) is devoted to a systematic description of the genera and species with their occurrences all most carefully set forth. Especial attention has been paid to that difficult group of little bivalves, the Pisidia. Here the specific descriptions of the several forms are given first and clearly illustrated by admirable and useful outline

drawings of the essential features of the hinges on which the determination of them depends, while the species occurring in the district are then gone over *seriatim* and their local distribution and variations discussed. The biological aspect of the fauna is not dwelt on, but the ecological is dealt with: the association of species, their vertical and bathymetrical distribution being fully treated. The description of the various post-glacial deposits and their fossil contents, which are considered to date back in age to the Upper Magdalenian, form the rest of the work. A useful bibliography and index are appended. The thirteen plates depicting the deviations in form of certain of the more variable species are well reproduced either from photographs or, in the case of the Pisidia, outline drawings by the author. The monograph is one that no worker on the European non-marine molusca can afford to neglect.

SOUTH-EASTERN ARABIA.—In a paper on "The Physical Geography of South-Eastern Arabia," read before the Royal Geographical Society on Jan. 16, Mr. G. M. Lees stated that Arabia is essentially a great table-land of simple geological structure, so far as Mesozoic-Tertiary tectonics are concerned, and the great monotony of its surface form is the direct result. The high mountain belt of Oman, sticking like a spur into the structures of the Persian mainland, appears as a foreign element on Arabian soil. Three distinctive types of topography constitute the ranges of Oman: (1) a highly dissected limestone country, the best example of which is the northern promontory or Ruus al Jibal; (2) a mountain belt formed of steep, jagged peaks of igneous rock; (3) a limestone plateau country formed of great sheets of horizontal or gently folded limestones. The mountains of Ruus al Jibal are penetrated by many narrow fiord-like inlets up to 9 miles in length and with 20 to 25 fathoms of water up to their heads. They are splendid examples of drowned valleys and indicate a relative depression of at least 1500 feet. Oman proper receives winter rains and Dhofar summer monsoon rain, while the intervening stretch of coast is almost waterless. Dhofar province has a wealth of tropical vegetation. It is the land of frankincense. The nomad tribes of the Samhan hills are non-Arab, and in appearance strongly resemble the Hadandowa tribes of the Sudan Red Sea province. The Sabæan ruins described by Bent were seen. Oman has always been regarded as part of an outer arc of the Persian Zagros system. This arc may exist in fact, but it is of subordinate importance compared with older compressive movements which followed an independent direction. These movements are of Cretaceous age. An intensively folded zone branched off from the Zagros system and passed through Oman. Its last outposts are Masira Island and Ras Madhraka, where it disappears into the Arabian Sea striking in a southerly direction. Argand and Wegener regard the birthplace of India as lying to the east of South Africa; if one assumes a drift of India away from Madagascar, the south coast of Arabia should lie in a region of tension and not of compression.

TERTIARY IGNEOUS ROCKS OF BURMA.—The *Transactions of the Mining and Geological Institute of India*, Part 3, May 1927, contain two valuable papers on the volcanic rocks of Mt. Popa (by H. L. Chhibber) and the Lower Chindwin region (by E. S. Pinfold, A. E. Day, L. D. Stamp, and H. L. Chhibber). These two regions, together with the doleritic rocks of the Pegu Yomas, constitute a petrographic province of the circum-Pacific type. The Popa district exhibits the sequence: older andesite (post-Peguan), biotite-andesite, rhyolite, hornblende- and augite-andesites, olivine-basalt; with accompanying tuffs and agglomerates. Possibly volcanic activity ceased only within historic times. The Lower Chindwin volcanics occur as conical hills; as crater-walls surrounding crater-lakes; or as sheets interbedded with Irrawadian sands. Here again there are andesitic types, occurring mainly as sheets; rhyolites and tuffs building the cones; and olivine- and picrite-basalts forming plugs. The rocks of the main volcanic axis of Burma thus present a striking contrast to those of the neighbouring Kabwet area (on the edge of the Shan Plateau), which resemble in a general way the analcitic and titaniferous basalts of the midland valley of Scotland.

TIDAL DATUM PLANES.—A useful monograph on "Tidal Datum Planes" has been issued by the U.S. Coast and Geodetic Survey as *Special Publication* No. 135, the author being H. B. Marmer. Tidal planes, such as those of mean sea-level, half-tide level, mean high water, and so on, form the most convenient datum planes for observations of elevation, because of their simplicity of definition, ease and accuracy of determination, and certainty of recovery, even though all bench-mark connexion be lost. Such planes are the basis of reference in the hydrographic and geodetic work of the United States and in other countries. The monograph provides a working manual for the actual determination of the more important planes, including a discussion of tide gauges, their use and measurement. There is also a detailed discussion of the principles involved and the accuracy attainable in the work.

FIRST-ORDER TRIANGULATION IN THE UNITED STATES.—Geodetic operations in the United States for the two years ending Dec. 31, 1926, are recorded by Dr. W. Bowie in *Special Publication*, No. 134, of the United States Coast and Geodetic Survey. The most important task undertaken was the continuation of the readjustments in the first-order triangulation net east of the ninety-eighth meridian. The total length of the arcs of triangulation included in this readjustment is approximately 13,000 miles. The necessity for the work became apparent when attempts were made to fit new work into the previously adjusted arcs. About 1909, Laplace azimuths began to be introduced into all new arcs, and it was evident that they could not be used at the beginning or end of an arc when it started from or ended in an old arc. During the next few years it is proposed to conduct similar work in the eastern half of the country and also to cut the area into comparatively small circuits, as has been done in the west. The arc of first order triangulation along the Canadian boundary was extended to the Pacific, and among other work of this nature was the continuation of the reoccupation of the old stations in California in connexion with the earthquake investigations. The survey of Alaska makes continued progress.

FUEL TESTING IN CANADA.—The Mines branch of the Canadian Bureau of Mines has issued a report (Ottawa, 1927) on the "Investigations of Fuels and Fuel Testing" carried out in 1925. This somewhat tardy report indicates a considerable breadth of activities of the staff, and although dealing with local problems, some of the work is of general value. There is an analytical survey of cokes sold in Canada as household fuels, balanced by a series of actual tests on various fuels in a typical domestic hot-water boiler. Thermal efficiencies of 70–75 per cent. on the gross calorific value were commonly obtained. The method of tabulating results in comparison with American anthracite is interesting, showing as it does the pre-eminence of Welsh anthracite, while gas

and oven cokes also proved more valuable, weight for weight, than the standard. Examination of 46 samples of lubricating oils after use in eight different motor-car engines is reported. The outstanding conclusion was that, contrary to popular opinion, "lubricating oils do not wear out." They become diluted with heavy fractions of petrol and contaminated with dust and carbonaceous matter, but by suitable treatment a new oil, almost as good as the original, may be prepared. The report records laboratory experimental work on the carbonisation of coal and shale at low temperatures.

DAYLIGHT IN BUILDINGS.—*Technical Paper* No. 7 of the Illumination Research Committee of the Department of Scientific and Industrial Research deals with the access of daylight to the interior of buildings. It is to a large extent an account of the present state of our knowledge on the subject, and at a later stage will be supplemented by an account of work done by the Committee. The principal point dealt with in the present paper is the 'sill ratio,' which is defined on p. 1 as the ratio of the internal illumination at a point in a room to "the illumination of a horizontal surface placed on the window sill of the room, all external buildings or other obstructions being supposed removed. . . . This sill ratio can be measured by some forms of portable illumination photometer." It is not made clear in the paper how this measurement can be made without the "external buildings and obstructions" being actually removed.

STREET LIGHTING.—The street lighting of London is a problem the importance of which it is difficult to overestimate. It was discussed in a paper read by W. J. Jones on Nov. 15 to the Public Works, Roads, and Transport Congress. Owing to the changes taking place in the habits of people, both the volume and speed of the traffic are ever increasing. Thoroughfares which were essentially of a residential character are quickly becoming main traffic arteries leading into the heart of London. It is now universally admitted that the eye is the final judge in assessing the effectiveness of street lighting systems. The requirements of good lighting are now well known. In this connexion it is interesting to recall that in 1716 all houses of a rental of £10 or above were required to hang out one or more lanterns with sufficient wick candles lighted therein to last from 6 P.M. to 11 P.M. In State Street, Chicago, the street illumination is very brilliant owing to the shopkeepers voluntarily taxing themselves for this purpose, the idea being that people will buy more readily when the illumination is brilliant. The author states that it is best to place the light source at a bend in a road at the outside of the bend, as this lights the road surface better. He also recommends placing a lamp with a large reflecting surface behind it at those places where a side road leads directly into a main thoroughfare, and that the London County Council should form a central organisation similar to that in Glasgow, to consider all street lighting problems in the London area.

ANOMALOUS DISPERSION AND ABSORPTION OF ELECTRIC WAVES.—An important paper by S. Mizushima on the anomalous dispersion and absorption of electric waves has recently been received (*Scientific Papers of the Institute of Physical and Chemical Research*, Tokyo, March). By using a thermionic bulb as an oscillation generator for producing waves of short wave-length, the author has made systematic measurements on the anomalous dispersion and absorption of these electric waves. He used a resonant receiver, the circuit being shunted by a small capacity the dielectric of which was to be tested. He found that when distilled water, acetone, benzene, and various mixtures were used, there was no absorption and so they could be used as standard substances in the measurement of dielectric constants. The results of measurements of the dielectric constant for glycerine, methyl, and ethyl alcohols, etc., are given at various temperatures and at given wave-lengths. Great variations in its value are found. Values ranging from that of the static field to the square of the refractive index for visible light are observed. The anomalous dispersion is accompanied by an intense absorption band. As the temperature is lowered the position of the anomalous dispersion shifts in the direction of the longer wave-length. According to Debye, the large values of the dielectric polarisation in a static field must be ascribed to the orientation of a molecule which has a permanent dipole in it. When a molecule rotates to adapt itself to external force, there must be a resistance which depends on the internal friction and the dimensions of the molecule. The experimental results are discussed from the point of view of this theory. The results obtained with alcohols are in good agreement with the dipole theory.

THE PHOTO BROMINATION OF *CYCLO*-HEXANE.—Pusch, and later Noddack, showed several years ago that in the photochemical bromination of *cyclo*-hexane vapour, each quantum of light absorbed effects the removal of one molecule of bromine. This result has been confirmed, and further data concerning the reaction have been published by B. J. Wood and E. K. Rideal in the October number of the *Journal of the Chemical Society*. Using the mercury green line, they found that the velocity of reaction varied directly with the light intensity, but was independent of temperature and of the concentration of *cyclo*-hexane. The presence of oxygen caused a reduction in the rate of reaction, and this was independent of the presence of *cyclo*-hexane. It is suggested that each quantum of absorbed radiation serves to excite one molecule of bromine, which then unites with a molecule of *cyclo*-hexane to form an excited complex $C_6H_{12}Br_2'$, which has a mean life of approximately 3×10^{-8} sec. This excited complex can either decompose spontaneously: $C_6H_{12}Br_2' \longrightarrow C_6H_{11}Br' + HBr$ and $C_6H_{11}Br' + Br_2 \longrightarrow C_6H_{10}Br_2 + HBr$; or it can, in the presence of oxygen, be deactivated by collision: $C_6H_{12}Br_2' + O_2 \longrightarrow C_6H_{12} + Br_2 + O_2 + \epsilon$.

THE SOLUBILITY OF WATER IN LIQUID CARBON DIOXIDE.—An attempt to determine the solubility of water in liquid carbon dioxide is described by H. H. Lowry and W. R. Erickson in the November issue of the *Journal of the American Chemical Society*. The method used was to determine the density of gaseous carbon dioxide coexisting with liquid, both in the presence and absence of water, since if the latter is soluble in liquid carbon dioxide, it should cause a decrease in the vapour pressure and, consequently, in the density of the co-existing gas. Known weights of carbon dioxide were sealed into glass tubes, calibrated for volume, and the volumes occupied by the gas and liquid measured. Assuming the critical temperature to be 31°, the critical density, obtained by extrapolation, was found to be 0·4683 in satisfactory agreement with previous values. Between − 5·8° and 22·9° the density of saturated carbon dioxide vapour is the same in the presence and absence of water, and the solubility of water in liquid carbon dioxide must therefore be less than 0·05 per cent. by weight over this range. At about 4° the formation of a hydrate was noticed; possibly this was $CO_2 . 9H_2O$ described by Hempel and Seidel (1898).

Annual Exhibition of the Physical and Optical Societies.

THE eighteenth Annual Exhibition of the Physical and Optical Societies took place on Jan. 10, 11, and 12 at the Imperial College of Science and Technology, London. The secretary, Mr. T. Martin, is to be congratulated on the excellence of the arrangements. When space is necessarily limited, as in this journal, in an account of an exhibition on so wide a scale only some typical features can be mentioned. The reader is referred for a detailed report to the *Journal of Scientific Instruments*, where the lectures will be published in full and a description of the principal exhibits given by experts on the various subjects. A new feature in the arrangements this year was that on the second day of the exhibition the morning was devoted to a private view by the members of the co-operating societies, of which full advantage was taken, and it is to be hoped that this will prove of increasing value. A larger number of visitors attended the exhibition this year, and there was also an increase in the number of firms (eighty-one) exhibiting apparatus, which covered a wide range, and in which the high standard associated with this exhibition was maintained.

Among the exhibits in the Trade Section the following may be mentioned: Messrs. Adam Hilger, Ltd., a travelling microscope measuring to one-tenth of a micron; a quartz spectrograph of the all-metal type; and a fluorite spectrograph. Messrs. Carl Zeiss (London), Ltd., an illuminated pointer on the principle of an advanced torchlight, as used in the planetarium at Jena; a microscope affording binocular vision with one objective only, the binocular tube being interchangeable with a monocular tube. Messrs. Charles Baker, a boxform dissecting microscope with sliding arm to carry arms and arm rests. The Automatic and Electric Furnaces, Ltd. a Wild Barfield high temperature furnace suitable for pottery work and high speed steel hardening. Messrs. Gallenkamp and Co., Ltd., a variety of apparatus, including electric furnaces for metallurgical and dental work, optical glass heat treatment, an optical table of new design. Messrs. W. Edwards and Co., a new method of absorbing mercury vapour from high vacuum systems by the use of liquid alloys of the alkaline metals, rendering the use of liquid air largely unnecessary. Messrs. Bellingham and Stanley, Ltd., a spectrograph specially designed to photograph spectra of feeble intensity; a simple spectrograph for industrial work, photographing eight spectra on a quarter plate; a simple form of arc lamp, burning a special metallic alloy, giving a spectrum about five times as intense as tungsten, in the region 2900 A. and 3100 A.; an ultra-violet lamp for use in the home, for radiating the body with actinic light; and the latest form of the Hartridge microspectroscope.

Among other exhibits, new devices shown by Messrs. Elliott Brothers (London), Ltd., were a portable moving coil galvanometer, combining high sensitivity with a robust form; vacuum thermocouples of various capacities, special feature being that the heater is insulated from the thermocouple itself. Messrs. Houghton-Butcher (Great Britain), Ltd., gave a number of demonstrations of educational films; a new lantern attachment was shown in which films or lantern slides can be projected alternately by one movement of a change-over switch. Among some interesting new developments seen in the exhibits of the Igranic Electric Co., Ltd., attention may be directed to the Igranic neutro-regenerative short wave amplifier kit, by means of which high frequency amplification on wave-lengths so low as 15 metres may be obtained. The Mullard Wireless Service Co., Ltd., demonstrated a loud speaker of very high quality, a combination of the horn and cone type with a balanced armature. To mention a few more, there were exhibits in connexion with recent developments in wireless apparatus (Marconi's Wireless Co., Ltd.); electrical aids for the deaf (Mr. W. H. Pettifor); temperature recording (Siemens Brothers and Co., Ltd.); thermometry (Messrs. Negretti and Zambra). Among the many interesting exhibits of the Cambridge Instrument Co., Ltd., may be mentioned an ingenious device used in their new recording potentiometer of the slide wire type, in which a balance is obtained automatically by the recorder mechanism instead of by hand manipulation of the slide wire contact.

In the Research and Experimental Section there were sixteen stands in the group of exhibits illustrating recent physical research. Among these exhibits, typical of progress in the development of physics in its application to various modern problems, were the following: The Rothamsted dynamometer, shown by Rothamsted Experimental Station, the chief characteristics of which are its light weight and adaptability for a widely different range of cultivation implements. The Technical Optics Department of the Imperial College of Science and Technology showed an equipment for ultra-violet microscopy for instructional purposes, and other apparatus and accessories in connexion with ultra-violet refractometry. The arrangements make possible theoretically a resolving power which is double that attainable with the green light of the visible spectrum, and permit of photographic application to biological or metallographic subjects.

Among the ingenious devices developed by the National Physical Laboratory for overcoming practical difficulties were an improved portable illumination photometer in which the lamp current can be adjusted to within a small fraction of a milliampere by means of a special bridge, and in this way the illumination can be kept very nearly constant; a modification of the Haughton-Hanson thermostat furnace, in which an oscillating temperature is produced by means of a clockwork device, while an upward or downward tendency can be imposed as desired on the temperature curve by another special device in connexion with the thermostat furnace.

In the section devoted to Lecture Experiments in Physics, Mr. C. W. Hansel's exhibit, which was of considerable interest to those concerned with teaching, consisted of a demonstration of the rapid construction of scientific apparatus from simple units, couplings, and accessories suitable for use in schools and colleges, and in connexion with this he gave an explanatory lecture each afternoon and evening. Dr. D. Owen's exhibit showed very effectively the appreciable time taken to establish a current in an inductive circuit. Mr. F. W. Shurlock had a set of diffraction slides, among which was a set illustrating the principal results of the wave theory of light.

In the Historical Section, Prof. E. N. Da C. Andrade had a series of illustrations of the early history of the air pump, while another series of pictures showed how closely the present types of rotary air pump were anticipated by early water pumps. The Research Department of Messrs. W. and T. Avery, Ltd., had an exceedingly interesting series of illustrations, specimens, and reproductions from the Avery Historical Museum, Soho Foundry, Birmingham, showing the development of weighing instruments. An important section of the exhibits of the Research Department of the Gramophone Co., Ltd., was a series of gramophones illustrating development from the earliest

instruments to the present day. A striking feature in this section was a gramophone with an electric pick-up operating a coil-driven loud speaker, consisting of a light alloy sheet (stretched almost to its elastic limit) on a frame also of light metal. The coil is attached eccentrically to the sheet, thus preventing the formation of nodes and resulting in a purer tone than would otherwise be possible. This section was certainly the most audible in the Exhibition.

The lectures in the evenings again attracted large audiences. That on the first evening was given by Mr. Whitaker, of the Gramophone Co., Ltd., on "Progress in the Recording and Reproduction of Sound." The number of people interested in this subject was too large to be accommodated in the lecture theatre, and Mr. Whitaker therefore consented to repeat his address in order to avoid causing disappointment. He sketched the development of acoustic recording from the phonautograph of Scott and Koevig and the reproduction of sound from Edison's phonograph. Development up to 1925 was largely empirical, and the slow improvement in quality was demonstrated by a series of gramophones of different dates which played contemporary records. Improvement in the quality of response was traced from 1925 when electrical recording came into use, followed by electrical reproduction. An electrical reproducer was demonstrated that will give natural reproduction of tones as low as the pedal notes of an organ with very great volume. There are great possibilities in the method of recording and reproducing sound that utilises a photographic film, as moving parts are completely eliminated, except in the microphone and loud speaker. Photographs were shown demonstrating that reproducing devices which put a 'reactive' load on a record wear it excessively, proving that when special attention is given to this aspect a sound box which causes the minimum possible wear can be made, while an equally good pick-up scarcely wears a record at all.

Mr. V. E. A. Pullin, who lectured on the second evening, took for his subject "Recent Applications of X-rays." He gave an outline of the scope of the work of the Radiological Research Laboratory at Woolwich, illustrated by numerous slides typical of the matter with which he dealt. He sketched the origin of the work from a suggestion during the War that X-rays should be used to examine the bases of shells for flaws. This led to the planning of a scheme of research which involved the study and improvement of a wide range of technique. Among examples mentioned of practical applications were the study of gun steels, the effect of heat treatment and mechanical working, structure of electrically deposited metals, and a survey of many of the alloy systems. It has been found possible to develop X-ray technique so that comparatively large metal specimens can be radiographed, and to extend the use of X-rays beyond the research laboratory into the dockyards and factories of the services. Among the problems now receiving attention, the necessity of extremely high voltages for metal penetration is important. It is now possible to penetrate in a practical manner about 4¾ in. of steel, whereas in 1917 the maximum penetration that could be achieved was 1 in.

On the third evening Dr. J. W. T. Walsh, of the National Physical Laboratory, lectured on "Artificial Daylight." He pointed out the importance of artificial daylight for certain types of work. The most exacting use, he said, is for colour matching, and this demands the closest of daylight with correspondingly lower efficiency. For general lighting purposes a higher efficiency may be obtained, and accuracy of imitation may be sacrificed to a considerable extent. The spectral distribution curves of a number of actual units were shown by Dr. Walsh, as well as the units themselves. Among them was the daylight gas mantle, in which a fair imitation of daylight can be obtained at an efficiency of about 80 per cent. of that of the ordinary mantle. Dr. Walsh urged that picture galleries should be illuminated by artificial daylight.

The Science Masters' Association.

THE Science Masters' Association has recently grown in numbers so rapidly that it was decided this year to hold the annual meeting on Jan. 4-6, partly in the Chemical Department of the Imperial College at South Kensington, and partly at King's College for Women, Campden Hill Road. The trade exhibition of scientific apparatus and books—the largest ever seen at these meetings—was displayed at the Imperial College throughout the meeting. The daytime programmes of lectures, meetings, and demonstrations were all at the Imperial College, but for those in the evening the large hall of King's College for Women was used.

The meeting was opened on the evening of Wednesday, Jan. 4, by the address of the president, Sir Richard Gregory, who took for his subject the relationship between science and the humanities. In the course of the address it was pointed out that these are the warp and woof of the fabric of modern life. Though in scientific assemblies this is commonly recognised, representatives of science miss reciprocity of attitude from their literary colleagues, who more easily find fault with the non-literary scientific worker than with the humanist wholly oblivious of science.

"It is commonly assumed," said the president, "that devotion to science inhibits all sense of pleasure in emotional expression and that familiarity with the structure and processes of Nature breeds indifference to her charms, and destroys the æsthetic veil which gives her both mystery and beauty. Science and poetry thus seem to most people to be poles apart, yet Coleridge said that he attended Sir Humphry Davy's lectures at the Royal Institution for the purpose of increasing his stock of metaphors, and modern poets might well be inspired by the scientific imagination of Sir William Bragg shown in his insight into the atomic structure of crystals. Though poetry and science represent different attitudes towards Nature, they are not mutually destructive, and may be complementary to each other.

"Science does not want a divorce from literature, but closer union with it and a common understanding of the distinctive qualities by which each can contribute to the fullness of life."

Sir Richard Gregory dealt also with the respective claims of classical and scientific education. "When a student of science confesses that he knows little or nothing of classical literature," he said, "he does so in a spirit of humility; but classical scholars often seem to be supercilious in their disregard of science. This vestige of social snobbery will no doubt disappear in the course of time, and it will be understood more clearly than it is to-day that science is as necessary a part of the mental equipment of a cultured man as is classical or modern literature or any other art of expression."

During the meeting two discussions were held on the subject of scientific careers. The first dealt especially with biological openings overseas. Sir John Farmer, who opened the discussion, made it very

clear that in few directions are prospects so good for men of the right type and training, and that the present shortage of suitable candidates for work that is urgently needed is a very serious hindrance to the development in the Empire of what is by far its most important industry, namely, agriculture. Capt. Irby, of the Colonial Office, supplied details of recent appointments made in the Crown Colonies and Dependencies.

The second discussion dealt with industrial openings in chemical technology, and was opened by Prof. W. A. Bone. He pointed out that the formation of large industrial combines is tending to bring in more and more scientific research and control. The economic existence of Great Britain depends upon production, and production depends upon efficiency of control. For this the best type of men is needed, and of the qualifications required sound character is by far the more important, although adequate technical knowledge is also necessary. Prof. Bone thinks that proper training for work of this kind requires seven years after leaving school. Such a long and expensive course could be financed by industries themselves, who would find it a cheap and safe investment; some industries are moving in this direction already.

Lectures were delivered to the Association during the meeting by Dr. J. W. T. Walsh, of the Photometric Department, National Physical Laboratory, who lectured on "Some Modern Methods in Photometry"; also by Prof. J. C. Philip, of the Imperial College, on "Charcoal and its Activation." These lectures were well attended and much appreciated by audiences who, knowing well enough how easily a science master gets out of touch with modern developments, welcomed such chances of renewing contact with some recent investigations.

A large number of members exhibited apparatus designed by themselves for various uses in connexion with teaching. Among these the most notable collections were those staged by Mr. E. H. Duckworth, of Dean Close School, Cheltenham, and Mr. F. A. Meier, of Rugby School. Lecture demonstrations were given by Mr. C. W. Hansel, Bedford School, in connexion with apparatus of his own design for use in mechanics and optics; by Mr. S. R. Humby, of Winchester, on experiments with high-frequency sound waves, in which he was able to demonstrate effectively most of the familiar phenomena of optics; and by Mr. W. A. D. Rudge, of Rugby School, who demonstrated atomic models. These exhibits and informal lectures by members were a very satisfactory feature of this meeting, in which they occupied a much larger part in the programme than has been the case at most recent meetings. One of the most useful functions of the Association is to enable its members to pick up valuable ideas from one another, and a distinct revival in this particular branch of its activities is therefore to be welcomed.

Among the most popular events at every annual meeting are the expeditions, applications for which commonly exceed the number that can be taken. On this occasion a tour of the London Docks was arranged during the afternoon of Jan. 4; visits to the United Dairies Ltd.; to the Lighting Service Bureau at 15 Savoy Street, Strand; and to the Æolian Hall, New Bond Street, to see the Duo-Art piano-playing reproduction process, filled the programme for the following afternoon. On Friday afternoon nearly 250 members accepted a generous invitation from the Gas Light and Coke Company. After they had been entertained to lunch by the Governor and Court of the Company, a very interesting afternoon was spent in viewing first the gas-producing plant at Fulham, where a large retort house of the latest type has recently been installed, and afterwards the Company's store and training depot at Nine Elms. The Governor, Sir David Milne-Watson, in welcoming his guests at lunch, expressed the view that some people were inclined to suppose that, with the competition of electricity, the gas industry would decline, and he hoped that they would be convinced of the contrary by what they would see during the afternoon. His hope was very fully justified.

It is hoped to meet next year, for the second time, at Cambridge, and Prof. A. C. Seward, Master of Downing College, has been elected president of the Association for the forthcoming year.

The Loutreuil Foundation of the Paris Academy of Sciences.

THE following grants for research have been made from the Loutreuil Foundation:

(a) Grants to institutions named by the founder.

(1) National Museum of Natural History. 4000 francs to Désiré Bois, to aid in the publication of the third part of a "Guide aux collections de plantes vivantes du Muséum"; 6000 francs to Paul Chabanaud, to pursue in Austria and Holland work relating to a general study, morphological and systematic, of the heterosome fishes. (2) Collège de France. 3000 francs to Charles Moureu for altering the large cathetometer in his laboratory with the view of the determination of the densities of gases, particularly of pure xenon and krypton. (3) Central Council of Observatories. 3000 francs to the Paris Observatory for the publication of Lalande's catalogue; 3000 francs to the *Journal des Observateurs* to assist this useful publication. (4) Conseil de perfectionnement de l'École polytechnique. 15,000 francs to the library of the École polytechnique, for the purpose of filling up the gaps in a certain number of periodicals. (5) National Veterinary School of Alfort. 11,000 francs to the library, to complete various collections and to purchase important French or foreign books relating to veterinary science. (6) National Veterinary School of Lyons. 5000 francs to the library for completion of collections of periodicals interrupted during the War; 1000 francs to Jean Basset, to carry on his researches against anthrax. (7) National Veterinary School of Toulouse. 3000 francs to Marcel Petit, for the study of the lymaphatics of the foot of the horse, especially those in the keratogen layer. (8) National Agronomic Institute. 2000 francs to Charles Voitellier, for experiments on egg control.

(b) Grants to institutions admitted for one year by the president.

Conservatoire national des Arts et Métiers. 5000 francs to Emilio Damour, for pursuing his bibliographical work on glass.

(c) Independent bequests.

3000 francs to Norbert Casteret, for continuing his researches and his spæleological work in the region of the central Pyrenees. 6000 francs to the Comité français de géodésie et géophysique, towards the cost of the seventh survey of the new magnetic network of France, and the calculations necessary to the coordination of the observations collected. 5000 francs to Gaston Deléfine, for the pursuit of his studies on the carboniferous limestones of the Asturia. 5000 francs to the École supérieure d'aéronautique et de construction mécanique, for acquiring the necessary material for the determination of critical points and for experiments on hardness. 6000 francs to the École technique de photographie et de cinématographie, for

completing the equipment of the research laboratories of the School in view of undertaking a systematic study of photographic preparations. 5000 francs to Gaston Fayet, to ensure the regular publication of the *Bulletin* of the Nice Observatory. 5000 francs to the Fédération française des Sociétés de sciences naturelles as a grant to the "Faune de France." 10,000 francs to the Musée d'histologie de l'hôpital Saint-Louis, for the purchase of instrumental material. 6000 francs to Emmanuel Passemord, to assist the continuation of his researches on the Quaternary period. 2000 francs to Paul Pallary, for assisting his zoological and prehistoric studies in Morocco. 10,000 francs to Pierre Teilhard de Chardin, to aid his geological and palæontological researches in northern China.

University and Educational Intelligence.

DURHAM.—Dr. A. K. Macbeth, reader in chemistry (Durham Division) since 1924, has been appointed to the Angas chair of chemistry in the University of Adelaide. In connexion with the changes following on Dr. Macbeth's departure, Dr. W. A. Waters has joined the staff of the chemical laboratories as a lecturer in chemistry.

EDINBURGH.—The Cameron Prize "awarded to a person who, in the course of the five years immediately preceding, has made any highly important and valuable addition to practical therapeutics," has been awarded to Prof. C. Levaditi, of the Pasteur Institute, Paris, for his work on the chemotherapy of syphilis and his other contributions to our knowledge of microbiology.

IT has been decided to found an institute at Prague for the scientific investigation of coal. It will have the support of the State and of the various coal undertakings in Czechoslovakia.

THE British Federation of University Women, Crosby Hall, Cheyne Walk, S.W.3, directs attention to the fact that applications for the first international junior fellowship offered by the International Federation of University Women and for the Rose Sidgwick memorial fellowship must reach the secretary by, at latest, Feb. 15.

THE annual general meeting of the Association of Women Science Teachers will be held at St. Paul's Girls' School on Feb. 4. In the morning, members of the Association will visit the Royal Institution; in the afternoon the programme will include short discussions on general science as an alternative to the separate sciences in the school certificate course (opened by Miss F. E. M. Morgan), and holiday work in chemistry for girls (opened by Miss C. H. Spencer). In the evening, Sir John Russell will deliver a lecture on "The Growth of Crops—Applications of Botany and Chemistry to Country Life." Further particulars can be obtained from Miss M. E. Birt, 20 Longton Avenue, Sydenham, S.E.26.

NOTICE is given that, subject to candidates of sufficient distinction presenting themselves, the president and Council of the Royal Society of London propose to appoint a second Foulerton research professor, whose duties will be to conduct original researches in medicine or the contributory sciences, calculated to fulfil the objects of the bequest, namely, "The discovery of disease, the causes of it, and the relief therefrom of human suffering." The yearly stipend will be not less than £1400 and the appointment will be made, in the first instance, for five years, renewable for further successive periods of five years up to the age of sixty years. Applications must be received by the assistant secretary of the Royal Society, Burlington House, W.1, not later than May 1.

THE Department of Textile Industries of the University of Leeds has been conducting researches in relation to the colloid character of wool, and these have led to the invention of a device, now being tried out on a large scale, for imposing some of the properties of wool on artificial fibres. Other main lines of research in the department, as reported in Prof. Barker's account of the work of the session 1926–27, related to the chlorination of wool and the physicochemical properties of wool fat. The work on colour inheritance in animals associated with the institution of a White Wensleydale Flock is, for the time being, discontinued owing to lack of funds. Meanwhile the work already done has led to the Wensleydale-Peruvian Merino cross, with important results. In the Department of Colour Chemistry and Dyeing, satisfactory arrangements for obtaining free samples from manufacturers have made it possible to devote more attention to artificial silk.

THE education of the chemist forms a frequent theme of discussion, and very varied views are held concerning what he should and should not be taught. It has rarely been suggested that legal knowledge should form part of a chemist's equipment, but no one engaged in industrial work will deny that a working knowledge of the numerous Acts of Parliament, and the still more numerous Orders-in-Council and Statutory Regulations governing chemical works, is absolutely essential to anyone holding an appointment of an executive nature. The necessity of this knowledge has been realised by the Sir John Cass Technical Institute, which announces a short course of lectures on Tuesday evenings at 7 P.M. on "English Law as Related to Industrial Chemistry." As the lecturer, Mr. G. S. W. Marlow, is both a chemist and a barrister in practice, the requirements of the industrial chemist will be fully met. At the first lecture, which is to be given on Jan. 24, the chair will be taken by Mr. James Whitehead, K.C.

"ENGINEERING DEGREE SERIES" is the title of a new series of books being issued by Sir Isaac Pitman and Sons, Ltd., intended for students preparing for the national certificate, City and Guilds, associate memberships of the engineering institutions, and B.Sc. (Eng.) examinations. The publishers are to be congratulated on this series of primers, which are all clearly printed, well illustrated, and, what is probably most important, contain many well-chosen examples. The idea of publishing this series in weekly parts should make a wide appeal to part-time students who, although not in a position to purchase the necessary text-books outright, may welcome the opportunity of making weekly contributions towards this end. The scheme of covering the syllabus of the B.Sc. examination in eight to twelve weekly parts of about forty pages each seems rather ambitious, and students preparing for this examination will require to supplement their knowledge by reference to standard text-books. On the other hand, the subject matter of Parts I of "Strength of Materials," by Dr. F. V. Warnock, "Applied Thermodynamics," by Prof. W. Robinson, and "Performance and Design of D. C. Machines," by Dr. A. E. Clayton, seems to be clearly stated and condensed into as short a form as possible. This again will make a special appeal to the part-time student, who may receive at the most only thirty lectures in the subject during a session, and can, therefore, only hope to acquire the basic principles during class instruction. The series should thus meet a definite need, as one of the greatest difficulties of teachers in evening institutes is to recommend a text-book which will adequately cover the syllabus, and at the same time be within the limited purchasing power of the student.

Calendar of Customs and Festivals.

January 24.

ST. PAUL'S EVE.—In Cornwall known as St. Paul's Pitcher Day or Eve of Paul's Tide, the former name derived from a curious custom of tin streamers, the mixed agricultural and mining population of Bodmin and the seafaring population of Padstow. The custom was that a pitcher should be set up at a convenient distance and pelted with stones until demolished. A new pitcher was then bought, with which an adjournment was made to the nearest ale-house, and the pitcher was used in the merry-making which followed. Popularly the custom was explained as a festival to celebrate the discovery of tin-smelting. A variant was observed in Bodmin when boys paraded the town with broken pitchers and threw sherds into any door which had been left open.

In Cornwall popular tradition has assigned super-human powers to its local saints freely. St. Just and St. Keverne hurl boulders at one another which elsewhere, and even in Cornwall, are the missiles of giants. Numerous wells were endowed by them with miraculous powers, such as that at St. Ludgvan, which protected any child baptised with its waters from being hanged. St. Kea floated to Cornwall from Ireland on a rock; and St. Piran was conveyed there on a millstone which had been hung around his neck when he was flung into the sea by the order of an ungrateful Irish king, whose hounds killed in hunting and whose warriors slain in battle he had restored to life. Previously he had fed ten Irish kings and their armies for ten days with three cows. The early connexion between Ireland and Cornwall is indicated by the Irish origin of a number of Cornish saints, and there was a similar link with Wales.

In view of the peculiarly localised character of Cornish saints, it might be expected that a distinctively local industry like tin mining, which goes back to a remote past, would be associated with a local saint rather than St. Paul; in fact, St. Piran and St. Chiwidden are credited with the discovery and working of tin. If the destruction of the pitcher represented a sacrifice, human or other, it might be simply a survival of a 'Celtic' rite; but the very fact that it is associated with an observance of tin-workers, and its restricted but peculiar distribution, which extends to the fishing as well as the mining population, suggests that the festival of St. Paul may have overshadowed a rite belonging to another culture, such as might be associated with the so-called "Cornish fisher type," found at Padstow among other places, which, distinct in physique and often in custom, still to some extent holds aloof from the rest of Cornwall.

January 25.

ST. PAUL'S DAY.—Strype records that on this day —the day of the conversion of St. Paul—a solemn procession, in which the civil dignitaries and representatives of all the parishes took part, was made through the City of London to St. Paul's. The court, on one occasion at least, was also present. At night bells were rung and bonfires were lit.

There are some curious features in an old custom connected with the tenure of lands in Essex from the Dean and Chapter of St. Paul's. The lands were held by the Le Baud family from 1274 on payment annually of a buck on the day of St. Paul's conversion and a doe on the Commemoration of St. Paul. The buck was brought to the steps of the altar, where it was received by the Dean and Chapter in full canonicals with garlands of roses on their heads. The head and horns of the buck were then placed on a pole and carried in front of the cross around the church until the procession came out of the west door, when the huntsman sounded the death of the buck and the city horns replied. Among the gifts to the huntsman from the Dean was a loaf bearing the image of St. Paul. This custom was discontinued in the reign of Elizabeth. There is no evidence to show whether the custom of carrying the horns in procession arose out of the terms of the tenure or whether, as is not improbable, the tenure was instituted to ensure the continuance of a custom which had grown out of a tradition connected with the previous use of the site for a pagan temple of great sanctity.

In popular belief St. Paul's Day is one of several days in the calendar connected with prognostication of the weather in the coming year. If the sun shines, it betokens a good year; if rain or snow, indifferent; if misty it predicts a great dearth; if it thunders, great winds and death. Another form of the belief holds that a cloudy day will be followed by pestilence. A number of forms of the prognostication are recorded. The belief is evidently of some antiquity and wide-spread. It is recorded by Hospinian. It is also recorded that in many parts of Germany, if it were cloudy on this day it was the custom to drag the images of St. Paul and St. Urban to the river—a familiar method of treating the images of saints popularly connected with the weather, but more usually to secure rain rather than avert it, as it seems in the present instances. In an ancient calendar of the church of Rome, this day is marked as one on which husbands do not lie with their wives.

ST. DWYNWEN'S DAY.—Formerly celebrated in Wales on Jan. 25 with many festivities, the trying of love spells, and the exchange of love tokens. The saint was the patron of lovers and of all between whom ties of affection prevailed. According to the legend, Dwynwen was loved by Prince Maelon Dafodrill, but a marriage had already been arranged for her by her father. Dwynwen prayed to be cured of her love, and dreamed that an angel administered a potion to her which effected her wish, but that a similar potion turned her lover to ice. The angel asked her to express three wishes. She wished her lover to be unfrozen, that all true lovers should either obtain the object of their affections or be cured of their love, and thirdly that they should never wish to be married. Her wishes were granted, and she then devoted herself to a religious life. Her symbol is the crescent moon, her girdle had the same attributes as the cestus of Venus, and she carried the bow of destiny, which on her last visit to earth she left at Tresillian Cave, Glamorgan, in the form of a natural arch of stone. This is used as a means of divination in connexion with marriage. If a pebble is thrown over the arch at the first attempt, it indicates a marriage within the current year. Each failure indicates a year to wait.

The similarity between the popular cults of St. Agnes and St. Dwynwen in connexion with marriage is apparent. The legend of St. Dwynwen, it may be conjectured, represents a working over and Christianising of a cult of a Celtic goddess, while in the case of St. Agnes the cult has been absorbed by the legend of a saint of which the central feature was a love episode. In both cases the desired end was not attained, and yet two virgin saints are associated with the forecast of a love affair with a successful issue, which clearly points to an imperfect assimilation of pagan-Christian elements. The Welsh legend attempts a logical solution by illogically granting the *faithful* lover forgetfulness.

Societies and Academies.

LONDON.

Linnean Society, Jan. 5.—**Suzanne Leclercq** and **M. Bellière**: *Psygmophyllum Gilkineti*, nov. sp., from the Middle Devonian (with Old Red Sandstone facies) of Malonne, Belgium. *P. Gilkineti* is an arborescent or at least suffrutescent plant. Axis woody, smooth, ramified, furnished with numerous distant, non-sheathing leaves, spirally arranged. Leaves large, coriaceous, and with long petioles. The whole extent of the principal specimen is about 1 ft. 10 in. in height by 3 ft. 2 in. in width, with leaves reaching to 18 in. in length, including the long and rigid petiole.—**S. H. Williams**: A naturalist in the Guiana jungles. Prof. Williams was in charge of the University of Pittsburg Investigations in British Guiana. The tropical research station, acquired from the New York Zoological Society, is situated at the junction of the Mazaruni and Cuyuni Rivers, in the heart of the largest and least-known jungle area in the world. Prof. Williams also travelled into the highlands in the interior, beyond Kaieteur Falls, in order to make a study of zonal distribution of Coleopterous insects.

GENEVA.

Society of Physics and Natural History, Dec. 1.—**G. Tiercy**: The variations of the radial velocities of η-Aquilæ, Y Ophiuchi and X Cygni. The author has proved a remarkable parallelism between the curve of radial velocities and the light curve of those three variable stars.—**P. Ferrero** and **R. Wunenburger**: Researches on the chlorination of naphthalene. The chlorination has been carried out in the gaseous state; the maximum yield of chlornaphthalene compared with the theoretical yield based on the naphthalene (60 per cent.) is realised at 350° C. with a ratio of 1·5 molecules of chlorine for one of naphthalene.—**A. Van der Wijk**: The formation of ammonia by the silent electric discharge in the presence of mercury. The author establishes that the velocity of the reaction varies according to the formula

$$V = -\left(\frac{\partial x}{\partial t}\right) = K[H_2][N_2]^{\frac{1}{2}},$$

which, for a maximum of V, requires a mixture of 67 per cent. hydrogen and 33 per cent. nitrogen.—**P. Balavoine**: A seasonal variation of the composition of butter fat. A diminution of the volatile acids is produced in August and September (23·5 against an average figure of 28) with a refractive index of 46 against 43·5 (measured with the Zeiss butyro-refractometer).—**R. Chodat** and **W. H. Schopfer**: Carotine and sexuality. The authors prove, by various reactions, that in the Mucorineæ the (+) progamete contains the carotine dissolved in a fat whilst this is not the case for the (−) progamete.—**E. Cherbuliez** and **P. Rosenberg**: Researches on the silicates. The increase of conductivity of orthose at constant temperature above 900° C. is explained by a dissociation, which leads to the final nepheline stage passing through the leucite stage. The variation mentioned exists for leucite but not for nepheline. This phenomenon does not take place with augite.

SYDNEY.

Royal Society of New South Wales, Dec. 7.—**H. B. Taylor**: The determination of minute quantities of metals in biological material (Part 1). The determination of lead. The lead present in urine is separated directly by adsorption on calcium oxalate formed by the addition to the urine of ammonium oxalate. The calcium oxalate precipitate is heated to convert it into carbonate, treated with hydrochloric acid, evaporated to dryness, taken up in water, made slightly alkaline, and filtered. The lead is left on the filter, together with a small amount of calcium phosphate. The lead is determined by dissolving the precipitate in hydrochloric acid, neutralising with sodium hydrate, and adding a freshly prepared solution of sodium-bisulphite. The amount of lead present is proportional to the opalescence produced. The method is capable of determining 0·005 mgm. of lead per litre of urine.—**A. R. Penfold**: The essential oil from the timber of rosewood (*Dysoxylon Fraseranum*). This excellent furniture timber suffers from the drawback of 'sweating,' due to the high content of oil and its peculiar nature. Although the wood is red in colour, the oil is viscous, with a pronounced bacon odour, and is intensely blue in colour, due to the presence of about 0·75 per cent. of azulene. The principal constituents were found to be cadinene, probably copaene, two new sesquiterpenes yielding azulene on dehydrogenation with sulphur, and a further sesquiterpene which has been named 'dysoxylonene.'—**Sir George H. Knibbs**: Proof of the laws of twin-births. Earlier analyses based upon means have shown that the ratios of the total number of twins born to mothers of any age, of cases of two males, of a male and a female, and of two females, were different functions of their age; the uniovular cases among them were always 0·00300 of the cases of maternity, whatever the age. Taking the masculinity into account, the numbers of uniovular and diovular cases for each year of age from 13 to 49, of *MM*, *MF*, and *FF* twins, agree very closely with the numbers actually observed in Australia in the six years 1920 to 1925. The formulæ were:

Ages.	Ratio.	Uniovular Cases.	Diovular Cases.
Up to age 37	$t =$	0·00300	$+0{\cdot}00058(x-15)$
Beyond age 37	$t =$	0·00300	$+0{\cdot}01276-0{\cdot}00128(x-37)$

The masculinity of the uniovular cases was 0·020, and of the *MM* and *FF* of the diovular cases, 0·040; t denotes the ratio of the cases of twins to the cases of maternity for mothers of age x.—**M. B. Welch**: Some mechanical properties of Australian grown *Pinus insignis* (*P. radiata*) with notes on the wood structure. The effect of rate of growth under different conditions has been studied in comparison with the mechanical properties of the wood. In general, slow growth results in a stronger wood. Impact tests indicate that the wood possesses remarkable toughness, especially material of fairly high density.—**W. R. Browne**: Petrological notes on some New South Wales basic alkaline rocks. Brief notes are given on a number of Tertiary basic alkaline rock-types, mostly from localities hitherto unrecorded; they comprise analcite and nepheline-bearing olivine-dolerites, a nepheline-basalt, and a texhenitic aplite containing barkevikite, recently collected from the Prospect intrusion.—**E. Cheel**: Descriptions of four new species of Boronia, with notes on certain other species. The new species described are: *B. subulifolia*, an 'awl-shaped leaved' species found on Mount Currockbilly near Braidwood which had previously been confused with *B. pilosa*, a Tasmanian species. *B. hispida*, a small plant covered with stiff hairs from the Grampian Mountains and head of the Turos River in N.S.W.; *B. Ruppii*, named after Rev. H. M. R. Rupp, who collected it near Barraba; and *B. Whitei*, which seems to be confined to the New England district, chiefly in the neighbourhood of Torrington. Five distinct species have previously been confused with the 'Ledum-leaved Boronia.' They are: *B. ledifolia* (Ledum-leaved Boronia); *B. rosmarinifolia* (Rosemary-leaved Boronia); *B. repandra* (Repand-leaved Boronia); *B. glabra* (Smooth-leaved Boronia); *B. triphylla* (Three-leaved Boronia), and *B. rubiginosa* (Rust-coloured Boronia).

Official Publications Received.

BRITISH.

Malayan Forest Records. No. 3: Commercial Timber Trees of the Malay Peninsula. By F. W. Foxworthy. Pp. 195+140 plates. (Kuala Lumpur: Forest Department.) 5 dollars; 12s.

Agricultural Research Institute, Pusa. Bulletin No. 168: List of Publications on Indian Entomology, 1926. Pp. 48. (Calcutta: Government of India Central Publication Branch.) 10 annas; 1s.

Memoirs of the Department of Agriculture, Trinidad and Tobago. No. 4: The Useful and Ornamental Plants of Trinidad and Tobago. By W. G. Freeman and R. O. Williams. Pp. iii+193. (Trinidad: Government Printing Office, Port-of-Spain.) 2s. 6d.

South Australia: Department of Mines. Mining Review for the Half-Year ended June 30th, 1927. (No. 46.) Pp. 70+7 plates. (Adelaide: Harrison Weir.)

South Australia. Annual Report of the Director of Mines and Government Geologist for 1926. Pp. 8. (Adelaide: Harrison Weir.)

Proceedings of the Prehistoric Society of East Anglia for 1926. Vol. 5, Part 2. Edited by G. Maynard. Pp. xii+91-255. (Ipswich: W. E. Harrison; London: H. K. Lewis and Co., Ltd.) 10s. net.

The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 45: *Catenaria anguillulae* as a Parasite of the Ova of *Fasciola hepatica*. By Prof. J. Bayley Butler and J. J. C. Buckley. Pp. 497-512+plates 23-26. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 3s.

Transactions of the Institute of Marine Engineers, Incorporated. December. Pp. 627-710. (London.)

Journal of the Chemical Society: containing Papers communicated to the Society. December. Pp. x+iv+2901-3205. (London: Gurney and Jackson.)

Madras Agricultural Department. Year Book, 1926. Pp. ii+123. (Madras: Government Press.) 1.8 rupees.

Department of Agriculture, Madras. Bulletin No. 88: Statement giving the History of certain Important Crops from Sowing to Harvest and describing their Vicissitudes under Adverse Seasonal Conditions. Pp. 16. (Madras: Government Press.) 2 annas.

Report on the Operations of the Department of Agriculture, Madras Presidency, for the Year 1926-27. Pp. ii+93+6 plates. (Madras: Government Press.)

Malta. Annual Report on the Working of the Museum Department during 1926-27. Pp. xv. (Malta: Government Printing Office.)

The Indian Forest Records. Entomology Series, Vol. 13, Part 2: Part i. Identification of Immature Stages of Indian Cerambycidae, II.; Part ii. Descriptions of three Indian Beetle Larvae (Carabidae, Col.). By J. C. M. Gardner. Pp. 37+5 plates. (Calcutta: Government of India Central Publication Branch.) 1.4 rupees; 2s. 3d.

Memoirs of the Department of Agriculture in India. Veterinary Series, Vol. 4, No. 2: Studies in Bovine Lymphangitis. By Prof. V. Krishnamurti Ayyar. Pp. 103-127+8 plates. 1.3 rupees; 2s. Botanical Series, Vol. 14, No. 7: The Kolamba Rice of the North Konkan and its Improvement by Selection. By R. K. Bhide and S. G. Bhalerao. Pp. 197-245+7 plates. 1.4 rupees; 2s. (Calcutta: Government of India Central Publication Branch.)

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 38, Part 4. Pp. 405-567+viii+plates 14-22. (London: Edward Stanford, Ltd.) 5s.

South-Eastern Agricultural College, Wye: (University of London), County Councils of Kent and Surrey. The Downy Mildew of the Hop. By Prof. E. S. Salmon and W. M. Ware. Pp. 28+4 plates. (Wye.) 6d.

Proceedings of the Royal Irish Academy. Vol. 37, Section B, No. 26: Seasonal Changes in Conifer Leaves, with special reference to Enzymes and Starch Formation. By Prof. Joseph Doyle and Phyllis Clinch. Pp. 373-414. 1s. Vol. 37, Section B, No. 27: The Relative Food Values of Brown and White Wheaten Flour, and their Comparative Potency for the Prevention of Xerophthalmia in Guinea-Pigs. By E. J. Sheehy. Pp. 415-425. 6d. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

City and County of Bristol: The Bristol Museum and Art Gallery. Report of the Museum and Art Gallery Committee for the Year ending 30th September 1927. Pp. 20+8 plates. (Bristol.)

Department of Scientific and Industrial Research. Report of the Building Research Board, with the Report of the Director of Building Research, for the Period ended 31st December 1926. Pp. v+118+6 plates. (London: H.M. Stationery Office.) 2s. net.

Board of Trade. Catalogue of the British Industries Fair, 1928, The White City, Shepherds Bush, London, W.12, February 20th-March 2nd. Organised by the Department of Overseas Trade. Special Overseas Advance edition. Pp. xvi+364+Ad.220. (London: Department of Overseas Trade.) 1s.

FOREIGN.

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 13: Statistics of State School Systems, 1924-1925. Pp. 54. 10 cents. Bulletin, 1927, No. 16: The Reading of Modern Foreign Languages: Extent to which those who have pursued French, German or Spanish in High School or in College or in both read these Languages after Graduation. By Prof. M. V. O'Shea. Pp. vii+78. 15 cents. Bulletin, 1927, No. 17: Typical Child Care and Parenthood Education in Home Economics Departments. By Emeline S. Whitcomb. Pp. v+62. 20 cents. Bulletin, 1927, No. 18: Public Education of Adults in the Years 1924-1926. By L. R. Alderman. Pp 26. 5 cents. Bulletin, 1927, No. 21: Public Evening Schools for Adults. By L. R. Alderman. Pp. 22. 5 cents. Bulletin, 1927, No. 25: Record of Current Educational Publications, comprising Publications received by the Bureau of Education during April-June 1927. Pp. 54. 10 cents. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Bulletin 792-C: The Tokiat-Tonsona Region, by Stephen R. Capps; Geologic Investigations in Northern Alaska, by Philip S. Smith. (Mineral Resources of Alaska, 1925-C.) Pp. ii+73-122+plates 2-4. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 568: Surface Water Supply of the United States, 1923. Part 6: Missouri River Basin. Pp. viii+395. 50 cents. Water-Supply Paper 570: Surface Water Supply of the United States, 1923. Part 10: The Great Basin. Pp. v+183. 25 cents. Water-Supply Paper 596-C: Ground Water in the Ordovician Rocks near Woodstock, Virginia. By George M. Hall. (Contributions to the Hydrology of the United States, 1927.) Pp. ii+45-66+plates 7-8. Water-Supply Paper 596-D: Quality of Water of Pecos River in Texas. By W. D. Collins and H. B. Riffenburg. (Contributions to the Hydrology of the United States, 1927.) Pp. ii+67-88+plate 9. (Washington, D.C.: Government Printing Office.)

Publikace Pražské Státní Hvezdarny. No. 4: Recherches sur les mouvements propres de 8502 étoiles. Par V. Nechvile. (Mémoire paru dans le Bulletin Astronomique, Tome 5, Fascicule 3.) Pp. 97. (Paris: Gauthier Villars et Cie.)

Spisy vydávané Přírodovědeckou Fakultou Masarykovy University: Publications de la Faculté des Sciences de l'Université Masaryk. Čís. 82: Náčrtek geologických poměrů v okolí Luhačovic se zřetelem na vznik jejich minerálních pramenů (Sur la situation géologique des environs de Luhačovice et l'origine de leurs sources minérales). Napsal J. Woldřich a J. Augusta. Pp. 17. Čís. 83: Příspěvek k analytickému studiu kyseliny dusité (Contribution à l'etude analytique de l'acide azoteux). Napsali J. V. Dubský a Arn. Okáč. Pp. 84. Čís. 84: On the Occurrence of Syphilis and Tuberculosis amongst Eskimos and Mixed Breeds of the North Coast of Labrador (A Contribution to the Question of the Extermination of Aboriginal Races). By Prof. V. Suk. Pp. 18. Čís. 85: Sur les *correspondances analytiques entre deux plans projectifs* (Deuxième partie). Par Otakar Borůvka. Pp. 34. Čís. 86: Zobecnění pojmu variety (Sur une généralisation de la notion de variete). Napsal Zdeněk Horák. Pp. 20. Čís. 87: Copský ohyb Tisy (Le détour de la Theiss près le Cop). Napsal Viktor Šauer. Pp. 18. Čís. 88: Příspěvek ke studiu tukového tělesa Chironomid I (Contribution à l'étude du corps adipeux des Chironomides I). Napsal O. Kriebel. Pp. 15. Čís. 89: Měření modulu pružnosti v tahu metodou dynamickou (Determination of the Elasticity Modulus of a Rod as Cantilever or with Loads by Dynamical Methods). Napsal Josef Zahradníček. Pp. 12. (Brno: A. Píša.)

Sborník Vysoké Školy Zemědělské v Brně, ČSR: Bulletin de l'École supérieure d'Agronomie, Brno, RČS. Sign. C10: Hltanové žlázy včely medonosné (Apis mellifica L.) (The Pharyngeal Glands of the Honeybee (Apis mellifica L.).) Napsal Štěpán Soudek. Pp. 63+8 tabulkami. Sign. C11: Měření povrchového napětí biologických tekutin v systému s látkou obdobnou protoplasmatu (The Measure of the Surface-Tension of the Biological Liquids in a System with Substance analogous to the Protoplasm). Napsali Jaroslav Krizenecky a Olga Dubska. Pp. 42. Sign. D6: Půdoznalecký průzkum lesního velkostatku Adamova vysoké školy zemědělské v Brně. Část prvá, pedogenetická (Examinations of Soils of Adamov, the Forest-Estate of the College of Forestry at Brno). Napsali Vaclav Novak a Ivan Zvorykin. Pp. 94. Sign. D7: Addenda ad floram Čechoslovakiae mycologicam III. Napsal Richard Picbauer. Pp. 25. (Brno: A. Píša.)

CATALOGUES.

Reichert, 1876-1926. List E7. Pp. 138. (Wien: C. Reichert.)

Mr. Murray's Quarterly List. January 1928. Pp. 32. (London: John Murray.)

A Catalogue of Important and Rare Books on Astronomy, Chemistry, Physics, Engineering, Electricity, Mathematics and Navigation. (No. 413.) Pp. 68. (London: Bernard Quaritch, Ltd.)

Catalogue of Interesting Works on Flowers, Shells, Insects and General Literature (including early editions of Bacon, Black, Byron, Johnson, Lamb, Masefield and others). Pp. 8. (London: John H. Knowles, 92 Solon Road, S.W.2.)

Catalogue of Interesting Items on Art, including an Original Drawing by Guilio Romano, circa 1510; useful Colour Prints and New Books; Birds, Insects and other Branches of Animated Nature; Botany and Horticulture, Voyages, Travels and General Literature. Pp. 16. (London: John H. Knowles, 92 Solon Road, S.W.2.)

Catalogue of Fine Chemical Products for Laboratory Use: including Organic and Inorganic Chemicals, Analytical Reagents, Standard Stains, Indicators. Pp. 180. (London: The British Drug Houses, Ltd.)

A Catalogue of Books published by the Syndics of the Cambridge University Press, 1928. Pp. xv+284. (London: Cambridge University Press.)

A Catalogue of General Literature, including History and Biography. (No. 440.) Pp. 20. (Cambridge: Bowes and Bowes.)

The Work Meter. Pp. 12. (London: Lewens and Wilkinson, Ltd.)

Hints on Gas Welding (Oxy-Acetylene Process). (Booklet No. 1.) Pp. 64. Hints on Oxygen Metal Cutting. (Booklet No. 2.) Pp. 64. 6d. Gas Welding and its Applications. (Booklet No. 4.) Pp. 36. (London: The British Oxygen Co., Ltd.)

Patents for Inventions: including some Useful Information on Trade Marks, Designs and Copyright. By Benj. T. King. Seventeenth edition. Pp. 16. (London: Kings Patent Agency, Ltd.)

Diary of Societies.

SATURDAY, JANUARY 21.

BRITISH MYCOLOGICAL SOCIETY (at University College), at 11 A.M.—Dr. E. J. Butler: Morphology of Catenaria in the Eggs of the Liver Fluke. —Miss M. M. Duke: The Genera Vermicularia and Colletotrichum.—N. C. Preston: A Cercospora Leaf Spot of Turnip.—J. Ramsbottom: Mycological Nomenclature.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Southern District Meeting) (at Town Hall, Devizes), at 12 noon.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District) (at Town Hall, Sheffield), at 2.—W. J. Hadfield: Report of the Royal Commission on Land Drainage.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. R. W. Chambers: Some Tudor Biographers (1).

PHYSIOLOGICAL SOCIETY (in Department of Physiology, King's College), at 4.—Prof. J. Mellanby: The Preparation and Properties of Secretin.—

D. T. Barry: Cardio-inhibitor Threshold of Vagus in Relation to *Perfusion Pressure*.—*H. Dunlop: The Duration of the Action of* Pituitary Extract on the Circulation.—Prof. R. J. S. McDowall: The Production of High Blood Pressure by Small Doses of Histamine.—Prof. J. Barcroft: Effect of Pregnancy on the Size of the Spleen.—Demonstrations:—(*a*) The Recording of the Velocity of the Pulse Wave in Animals, (*b*) The Automatically Developing Camera, (*c*) A Simple Fluid Circulator, (*d*) A Convenient Anæsthetic Spray, by Prof. R. J. S. McDowall and R. A. Collier.—The Effect of the Circulation on the Electrical Resistance of the Skin, by H. B. A. R. Densham and H. M. Wills.—Specimens Illustrating the Comparative Physiology of the Epiglottis, by V. E. Negus.—The Estimation of Chlorides in Biological Fluids, by B. K. Christy and W. Robson.—Chromosome Linkage in Œnothera, by Prof. R. Ruggles Gates.—The Effect of *Temperature Gradients on the Early Development of the Frog and* Chick, by M. A. Taraisar and M. E. Shaw.—Stromuhr, by H. Barcroft.—Section of Exterised Intestine, by Prof. J. Barcroft.

HULL ASSOCIATION OF ENGINEERS (at Technical College, Hull), at 7.15.—L. C. Perkin: Gyroscopic Aids to Navigation.

MONDAY, JANUARY 23.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Influence Exerted by the Thyroid and Parathyroid Glands on the Growth of the Body.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 6.30.—C. G. Bainbridge: Cutting Steel and Iron with Oxygen.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—E. W. Dorey and C. S. Buyers: Discussion on Power Factor Correction.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—A. H. Law and J. P. Chittenden: Higher Steam Pressures and their Application to the Steam Turbine.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—W. Ellerd-Styles: Large Electric Baking Ovens.

INSTITUTION OF WELDING ENGINEERS (at Caxton Hall, Westminster), at 7.30.—A. E. Plumstead: Electric Welding Repairs to Inflated Gasholders.

ROYAL SOCIETY OF ARTS, at 8.—Dr. A. E. Dunstan: The Scientific Foundation of the Refining of Petroleum (Cantor Lectures) (2).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—A. Bulleid: On Apical Infection.—H. P. Baylis: Case of Necrosis of the Mandible.—W. Rushton: An Abnormally Small Premolar.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—President's Address and Presentation of Prizes.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Capt. C. J. Morris: *Some Valleys and Glaciers of Hunza.*

TUESDAY, JANUARY 24.

ROYAL DUBLIN SOCIETY (in Science Room, Ball's Bridge, Dublin), at 4.15.—Dr. J. H. J. Poole: Atomic Mechanics.

INSTITUTE OF CHEMISTRY (Bristol Section) (jointly with Bristol University Chemical Society), at 5.—Prof. A. Smithells: What has become of Inorganic Chemistry?

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—P. R. Coursey: The Development of Dielectrics for Electrical Condensers (2).

INSTITUTION OF CIVIL ENGINEERS, at 6.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Leeds University), at 7.—Dr. S. Z. de Ferranti: Electricity in the Service of Man (Faraday Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (jointly with Institution of Post Office Electrical Engineers) (at Milton Hall, Manchester), at 7.—H. C. Gunton: Recent Applications of Power in the Post Office.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—Capt. G. I. Finch: Mountaineering Photography.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Exhibition of Opaque Objects under Various Methods of Illumination.

ROYAL ANTHROPOLOGICAL INSTITUTE (Anniversary Meeting), at 8.30.—H. J. E. Peake: Presidential Address.

ILLUMINATING ENGINEERING SOCIETY.—Discussion on Various Problems in Illuminating Engineering.

WEDNESDAY, JANUARY 25.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.30.—Dr. G. Carter: Tests for Drunkenness, particularly in Relation to Motor Accidents.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases, Dermatology, and Comparative Medicine Sections), at 5.—Special Discussion on Cutaneous Mycoses in the Tropics. Opener: J. Ramsbottom (for the Section of Tropical Diseases).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Present Position of Knowledge Regarding the Manner in which Sex Glands Exert their Influence on the Growth of the Body as a Whole and on its Special Parts and Organs.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. J. K. Charlesworth: The Glacial Retreat from Central and Southern Ireland.

GLASGOW UNIVERSITY ALCHEMISTS' CLUB (at Glasgow), at 7.30.—Prof. A. Findlay: The Appeal of Science.

SOCIETY OF DYERS AND COLOURISTS (Midlands Section) (jointly with Foreman Dyers' Guild) (at Globe Hotel, Leicester), at 7.45.—G. H. Ellis: Dyeing Hosiery containing Celanese.

ROYAL SOCIETY OF ARTS, at 8.—H. de Koningh: Enamels.

EUGENICS SOCIETY (at Linnean Society), at 8.—R. B. Kerr, Dr. F. C. S. Schiller, and others: Super-men and Sub-men.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Medical Society of London, 11 Chandos Street, W.), at 8.30.—Dr. D. N. Hardcastle: A Physiological Approach to the Problem of the Unconscious.

THURSDAY, JANUARY 26.

ROYAL SOCIETY, at 4.30.—Prof. F. Horton, Dr. A. C. Davies, and U. Andrewes: Critical Potentials for Soft X-Ray Excitation.—H. Gough: The Behaviour of a Single Crystal of α-Iron Subjected to Alternating Torsional Stresses.—R. W. James, I. Waller, and D. R. Hartree: An Investigation into the Existence of Zero Point Energy in the Rock Salt Lattice by an X-Ray Diffraction Method.—*To be read by title only*:—Dr. H. T. Flint and J. W. Fisher: The Fundamental Equation of Wave Mechanics and the Metrics of Space.—B. Swirles: The Internal Conversion of γ-Rays.—A. Muller: On the Input Limit of an X-Ray Tube with a Circular Focus.—J. E. Sears, W. H. Johnson, and H. L. P. Jolly: A New Determination of the Imperial Standard Yard to the International Prototype Metre.—Dr. L. F. Bates: The Specific Heats of Ferromagnetic Substances.—Dr. W. Jevons: The Ultra-Violet Band System of Carbon Monosulphide, and its Relation to those of Carbon Monoxide (the 4th Positive Bands) and Silicon Monoxide.—Dr. H. T. Flint: Relativity and the Quantum Theory.—N. K. Adam: Note on the Explanation of a so-called Intertraction Phenomenon.—B. F. J. Schonland: (*a*) The Polarity of Thunderstorms; (*b*) The Interchange of Electricity between Thunderclouds and the Earth.—Prof. E. V. Appleton and J. A. Ratcliffe: On a Method of Determining the State of Polarity of Downcoming Wireless Waves.—H. Glauert: The Effect of Compressibility on the Lift of an Aerofoil.—Dr. A. T. Doodson: The Analysis of Tidal Observations.—H. R. Lang: On the Measurement of the Specific Heat of Aniline with Temperature, using the Continuous Flow Electric Method.—Prof. T. H. Havelock: Wave Resistance.—K. Yardley: An X-Ray Study of some Simple Derivatives of Ethane. Parts I. and II.

ROYAL SOCIETY OF MEDICINE (Balneology Section), at 5.—Dr. A. Schott: Carbon Dioxide *Thermo-saline Springs* in the Light of Modern Research.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. F. Thorpe: The Significance of Unsaturation in Carbon Compounds (2).

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—R. J. Mitchell P. A. Ralli, and Capt. G. S. Wilkinson: Schneider Trophy Machine Design.

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Town Hall, Bethnal Green, E.2), at 8.—Dr. Marie Stopes: The Ideals and Practice of Constructive Birth Control.

BRITISH PSYCHOLOGICAL SOCIETY (General Section and Education Section) (at 32 Upper Bedford Place, W.C.1), at 8.30.—Dr. O. Decroly: La Globalisation dans l'Écriture et la Lecture (Lecture).

INSTITUTION OF THE RUBBER INDUSTRY (Manchester Section).—Dr. W. J. S. Naunton: The Proper Use of Organic Colours in Soft and Hard Rubber.

FRIDAY, JANUARY 27.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: *A Review of the Evidence for Including the Suprarenal and Pineal* Glands among the Controllers of Growth.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Newcastle-on-Tyne), at 6.—J. L. Taylor: Ship Vibration Periods.

SOCIETY OF DYERS AND COLOURISTS (jointly with Society of Chemical Industry) (Chemical Engineering Group) (at Dyers' Hall, E.C.), at 6.45.—A. I. Hatfield: Dry Cleaning and Finishing Machinery.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section), at 7.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—C. H. Faris: Applications of Electro-Chemical Deposits of Metals to Engineering Purposes.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—R. H. Allen: *Powdered Fuel for Boiler Firing.*

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7.30.—J. C. Buchanan: The Metal Aeroplane.

ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Dr. J. E. McCartney: Some Observations on Diphtheria Carriers.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Miss D. A. E. Garrod: Prehistoric Cave Art.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at St. Thomas' Cafe, Swansea).—S. Robson: Paper.

SOCIETY OF DYERS AND COLOURISTS.

SATURDAY, JANUARY 28.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—D. W. Baron: Machine Mining at Ashington Colliery.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. R. W. Chambers: Some Tudor Biographers (2).

PUBLIC LECTURES.

SATURDAY, JANUARY 21.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Stoneworking in Ancient Egypt.

MONDAY, JANUARY 23.

GRESHAM COLLEGE, at 6.—G. P. Bailey: Modern Science and Daily Life: *Coal and Coal Tar.*

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—Prof. J. B. Buxton: Some Diseases of Pigs.

TUESDAY, JANUARY 24.

KING'S COLLEGE, at 5.30.—R. P. Wallis: Steam Boiler Plant. (Succeeding Lectures on Jan. 31 and Feb. 7.)

GRESHAM COLLEGE (Basinghall Street), at 6.—Sir Robert Armstrong-Jones: Physic. (Succeeding Lectures on Jan. 25, 26, and 27.)

UNIVERSITY OF LEEDS, at 8.—Prof. E. H. Davies: Australian Aboriginal Songs.

SATURDAY, JANUARY 28.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: Proofs of Evolution in Animals and Man.

SATURDAY, JANUARY 28, 1928.

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Science Teaching in England.[1]

THE inclusion of the history of science in the curriculum of higher educational institutions although very belated, is on many grounds warmly to be welcomed, and there appears to be no reason why its complement, the history of science teaching, should not also be given a place, particularly in the time-table of the future science teacher. At first sight it seems somewhat strange to speak of the history of science teaching, unless we use the word 'science' in a very wide sense; for the teaching of positive, experimental science is of such recent growth that it can scarcely claim to have a history; but what it lacks in age it makes up in importance, at least as a sidelight on the development of the scientific spirit. This is evidently the view of Miss Turner, who, in a volume recently published upon science teaching in England, has devoted only about one-half of her text to the history of teaching proper; her aim has been "to indicate in outline the growth of the scientific spirit in England, and the relationship of that growth to the development of a system of education into which the teaching of science gradually became incorporated." For this reason she transports us back in time to Thomas Aquinas, Roger Bacon, and Descartes, whose eminence as philosophical thinkers and writers was in no way matched by their achievements as scientific investigators, and who in the light of modern developments can scarcely be regarded as science teachers.

Apart from the writing of books and treatises, it may be said that systematic teaching of experimental science did not exist until the latter half of the nineteenth century. Teaching before that time was confined to a few private individuals, whose names have mostly been forgotten, and to such pioneering bodies as the Royal Society and the Royal Institution, the results of whose labours must at the time have been very small. The first educational movement that struck at the esoteric character of science was the founding of Mechanics' Institutes early in the nineteenth century, and this was supplemented later by the formation of local literary and scientific institutions for the express purpose of popularising literature and science.

In reading Miss Turner's interesting sketch of the dawn of science teaching in England, one cannot fail to be impressed by the extraordinary retarding power of tradition, especially in the ancient and pious foundations of Oxford and Cambridge and

[1] History of Science Teaching in England. By D. M. Turner. Pp. x+208. (London: Chapman and Hall, Ltd., 1927.) 7s. 6d. net.

in the great public schools. Although isolated attempts were made to teach experimental science in Oxford so early as the year 1704, it was not, we are told, until the second half of the nineteenth century that science secured a recognised place in the universities and a standard of academic teaching became established. Those early giants, Dalton, Young, Robert Brown, Darwin, Joule, Davy, and Faraday, received no training in experimental methods; and even the great mathematical physicists, Green, Stokes, Clerk Maxwell, and Kelvin, had no chance to do experimental work while they were at Cambridge. The backwardness of university science teaching in those days must not be charged to the investigators themselves, but to those in authority, whose policy seems to have been based upon the Platonic injunction of pursuing astronomy with the help of problems, like geometry, and of letting the heavenly bodies alone. On the whole, it must be confessed that Oxford and Cambridge played a very minor, if not an inglorious, part in the dissemination of natural knowledge; that task was left to the Mechanics' Institutes, local scientific societies, private individuals, and later on to the Royal College of Chemistry and the School of Mines. Under the lead of Huxley the last-named did really effective work in bringing science within reach of the masses.

The course of events in the schools was very similar to that in the ancient universities, the dead hand of tradition inhibiting any tendency to advance. The grammar schools and their derivatives, the nine great public schools, turned a deaf ear to the claims of science until well on in the nineteenth century, and it was only near its close that systematic instruction in science became at all general. Later developments are within the experience of most living teachers, but the recording of them was well worth while, if only as a guide for future workers. Some disappointment will, however, be felt that no attempt is made to use the past for illuminating the present by reference to the difficulties and disabilities of present-day science-teaching, and to indicate solvents for removing some of the blots that still disfigure the educational escutcheon. Miss Turner's story, illustrating as it does that inertia to the very idea of change is among the most characteristic qualities of the academic mind, nevertheless shows clearly that the thoughts of men do widen, and that therefore we should attempt to discern the lines along which future advance will proceed, so that we may try to facilitate its progress. Much excellent work is being done in our secondary schools; there is also some that is unworthy of the name either of science or of education; and there is a large intermediate class of teaching which is ineffective for one or more reasons; it may be too academic; it may be crippled and despiritualised by fear of the examination bogy; and what is still more important, the general organisation of the school may handicap or stultify the best efforts of the most gifted teachers.

Although lip-service may be done to science in the prospectus and at the annual prize-giving, the classical tradition still holds undisputed sway in too many of our schools, where the classical side is recruited mainly from the most promising pupils, whose success in after-life is claimed as convincing proof of the superiority of gerund-grinding and the study of grammatical forms. What hope is there of progress? History answers that we must look to the man rather than to the machine. In the past, reforms have been effected by men like Huxley, Clerk Maxwell, and Sanderson of Oundle, who combined high ability with outstanding fearlessness of character. It is to schools like Sanderson's Oundle, which do not fear to break with tradition and yet retain those character-forming elements that constitute the pride and justification of our great public schools, that we must look to supply the innovators and catalysers that our educational system still requires.

Primitive Marriage and Kinship.

(1) *The Mothers: a Study of the Origins of Sentiments and Institutions.* By Robert Briffault. In 3 volumes. Vol. 1. Pp. xix+781. Vol. 2. Pp. xx+789. Vol. 3. Pp. xv+841. (London: George Allen and Unwin, Ltd.; New York: The Macmillan Co., 1927.) Each vol. 25*s*. net.

(2) *The Mystic Rose: a Study of Primitive Marriage and of Primitive Thought in its Bearing on Marriage.* By Ernest Crawley. A new edition, revised and greatly enlarged by Theodore Besterman. In 2 volumes. Vol. 1. Pp. xx+375. Vol. 2. Pp. vii+340. (London: Methuen and Co., Ltd., 1927.) 30*s*. net.

STUDENTS of primitive mankind still indulge too frequently in bitter and futile controversy; their reputation on this score is deservedly bad, and anthropology, I fear, could well be described as the study of rude man by rude people. Among the various hotly discussed subjects, perhaps the most contentious is primitive sexual life and mating—the much disputed 'marriage of the missing link.'

The appearance of two remarkable books on this

subject, each standing for one side of the vast controversy, is a notable event, and affords a good opportunity for a statement of the problem as it now stands. One of the books, Crawley's "Mystic Rose," well brought up-to-date by Mr. Besterman, is exactly twenty-five years old, yet it is not only entirely fresh, but also in many respects it is bound to lead modern research for yet another quarter of a century. The other book, Mr. Briffault's "The Mothers"—in size and erudition an imposing achievement—leads us back to the early 'seventies, to the speculations of Bachofen, Morgan, and MacLennan. It is, in fact, an attempt to revive their now antiquated point of view that mother-right combined with sexual communism was the original form of organisation. Between them these two books represent a long span of anthropological history; the new contribution its past and the old one its future; while both mirror the present deadlock.

The anthropology of to-day can be divided into two camps on the issue of primitive marriage and kinship: those who believe in original monogamy and those who uphold the hypothesis of promiscuity. Was primitive man sexually promiscuous, or was he monogamous? Was he a thoroughgoing communist in wives and chattels, or a possessive individualist? Was he complaisant or jealous? Was it patriarchy or mother-right which shaped early institutions? Range Andrew Lang, Westermarck, Crawley, Lowie, and Kroeber on one side, and Frazer, Hartland, Rivers, Müller-Lyer on the other, and the latter will vote for communism, group-marriage, mother-right, and complaisance in the 'missing link' or primitive man, and the former for his monogamy, jealousy, and private possession.

(1) In my opinion, the problem has been distorted by this black-and-white, yea-or-nay treatment, and I regard it as the main defect in Mr. Briffault's book that he fights on the side of communism, as well as of mother-right, without compromise or reservation. The main thesis of the book is that mother-right was the source of social organisation, that male influence was entirely irrelevant in the dawn of culture, and that kinship, political organisation, the beginnings of law, economic life, magic, and religion were created and completely dominated by woman. To establish this, Mr. Briffault maintains that the maternal instinct is the sole origin of all tender emotions, hence also of all human organisation. Sexual love, on the other hand, leads to cruelty rather than to affection, and has been socially and culturally barren. "The mothers are the basis and the bond of the primitive social group. . . . The male takes no share in the rearing of the young. . . . Fatherhood does not exist."

It is difficult, perhaps, to reconcile this conception of the mother as a source of all affection and all social cohesion with the use which Mr. Briffault makes of her when he tries to explain the origins of exogamy by brutal expulsion of the males. In this context he describes her as: "a fierce enough wild animal . . . uncontrolled and violent . . . an object of horror . . . to the young male, terror-stricken by the anger of a despotic mother." The book is full of such provoking and fantastic exaggerations.

Mr. Briffault leaves no place whatever for the male in early culture. Such extremely important institutions as age grades, secret societies, initiation ceremonies and male political organisations are completely ignored in this work. Again, the rôle of the mother's brother in mother-right is scarcely accounted for; yet a male who intrudes into the very heart of maternal institutions is a formidable difficulty for the champion of an exclusively female culture. Avunculate, one of the most important features of matrilineal societies, is scarcely touched upon by the author—the word is not in the index.

The author then proceeds to prove that group marriage and sex communism exist, and in the course of this discussion commits himself to such extraordinary statements as that "among animals the maternal and derivative, parental, filial, and fraternal instincts operate in accordance with the 'classificatory,' and not with the 'descriptive' system of relationship. It would appear that it is the former that is in a biological sense 'natural,' and the latter which is 'artificial.'" The classificatory system in fact seems so 'natural' to Mr. Briffault that he does not discuss it at all, nor does he, in the whole three volumes, give any analysis of primitive kinship, a gap really astounding in a work dealing with mother-right—which is after all but one aspect of primitive kinship.

In the following chapters Mr. Briffault informs us that "girls and women who are not married are under no restrictions as to their sexual relations. . . . To that rule there does not exist any known exception." Since we know that, according to Mr. Briffault, married women also indulge in 'group-marriage' and other forms of 'licence,' continence and individual sexual relations seem to have been completely absent from primitive life. As a matter of fact, the statement quoted is a most

misleading generalisation, inaccurate in wording, unsupported by evidence, and based upon a fundamental misconception of human marriage and sexuality. After an account, given from his point of view, of primitive sex communism, group-marriage, sexual selection, and the various manners of concluding marriage, Mr. Briffault proceeds to attribute to woman the discovery of totemism, witchcraft and religion.

It would be easy to indict "The Mothers" for its dogmatic and one-sided affirmations; for the straining of evidence, sometimes to the breaking point; for unsatisfactory definitions—or absence thereof—in such capital concepts as marriage, communism, kinship, avunculate, and mother-right. Much space is wasted in futile controversy; above all in virulent attacks upon Prof. Westermarck, generally by first distorting his views and then destroying them. On the other hand, the contributions of Crawley and Sidney Hartland, and the new and important work of Schmidt and Koppers, are completely ignored. Briffault's three enormous volumes might almost be called an 'encyclopædia of matrimonial errors.' The work, however, will be useful to a student, even though he reject most of its conclusions; for it gives a clear, well-written, and certainly unreserved statement of one side of the main problem of anthropology. To the amateur it will prove attractive reading as an introduction; and will be the more useful for its dramatic, strong, and effective narrative, which rivets the attention more forcefully and leaves a sharper imprint upon the memory than a well-balanced, hence less colourful, account might do.

As a contribution to science the work has one or two real merits. It is the most exhaustive though one-sided account of the influence of maternity upon the cultural rôle of woman. In the discussion of that subject the author clearly sees and, to the best of his ability, discusses the relation of innate endowment to social institutions in the shaping of human nature; and, in my opinion, anthropology will in the future have to be more concerned with the place of culture within biological development and with the relation of instinct to institution, than with questions of 'origin,' 'evolution,' 'history,' or 'diffusion.'

(2) The biological foundations of culture, which Mr. Briffault attempts to consider in his new work, have already been fully discussed in the "Mystic Rose," where the psychology of human relations is explained by what Crawley has termed *physiological thought*. The book sets out to discuss the many strange customs and institutions which centre round sexual life—the couvade, sexual taboos, various avoidances, and ceremonies of marriage.

Crawley resolutely rejects all explanations in terms of survival from such original conditions of mankind as 'sexual communism,' 'mother-right,' and the total eclipse of the male sex. He regards these as imaginary fantasies constructed against all evidence. He also maintains that the "indiscriminate and careless use of the terms *survival* and *rudiments*" is one of the main sources of anthropological error. On both points anthropology will, in my opinion, have to follow his lead and become inspired by his methods.

The explanation of savage custom and institutions must be given in terms of primitive thought. When Crawley, in his brilliant analysis of savage mentality, declares that "primitive thinking does not distinguish between the natural and the supernatural, between subjective and objective reality," his wording is not quite satisfactory; yet even in this slight misrepresentation of what he terms "primitive logic," Crawley, in forestalling the theories of Lévy-Bruhl, Danzel, Vierkandt, and their followers, must be regarded as the pioneer of modern developments of the problem of primitive psychology. He himself, however, has eschewed the extravagances of some of his successors. He does not commit the fallacy of assuming that the savage has a mind different from that of civilised man. ". . . Human nature remains fundamentally primitive. . . . Primitive ideas . . . spring eternally from permanent functional causes. . . . Ordinary universal human ideas, chiefly connected with functional needs, produce the same results in all ages; and many so-called survivals, which have on the face of them too much vitality to be mere fossil remains, at once receive a scientific explanation which is more than antiquarian." These statements strike the keynote of the soundest developments in modern anthropology. In laying down this point of view, and in carrying it through consistently, Crawley has laid the foundations for the scientific treatment of primitive sexual and social relations.

The main form which "physiological thought" takes in the primitive mind, that is, in the human mind as we find it universally, is a strong apprehension of danger arising from contact with other human beings, especially when there is an element of the abnormal or unusual in the relation. Strangers, people in critical condition—such as sickness, death, or functional crisis—and, above all, people of the other sex, are surrounded with an

aura of supernatural fear. In savage culture such dangers are met by two devices: the taboo, and the ritual breaking of it.

Taboo is considered by Crawley as an inevitable by-product of human psychology; and, in a masterly survey of primitive social relations, we are shown how the various imperatives and prohibitions arise naturally out of savage life and savage outlook. Crawley constructs no hypotheses, invokes no *deus ex machina*—he explains quaint features and unrelated details in terms of intelligible and fundamental fact; he introduces order, he links up apparently disconnected phenomena and transforms the strange and unknown welter of "primitive superstition" into a familiar and comprehensible scheme of essentially human behaviour.

The taboo between men and women in its various aspects is treated against the background of mixed attraction and fear, of distrust undermining love—an attitude which is shown to dominate the relations between the two sexes. In this Crawley has anticipated the various theories of primitive society based on the principle of sex antagonism, theories set forth by Heape and several other writers long after the first edition of the "Mystic Rose" was published. In Crawley's work we also become acquainted for the first time with that emotional complexity underlying all social relations, especially as between men and women, which has been systematically worked out by A. F. Shand in his theory of sentiment ("The Foundations of Character"). Under the title of 'ambivalence' we have had similar phenomena dished up in a somewhat distorted shape in psycho-analytic literature. Crawley, in fact, can be described as the sane and sober forerunner of psycho-analysis, which, when the "Mystic Rose" was written, was unknown beyond a narrow circle of Viennese practitioners. It must also be remembered that psycho-analysis did not turn its attention to problems of primitive culture until a decade after the present book was first published. The "Mystic Rose," in the due emphasis which it places on sex, in its clear and courageous, but never fantastic or overheated, interest in that impulse, can be placed side by side with Havelock Ellis's "Psychology of Sex" as a pioneer in modern, scientific treatment of human love and mating.

In his theory of ritual and sacrament as mechanisms of breaking the taboo; in his theory of union; in his description of change and exchange; and in his analysis of the ritual in vital crises, Crawley has been a forerunner of several now developed branches of anthropology. To him can be attributed the first statement of the theory of *rites de passage*, afterwards so successfully developed by Schurtz, van Gennep, and Hutton Webster. He was the first to regard the sacrilisation of crises of life as the main function of religion—a theory to which he returned in his later work ("The Tree of Life"). His doctrines of change and exchange, of reciprocity and the principle of contact, are akin to the views of the French sociological school, especially of Durkheim, Hubert, Mauss, and Davy.

Finally, in the last part, a penetrating and original analysis is given of primitive kinship and relationship: that pivot problem and eternal puzzle of the anthropologist. In my opinion it ranks side by side with the first few chapters of Westermarck's "History of Human Marriage" as the best treatment of kinship yet given. Had such writers as the late Dr. Rivers, Mr. Briffault, and other latter-day Morganians read, digested, and assimilated the last three chapters of the "Mystic Rose," we would have had better field-work and fewer speculations about 'anomalous marriages,' 'group-motherhood,' and 'savage communism.' Even on this last point, Crawley, though not especially interested in economics, had a sound and a realistic view. All anthropological evidence, he maintains, tends "to disprove the common idea that early society had a communistic and socialistic character. The 'rights' of the individual in property, marriage, and everything else were never more clearly defined than by primitive man." Recently we have been told by a great authority that the Melanesians are 'communistic.' That such a view is based on superficial observation, and that Crawley is right here, as almost everywhere else, I have attempted to prove ("Crime and Custom in Savage Society").

The foundations of Crawley's work are so sound, so firmly established in the bedrock of human nature rightly understood, and of human culture correctly interpreted, that anthropologists will have to build on them for generations to come. To show this, one aspect of his views might be further developed in this place. Crawley has taken the primitive conception of the danger in sexual selection as the fundamental and irreducible datum. He speaks of "that difference of sex and of sexual characters which renders mutual sympathy and understanding more or less difficult"; and he adds: "woman is one of the last things to be understood by man." Again: ". . . woman is different from man, and this difference has had the same religious results as have attended other

things which man does not understand." He also speaks of "the instinctive separation of the sexes hardening into tradition and finally made the subject of taboo."

Now I think that here it is possible for modern anthropology to go a step further and to interpret the psychological attitude of primitive man by its cultural function. I maintain that sex is regarded as dangerous by the savage, that it is tabooed and ritualised, surrounded by moral and legal norms—not because of any superstition of primitive man, or emotional view of or instinct about strangeness, but for the simple reason that *sex really is dangerous*.

The sexual impulse has to be experimental if it is to be selective; and it has to be selective if it is to lead to the mating of best with best. This is the eugenic principle which I believe governs human marriage as well as animal mating. Hence sexual jealousy and competition is to be found in human societies, and it harbours serious disruptive forces for any social group living in close contact. In animal societies, rut not only allows the law of battle and sexual selection to operate in especially favourable circumstances, but it also circumscribes the duration of the disruptive impulse and thus eliminates most of its dangers. In man rut is absent, and sex holds him in permanent readiness and tension. Cultural regulations, the various taboos and barriers step in and fetter him, where natural endowment has left him freer than the beast. They safeguard the family by the prohibition of incest, the clan by rules of exogamy, and the bonds of marriage by the ban on adultery and what might be called the principle of legitimacy. This argument cannot be fully developed or substantiated by evidence in this place; nor is it necessary for me to do so, since my views are developed at some length elsewhere ("Sex and Repression in Savage Society").

In human culture, however, no physical force is sufficient without moral support; no social regulations, however strongly backed by executive power, can be effective without mental assent. The social and cultural rules which separate primitive man and woman in daily existence, at initiation, during the crises of life, in economic occupations, and within certain social groups, cannot stand without the support of some system of thought and belief. Here, indeed, we find all those ideas which express the danger of sex—the ideas of evil and sin—at the very core of love and passion; the conviction that highest happiness in erotic union can only be obtained at the cost of infinite pains and precautions; belief, in short, that sex is religiously sacred, *sacer*, that is, at the same time holy and polluting. The universally human conception of sex must be explained, I think, by its function within culture rather than by mere reference to primitive psychology and the early conditions of life. The sexual taboo, then, and the ideas upon which it rests, appear to us indispensable corollaries of culture and of the influence of this on the increased plasticity of instinct which, since in man it has become more free, more experimental, and therefore more dangerous than in the animal, needs elaborate regulation. The barriers imposed upon sex by culture—that is, the taboos and the correlated primitive conception of sex dangers—appear to us as an inevitable by-product of the change wrought in human endowment by the passage from the state of Nature to that of culture.

I hasten to add that this functional view is implied at many points in Crawley's argument, though it is nowhere clearly formulated by him. It is really implicit in his own concept of the primitive *Weltanschauung*, in which beliefs and ideas do not exist as useless 'idle survivals,' not as 'speculations of rude philosophers,' or even as 'mistaken associations of ideas.' Crawley treats these simple and often quaint 'savage superstitions' as what they really are: life forces, indispensable moral values which shape the destinies of mankind with a determinism as binding though not as rigid as that which obtains in the physical world. Thus Crawley has given us in the "Mystic Rose," what is, perhaps, the first truly scientific work of comparative anthropology, and he must be regarded as one of the founders of what is now known as the functional method of modern anthropology.

B. MALINOWSKI.

Electrical Research and Development.

The Interaction of Pure Scientific Research and Electrical Engineering Practice: a Course of Advanced Lectures delivered before the University of London, October and November 1926. By Dr. J. A. Fleming. Pp. x + 235. (London: Constable and Co., Ltd., 1927.) 15s. net.

THIS book by Dr. Fleming is a delightful record of the research, discovery, and development which has lain behind the infusion of electricity into the life of civilised lands over the last fifty years. It is written with the intimate knowledge and enthusiasm of one who has himself been a worker and a keen contemporary observer through-

out the period, and whose name will always be associated with some of its pioneer achievements. But perhaps of even more importance, Dr. Fleming has been unrivalled in the way in which he has interpreted the results of research to electrical engineers, applying always the latest discovery to the practical everyday technical problems, and expressing results in engineering units and magnitudes. He always sees the romance in every new theory or discovery, and seeks to make others see it too.

The book under review is characteristic. To those who know Dr. Fleming, more cannot be said. The reader is taken rapidly from one subject to another. Insulation, magnetism, thermionics, telephony, arcs, sparks, and glow discharges, radio, surges and pressure rises, electro-chemistry, and many other matters, are passed in review. The main historical features of each are traced, but the author hastens always to the latest development of each subject and leaves with the reader a vignette picture of the art as we know it to-day.

Dealing as he does with so many phases of electrical engineering, Dr. Fleming is careful not to assume on the part of the reader expert knowledge in any. His object is clearly to interest each branch of the profession in the advances of the others, and to show how almost every development has been the result of scientific research; research, not always with a deliberate objective in view, but always with a keen look-out for the unexpected and the anomalous.

Such a book would be easy to criticise. Where names and origins are mentioned freely, where there are a few pages only for handling each large subject, there must be important omissions and often lack of balance. The part in advances played by Great Britain is certainly not minimised. Electrical machinery and plant is scarcely touched upon, although its evolution has resulted from the same research and investigatory activity as in other branches. Nor is there in the book any effort to analyse the mass of examples with the view of drawing conclusions as to how research can best be encouraged or directed. One can quite believe that the attempt would be baffling. The spirit of research bloweth where it listeth; and it is the man of imagination and observation who produces results. Such have been found in all walks of life—in the factory as well as in the university—and it would be very difficult to deduce, from the evidence before us, rules for securing results. The few generalisations which Dr. Fleming allows himself are to be found in the concluding pages and are worth special note, for they are the mature conclusions of one who has worked long and hard and has a right to judge. Perhaps we may quote a few sentences:

"Many of the problems which invite inquiry lie on the borderland of two or three sciences. These are best dealt with by carefully organised team work in which specially trained workers in the respective sciences have a share and co-operate and, in any case, call for a scientific education not framed on too specialist lines." And again: "Genius cannot be produced at will. . . . Let us see to it, then, that whenever found, it shall be given adequate opportunity for labours which, even if they seem entirely destitute of practical value at the moment, will certainly yield the fruit at some future time in divers and very unexpected ways."

This book should please all who peruse it. If a reader should feel that he already knows well any part in which he is expert, there will be much with which he is less familiar that will fascinate and instruct.

Our Bookshelf.

New Year's Day: the Story of the Calendar. By S. H. Hooke. (The Beginning of Things Series.) Pp. vi + 89. (London: Gerald Howe, Ltd., 1927.) 2*s.* 6*d.* net.

The Golden Age: the Story of Human Nature. By H. J. Massingham. (The Beginning of Things Series.) Pp. vii + 88. (London: Gerald Howe, Ltd., 1927.) 2*s.* 6*d.* net.

Corn from Egypt: the Beginning of Agriculture. By Dr. Maurice Gompertz. (The Beginning of Things Series.) Pp. vii + 88. (London: Gerald Howe, Ltd., 1927.) 2*s.* 6*d.* net.

THESE three little books form part of an interesting series of popularisation dealing with the early history of civilisation. Mr. Hooke in "New Year's Day" traces the history of the calendar and describes the principal calendrical systems which are or have been in use at different periods and in different parts of the world. Mr. Massingham's "Golden Age" is a book of a more philosophical type. It is a statement of the position in regard to primitive culture with which Mr. Perry has made us familiar, namely, that early man was a pacifist who has degenerated under the influence of advancing civilisation. It seeks to demonstrate that the views of classical writers on the Golden and succeeding ages were substantially correct. Mr. Massingham justifies his theory in the case of palæolithic man by an appeal to the 'faultless artistry' of the drawings in the French and Spanish caves—a psychological argument which the history of art would perhaps not bear out.

In "Corn from Egypt," Dr. Gompertz describes the development of agriculture. His attractively written and well-reasoned sketch is an exposition of the view that agriculture originated in Egypt.

While the evidence is still too uncertain to admit of any conclusion approaching finality, there are certain considerations in favour of a Mesopotamian origin to which Dr. Gompertz might have given fuller weight, and certain facts which he should have taken into account, such as the wheat discovered by the Weld-Blundell Expedition at Kish. Further, although Mesopotamian dating is not final, agricultural implements from Abu Shahrein may turn out to be as early as any from predynastic Egypt, while the undoubted occurrence of wild wheat and barley in Syria has to be weighed against the inferential attribution of the latter to Abyssinia. The evidence is given in summary in Mr. Harold Peake's presidential address last year to the Royal Anthropological Institute. The argument from the Isis-Osiris cult is no more in favour of an indigenous Egyptian origin than the Ea legend, which the author rejects as in favour of Mesopotamia. Osiris was not Egyptian in origin, but came from the north, while the Isis legend is connected with Byblos.

Memoirs of the Geological Survey of England and Wales. The Geology of the Southern Part of the South Staffordshire Coalfield (South of the Bentley Faults). By Talbot H. Whitehead and T. Eastwood. With contributions by Dr. T. Robertson. Pp. xi + 218 + 13 plates. (London: His Majesty's Stationery Office; Southampton: Ordnance Survey Office, 1927.) 6*s*. 6*d*. net.

WHEN Jukes wrote his classic memoir on the South Staffordshire Coalfield, the Thick Coal was being actively mined. To-day it is almost completely worked out, except in the concealed fields beyond the boundary faults, and the surface geology of much of the coalfield is that of tip-heaps and slag-mounds; nevertheless, the authors of the present memoir, under the scrupulous editorial guidance of Mr. T. C. Cantrill, have compiled a concise, yet detailed, account of the Productive Coal Measures, showing their variations, structures, and probable limits on the south and west. The marshalling of the scattered and often obscure data relating to these measures is very skilfully done. Numerous plates of vertical sections supplement the descriptions.

In view of the importance of a proper understanding of the cover overlying the Productive Series, now that any new coal-ventures must needs take place below them, there is a full treatment of the Upper Coal Measures, in which the authors include not only the Etruria, Halesowen, and Keele Groups, but also provisionally the Enville Beds and even the Clent and Warley Breccias. The Hopwas Breccia is, however, regarded as more closely related to the Trias. These conclusions are reached after a critical review of the data and of the interpretations advanced by other observers.

The re-survey has shown that contemporary movement directly related to pre-existing structural axes was going on during the deposition of the Productive, Etruria, and Halesowen Groups, so that the thicknesses vary considerably from place to place. The detailed mapping appears to have disproved Kay's contention that there is an unconformity below the Etruria Marls; and, on the other hand, it seems to have demonstrated that the Halesowen Group is locally unconformable.

The structure of the sub-Carboniferous floor and of the coalfield itself is fully discussed, and the repetition of movement along some of the structural lines is emphasised. A chapter is devoted to the underground extensions of the coalfield and another to the associated igneous rocks.

An innovation in the index may be noted with approval. The names of authors quoted in the text are printed in capitals, and in this way a separate bibliography is avoided. The whole book is a very careful piece of work that fully maintains the standard set by Jukes. L. J. W.

(1) *Vorlesungen über theoretische Mikrobiologie.* Von Prof. Dr. August Rippel. Pp. viii + 171. (Berlin: Julius Springer, 1927.) 6·90 gold marks.

(2) *The Principles of Practical Bacteriology: for Scientific Workers.* By J. H. Johnston and Dr. R. H. Simpson. Pp. viii + 110. (London: J. and A. Churchill, 1927.) 5*s*.

(3) *An Introduction to Laboratory Technique in Bacteriology.* By Prof. Max Levine. Pp. xii + 149. (New York: The Macmillan Co., 1927.) 5*s*. 6*d*. net.

(1) THIS excellent little book by the professor of agricultural bacteriology at the University of Göttingen is designed chiefly for the use of non-medical students requiring instruction in general bacteriology and particularly in the chemistry of bacterial growth. Of the thirty-four brief lecture-chapters in the book, more than a dozen are devoted to the study of bacterial enzymes and bacterial metabolism generally. Considerable knowledge of organic chemistry is essential for the full appreciation by the student of this portion of the work. The volume closes with a brief sketch of immunity problems and an etymological glossary of biological terms.

(2) It is often desirable that technical workers in fields not primarily bacteriological should have some elementary knowledge of the general characters of bacteria and the principles governing their investigation. It is to meet this demand that Messrs. Johnston and Simpson's small volume has been written. The basic principles of the subject are dealt with in a very simple way, and no attempt is made to give instruction in technique or to acquaint the reader with the different members of the bacterial species.

(3) Prof. Levine's book is based upon a laboratory course in elementary bacteriology at the Iowa State College, U.S.A. It is arranged in the form of a series of exercises covering the commoner phases of the subject. A list of materials required for each exercise is given, together with instructions, and a number of questions at the end designed to test the student's knowledge of what he has just performed. The scope of the book is limited to elementary general bacteriology, and does not extend to special branches of the subject.

Penrose's Annual: the Process Year Book and Review of the Graphic Arts. Edited by Wm. Gamble. Vol. 30. Pp. xvi + 160 + 68 + 59 plates. (London: Percy Lund, Humphries and Co., Ltd., 1928.) 8s. net.

THE business of Penrose and Co., with which this *Annual* has been associated from its commencement, has been acquired by the firm of Hunters, Ltd., and will henceforth be known as Hunter-Penrose, Ltd. Mr. Wm. Gamble retires from the business, but will continue to edit the *Annual*, so doubtless its character will be fully maintained. The present volume is on the same lines as those that have preceded it.

The editor in his introductory remarks pleads for a more kindly attitude toward the inventor, for a greater receptiveness of new ideas, and for a bolder enterprise. He finds little that is new to record, but a general if slow progress along the lines that have been indicated in previous years. Perhaps the most striking item is the use of chromium plating for printing surfaces. Chromium is harder than steel, indeed a hardened steel graver will not cut its surface, and it can scarcely be scratched by any form of mechanical abrasion. After 240,000 impressions had been taken, there was no visible deterioration in the prints or in the plate. Another plate was still in use after a run of five million printings.

Mr. Chas. T. Jacobi gives the seventh of his series of descriptions of private presses—The Golden Cockerel Press, which was projected in 1920, and issued its first volume in the following year. Specimens are given. Mr. Paulson Townsend contributes a well-illustrated article on the history of woodcuts and wood engraving. Mr. S. H. Horgan deals with the beginnings of half-tone, and gives a reproduction in facsimile of the first published example in the *New York Daily Graphic* of Mar. 4, 1880. There are many other articles, and a large number of illustrations that show the high standard of present-day process work.

The Principles of Pathology. By Dr. Charles Powell White. (Publications of the University of Manchester: Medical Series, No. 17.) Pp. x + 279. (Manchester: At the University Press; London: Longmans, Green and Co., Ltd., 1927.) 15s. net.

PATHOLOGY is a subject to which considerably more attention is paid in the medical curriculum than was the case fifteen years ago. The student, however, still tends to regard it as static rather than dynamic, and this error is not sufficiently corrected in books and in the post-mortem room. Dr. Powel White's "Principles of Pathology" is not a text-book devoted to the description of macroscopic and microscopic appearances; the subject is approached from the biological aspect, and causes and processes are considered rather than nature and appearances. A comparatively small volume, it must be somewhat dogmatic in style, and though this is no disadvantage to the student, it renders the author's views more open to criticism. The term 'diathesis,' which is now rarely used in clinical medicine, is employed to group a number of conditions ranging from hæmophilia to neurasthenia and the tendency to bed-sore formation in paralysed patients. Psycho-pathology is so unsettled that the application of this term to abnormal mental states simply obscures them further; and it seems scarcely advisable to include bed-sore formation, which is as readily explicable as is the severance of the skin by a knife.

Dr. Powell White, however, does not dogmatise in the attitude of a final authority. He writes rather to attract attention and to stimulate thought, and in this his book should be successful. It will certainly assist the student to regard pathology, not as the product of laboratory and microscope, but as a biological science.

The Infancy of Medicine: an Enquiry into the Influence of Folk-Lore upon the Evolution of Scientific Medicine. By Dr. Dan M'Kenzie. Pp. xiv + 421. (London: Macmillan and Co., Ltd., 1927.) 15s. net.

THIS work, which emanates from a prominent London otologist with whom the study of folk-lore plays the part of the violin of Ingres, constitutes an attempt to show in what manner and to what extent primitive thought has influenced the evolution of the science and art of medicine. The work, as we learn from the preface, is intended not only for the small section of the medical public interested in medical history, but also for all practitioners of medicine, in that it seeks to explain the more obscure workings of the partially educated lay mind in civilised communities as well as in the savage and semi-civilised races of the world.

The book is divided into two parts. The first consists of three chapters, devoted respectively to the evolution of the medical man, primitive pathology, and primitive treatment; while the second part, which forms the bulk of the work, contains fourteen chapters dealing with the evolution of animal and botanical remedies, astrology in medicine, the evolution of balneology, primitive surgery, and midwifery, various superstitions and practices connected with menstruation, impregnation, and pregnancy, circumcision and other mutilations. An extensive bibliography for each chapter is appended. The work, which shows a characteristic blend of scholarship and humour, will appeal alike to the medical man and the anthropologist.

General Chemistry: Theoretical and Descriptive. By Prof. Thomas P. M'Cutcheon and Prof. Harry Seltz. Pp. x + 415. (London: Chapman and Hall, Ltd., 1927.) 16s. net.

"THIS book has been designed for use in a course of General Chemistry based on a series of illustrated lectures and quiz hours, and for a text of reference for the student performing the laboratory work, which usually accompanies such a course." It has probably been of value for this purpose, but it cannot be commended for independent reading, and it is unlikely that it will find any extensive field of usefulness where 'quiz hours' are not the normal method of 'cramming.'

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Hydrogen Molecule.

RECENT experimental and theoretical work by Richardson, Witmer, Dieke and Hopfield, Hori, Burrau, Condon, Dennison, Sugiura, and others, makes possible a reasonably certain determination of the more important constants of the hydrogen molecule and molecule ion. In order to compare the results of different investigators, it is essential that these be calculated consistently according to some adopted interpretation, and with definite values of the basic constants. I should like especially to emphasise the necessity of distinguishing results in terms of the new wave mechanics from those in terms of the older quantum mechanics. Failure to make such a distinction has already led to a number of errors in the published literature.

In a paper which will appear shortly in the *Proc. Nat. Acad. Sci.*, I have given the more important details concerning such a recalculation and intercomparison of the available data for hydrogen. The purpose of the present communication is to examine critically the results and to consider certain additional facts and conclusions. *All* data and constants are given here in terms of the *old* mechanics. Transformation equations for the two systems are given in the paper just mentioned.

Richardson (*Proc. Roy. Soc.*, A, **115**, 528 ; 1927) has definitely identified the final (lower) state of his 'A' and 'B' bands with the initial 'B' state of the A-B ultra-violet bands of Dieke and Hopfield. With an assumed Rydberg formula for the upper levels of these two systems, one obtains 15·34 volts for the ionisation potential of the neutral molecule. This should be accurate to about 0·01 volt. Richardson believes that this value cannot be reconciled with the electrical determination of about 16 volts, but Condon has shown that such an apparent discrepancy is to be expected, and the chief object of the present work is to show that this lower value is entirely satisfactory.

If I_M and I'_M represent the ionisation potentials of the neutral and ionised hydrogen molecule respectively, D the normal heat of dissociation, and I the ionisation potential of the atom, then $I_M + I'_M = D + 2I_A$. Of these four quantities only I_A (= 13·54 volts) is accurately known. For the other three quantities we have the following data. The best value of D is 4·34 ± 0·1 volts from Witmer's extrapolation of the vibrational levels of the normal state. (Dieke and Hopfield's determination of 4·38 volts is based on a probable misinterpretation of the spectrograms, according to later unpublished work by Hopfield.) The best value of I'_M is 16·16 ± 0·03 volts, as calculated by Burrau (*Danske V. S. Math.-fys.*, **7**, No. 14; 1927). His result of 1·402 R (= 16·30 volts) is in terms of the *new* mechanics. Dr. E. U. Condon has directed my attention to the fact that, due to an error in one of Burrau's formulæ, the correcting factor (s^+) should be 0·14 volt, and not 0·07 volt as calculated by Burrau.

With I_M = 15·34 volts, there is just 0·08 volt discrepancy between the three suggested values. I believe it most probable that I_M and I'_M are correct, as given, and that D = 4·42 volts. The value of I_M = 15·34 volts can be checked also by means of the heats of dissociation in the various excited states of the molecule. In the case of every level for which data are available, the agreement, as shown in my longer paper, is remarkably good.

The recent work of Hori gives $0·48 \times 10^{-40}$ as a very trustworthy value of I_0, the moment of inertia of H_2 in the normal state, and this checks with Dennison's value from the specific heat curve. For the 'B' level only B_0 is reliably known, but with a reasonable assumption as to the value of α ($B_n = B_0 - \alpha n$), I obtain B_0 and finally $I_0 = 1·99 \times 10^{-40}$. This is just twice the value given by Richardson, but is the value to be expected in view of the very small magnitude of ω_0 for this level. The process by which Richardson calculates I_0 from known vibrational data, plus the value of α, but *without* knowing B_0, is most interesting. It is based on Kratzer's expression for the potential function of a *polar* molecule and gives for I_0 a value 5 per cent. too low, as applied to HCl.

So far as I know, Richardson's method has never been tested on a non-polar molecule. I have accordingly carried out such a test for several non-polar molecules for which trustworthy data are available and find that this method gives values of I_0 ranging from 8 per cent. too large for the excited level of the Swan bands to 9 per cent. too small for the excited level of the CN violet bands. Assuming Hori's values of I_0 for the normal and the 'C' level of H_2, the same method gives results 21 per cent. and 26 per cent. too large respectively. Using my own probable value of α (0·614) for the B level, the Richardson method is correct to within 3 per cent. His value of α = 2·22 is derived from extremely uncertain data and cannot be correct, since even with his own doubled value of B_0 (27·8), it indicates that the mean moment of inertia becomes infinite for only 12·5 quanta of vibrational energy. The vibrational data, on the other hand, show that at least 42 quanta are needed. Richardson's other values of I_0 are probably roughly correct, and the product $I_0\omega_0$ shows the expected rough constancy for *all* levels, including the B level, *if* I_0 = 1·99 is used.

By extrapolating to ionisation the values of ω_0 in a given Rydberg series, one obtains an estimate of ω_0 for the normal state of H_2^+. My own result for this is 2247 cm.$^{-1}$, which corresponds to s^+ = 0·141 volt, in remarkable agreement with Burrau's value (*as corrected*), calculated directly on the new mechanics. The heat of dissociation of H_2^+ is given by $(D + I_A - I_M)$, and with the values finally adopted equals 2·62 volts. Burrau calculates I_0 for H_2^+ as $0·927 \times 10^{-40}$, and the fact that more than *double* this value is found in the B level of H_2 is most astonishing, and has interesting consequences.

RAYMOND T. BIRGE.
University of California,
Dec. 22, 1927.

Spatial Distribution of Photoelectrons Produced by X-rays.

JUDGING from recent papers on this subject, there seems to be considerable diversity of opinion concerning the explanation of the *dispersion* or 'spread' of the photoelectrons, whilst there appears to be no disagreement about the cause of the *longitudinal asymmetry*, which is generally assumed to correspond to the transfer to the photoelectrons of the momentum of the absorbed radiation. J. M. Nuttall, H. S. Barlow, and the present writer (hereinafter referred to as N.B.W.) recently investigated the longitudinal distribution of photoelectrons, and the results (not yet published) indicate an average forward component of momentum of the photoelectrons which is appreciably greater than the momentum, $h\nu/c$, of an incident quantum. The writer has also made a closer

quantitative study of the results of other observers, and finds that with the exception of P. Auger's results an 'excess asymmetry' is revealed in each case. As regards dispersion, experimental results seem to prohibit all theories except one, with which there is fair agreement.

According to E. C. Watson (*Proc. Nat. Acad.*, 584, Aug. 1927) the dispersion observed by the Wilson cloud method is entirely due to nuclear scattering of the photoelectrons within the volume represented by the photograph of the first droplet in a Wilson track. The magnitude of this effect depends directly on the diameter of the first droplet, and calculations similar to Watson's show that in the photographs examined by N.B.W. the dispersion due to nuclear scattering in the first droplet is very small compared with the observed dispersion, which is of the same magnitude as that observed by others. We must conclude that the observed dispersion undoubtedly exists when the electrons leave their parent atoms. Attempts have also been made to explain the dispersion by secondary processes *within* the parent atom, such as scattering by the 'parent' nucleus or the effect of the momentum of the electrons in the atoms before absorption. The dispersion afforded by such theories is, however, wholly inadequate, especially in the case of light elements (cf. A. H. Compton, "X-rays and Electrons," p. 247), and the rapid decrease of dispersion with decreasing atomic number which they require receives no corroboration at all from experiment. There remains the "$\cos^2\theta$" law first enunciated by Auger and Perrin and since derived by Wentzel on the wave mechanics. According to this law (provided we overlook longitudinal asymmetry) the probability of emission in a direction making an angle θ with the electric force in the incident wave is proportional to $\cos^2\theta$, and is independent of the atomic number of the atom and the wave-length of the rays. The dispersion is attributed entirely to the dispersion of the 'photoelectric impulses' and no secondary process within the atom is involved. This law represents satisfactorily the lateral distribution observed by Kirchner using polarised rays and the longitudinal dispersion observed by Auger and N.B.W., the experiments involving considerable variation of atomic number and wave-length. Bubb and Loughridge find somewhat less dispersion than is required by the $\cos^2\theta$ law. These, however, are the only discrepancies, and we may say that the $\cos^2\theta$ law leads to distribution functions which are, on the whole, the best representations of the experimental results for dispersion that can be chosen.

The quantities usually considered in measuring the longitudinal asymmetry are the ratio, ρ, of the forward to the backward emission, and the bipartition angle, ϕ_{bi}. The average forward component of momentum, μ, of a photoelectron is also a significant measure of the asymmetry, but up to the present it has not been considered. In order to correlate the asymmetries represented by different quantities, and thereby compare the results of different observers, it is convenient to regard the longitudinal distribution as the result of adding to each vector in a distribution of momentum vectors obeying the $\cos^2\theta$ law, momentum of magnitude $\sigma.(5/4).(h\nu/c)$ in the forward direction, the magnitude of the initial momenta being such that the resultant momenta are consistent with Einstein's equation. The factor 5/4 is introduced in order that $\sigma = 1$ may correspond to an average forward momentum of the photoelectrons equal to $h\nu/c$. σ can be regarded as a coefficient of asymmetry and its values, which correspond to the results of N.B.W., and other observers are given in the accompanying table. Except in the case of Defoe's results, the values of ρ, ϕ_{bi}, or $\overline{\cos\phi}$ as the case may be, have been deduced from other published data. [It is interesting to note that according to the theory of Perrin and Auger, in which σ is taken equal to 4/5, the average forward momentum of a photoelectron is $(4/5).(h\nu/c)$.]

Gas.	λ(A).	Number Examined.	σ * calculated from			Observers.
			ρ.	ϕ_{bi}.	$\overline{\cos\phi}$.	
Air . . .	0·37-1·0	1000	1·5	—	—	C. T. R. Wilson (1923)
Air . . .	0·71	250	2·1	—	—	O. K. Defoe (1924)
O_2, Argon .	0·71	450	2·1	2·3	2·0	D. H. Loughridge (1927)
Argon . .	0·13	300	1·4	1·3†	—	F. Kirchner (1927)
N_2, O_2 . .	0·54-0·71	1000	1·4	1·4	1·4	N. B. W. (1927)

* Denoting $\sqrt{h\nu/mc^2}$ by a, then $\cos\phi_{bi} = (5/4)\sigma a$, $\overline{\cos\phi} = \sigma a$, and $(\rho-1)/(\rho+1) = (15/8)\sigma a \div (15/8)\sigma a/8$ approximately.

† Kirchner gives the distribution of the tracks on the photographic plate and 'works back' to the space distribution, finding $\phi_{bi} = 73°$ which gives $\sigma = 0·8$. It seems to the writer that ϕ_{bi} must be close to 60°, giving $\sigma = 1·3$ which agrees with σ_ρ.

The last row in the table gives the results obtained by Nuttall, Barlow, and the writer. These observers made direct observations on the average value of $\cos\phi$ where ϕ is the angle with the forward direction, and the results indicate a forward momentum of the photoelectrons equal to about 1·4 times the momentum of the absorbed radiation. A. H. Compton ("X-rays and Electrons," 251) considers that the "electrons are ejected with an average forward momentum equal within experimental error to the momentum of an incident quantum." This is, however, not in agreement with the above result. Attention should be directed to the agreement in the last row between the values of σ deduced from different quantities, because it justifies, so far as it goes, the scheme adopted in building up the longitudinal distribution.

It is seen from the table that the results of other observers also lead to an 'excess' asymmetry, though the variation in the value of σ is not very satisfying. The experimental results of P. Auger are not included in the table. These lead to a value of σ differing inappreciably from unity and they require special mention for that reason. The differences between the results of various observers is not easy to explain. They may be due to the choosing of tracks or the use of non-homogeneous X-rays. What is desired to emphasise here is that it must not be assumed that *existing* experimental results show that the momentum of the photoelectrons is equal to that of the absorbed radiation. The results rather indicate that the photoelectrons have forward momentum nearly 50 per cent. greater than this.

As possible reasons for the excess asymmetry may be suggested (1) the effect of the nucleus or (2) the effect of the other k electron, both of which have up to the present been neglected. In individual quantum absorptions the nucleus must absorb momentum of magnitude comparable with that of the photoelectron, in order to conserve momentum, and this seems to the writer to invalidate the assumption that the nucleus can be neglected on account of its massiveness. The possibility of the other k electron being involved is suggested by the recent work of Prof. Alexander on the absorption of X-rays (*Phil. Mag.*, Oct. 1927).

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Differential Response of Barley Varieties to Manuring.

IT is a well-known fact that, by selection or hybridisation, varieties of any one plant can be produced which differ markedly in their yielding capacity. It is generally undecided as to what this difference of yielding capacity is due, and although yielding capacity of plants is controllable by manuring, it is not known whether the increase in yield gained in this way is a function only of the manure added, or whether different varieties respond to varying extents to the manurial combinations given. Interesting results were obtained in an investigation which has been carried out to test the efficiency in the use of manures by five well-known varieties of barley. Eleven manurial combinations consisting of different amounts of phosphate, nitrogen, and potash were used. The experiments were done in pot culture, using pure sand and solutions of pure chemicals. Each manurial combination was replicated seven times, giving in all 385 pots. The manurial scheme is tabulated below. The varieties used were Goldthorpe, Plumage, English Archer, Plumage Archer, and Spratt Archer.

TABLE I.

SCALE OF MANURING EMPLOYED (GM. PER POT).

	Phosphate-deficient Manuring.			Complete Manuring.	Nitrogen-deficient Manuring.			Complete Manuring.	Potash-deficient Manuring.		
	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.
P_2O_5 .	0	0·02	0·10	0·50	0·50	0·50	0·50	0·50	0·50	0·50	0·50
N . .	1·50	1·50	1·50	1·50	0	0·06	0·30	1·50	1·50	1·50	1·50
K_2O . .	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00	0	0·04	0·20

Varietal differences in response were apparent in all the types of manuring. The difficulty of separating variations in yield due to experimental error from differences in yield due to manurial treatment, varietal differences in general, and differential varietal response to the various manures, was met by application of R. A. Fisher's 'Analysis of Variance.' By this means it has been possible to separate out the various effects, and to estimate their significance.

The effect of immediate interest here is the differential varietal response with the different manures. This is shown in the table below where the varieties are compared in pairs.

TABLE II.

TOTAL DRY WEIGHT OF TOPS. SIGNIFICANCE OF VARIETAL DIFFERENCES.

Comparison.	P_2O_5 Starved.			N Starved.			K_2O Starved.			Complete.
	A.	B.	C.	E.	F.	G.	I.	J.	K.	
P. with G. .	0	+	0	0	0	+	0	0	−	+
E. A. with G. .	+	+	+	+	+	+	0	0	−	+
P. A. „ G. .	0	0	0	+	+	+	0	0	−	+
S. A. „ G. .	0	0	0	+	0	+	0	0	−	+
E. A. „ P. .	0	0	+	+	+	0	0	0	0	0
P. A. „ P. .	0	−	0	0	+	+	0	0	0	0
S. A. „ P. .	−	−	0	+	0	0	0	0	0	0
P. A. „ E. A.	−	−	−	0	0	0	0	0	+	0
S. A. „ E. A.	−	−	−	+	−	−	0	0	0	0
S. A. „ P. A.	0	0	0	+	−	−	0	0	−	0

+ indicates a significant positive difference.
− indicates a significant negative difference.
0 indicates no significant difference.

The absence of significant differences in Series I and J is almost certainly due to the great variability in these two sets.

A yield significantly greater in favour of the first variety is shown by a +, while a − indicates that the second variety has produced a significantly greater yield; zero indicates no significant difference in yield. It will be seen that for any one pair of varieties the relative magnitude of yield differs in an orderly way with the manuring; thus where a significant increase of the first variety over the second was obtained in the phosphate-deficient combinations, the order is reversed in the potash-deficient sets, and so on. Furthermore, even where no significant differences are found with complete manures, such differences show themselves in the partially deficient sets.

The facts presented in Table II. establish a difference in efficiency in the use of manures by these varieties, and further show that for different varieties tested over the same range of manurial combinations, it is not always the same manurial constituent which in minimum has the most marked effect on relative yield.

The agricultural bearings of the results obtained are twofold: (1) Varietal trials must be combined with manurial trials to be complete, and (2) the lines along which to develop selection and breeding of varieties to meet the requirements of different soil types are indicated.

F. G. GREGORY.
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Imperial College of Science and Technology,
London, Dec. 3, 1927.

The Nebulium Spectrum in New Stars.

IN a recent communication (NATURE, Jan. 7, p. 12) C. T. Elvey has applied the 'expanding shell' theory of novæ to calculate the maximum density at which oxygen can be made to give the nebulium spectrum. In Nova Aquilæ, No. 3 (discovered June 8, 1918), the line λ5007 was first seen on June 27, when its breadth was 55 A.; and the gases are therefore assumed to have been travelling outwards for 19 days with a velocity of 1700 km./sec. before reaching a low enough density to emit this line. If, then, the phenomena are due to the reversing layer of the star being blown off bodily as a shell of gas, we can find the density in the shell at any moment after the outburst, given the initial density and radius. Elvey finds in this way that at the first appearance of the nebulium lines the gas must have a density of the order 10^{-17} gm./c.c.

There is a serious objection to the foregoing reasoning, however, which becomes apparent if we consider the state of ionisation of the gases concerned. The lines λλ5007, 4958, and 4363 are due, according to Bowen, to the O^{++} atom, which has an ionisation potential of about 35 volts. We can, therefore, find at once from the Russell-Saha formula the various pressures and temperatures at which O^{++} atoms will just begin to appear (say 0·1 per cent.); and it follows that at the density given, the lowest admissible temperature is

$$T = 13{,}000° \text{ Abs.},$$

corresponding to a partial electron pressure $p_e = 2 \times 10^{-13}$ atm. (This is about half the total pressure.) Now if we apply Elvey's method to hydrogen, which on June 27 showed bright bands of identical width with that of the nebular ones, it is evident that the hydrogen too must have had a density of the order of 10^{-17} gm./c.c. on that date. The condition that it shall not all be ionised (say

99·9 per cent. only) imposes an upper limit to the temperature; we must have

$$T < 6000° \text{ Abs.}$$

Now it is obvious that at these densities the ionisation is mainly due to the radiation from the star; and so the relevant temperature must be the same for both shells of gas. This, of course, is incompatible with the foregoing conditions.

As time goes on, the density continues to fall, and the discrepancy becomes worse. *After three months*, hydrogen and nebulium bands are still present together, their widths remaining sensibly constant, though the hydrogen is now relatively much weaker. Thus it appears that the straightforward argument put forward by Elvey yields results which are self-contradictory; and careful consideration is necessary before his figures can be accepted.

Another way of looking at the matter is as follows: The lowest temperature at which two substances with different ionisation potentials I_1, I_2 can coexist at the same partial electron pressure is $T = 840 \ (I_2 - I_1)$, where 'coexistence' means that not more than 99·9 per cent. of the one substance is ionised, nor less than 0·1 per cent. of the other. For a mixture of hydrogen and 'nebulium' this gives $T = 18{,}000°$ Abs., corresponding to a minimum pressure $p_e = 2 \times 10^{-3}$ atm. and a density 4×10^{-7} gm./c.c.

If we suppose that these values apply three months after the outbreak, then, working backwards, the critical density at which the nebular lines first appear must be of the order 10^{-5} gm./c.c. at a pressure of about an atmosphere.

This is, of course, directly opposed to the idea that metastable transitions can only occur at very low pressures; but it is conceivable that very high temperatures might also be capable of inducing them. The strength of the ultra-violet continuous spectrum is a well-known feature both of novæ at a certain stage, and of O-type stars, which can also stimulate the nebulium spectrum.

A more probable way out of the difficulty, however, is to suppose that the oxygen and hydrogen shells originate in different layers of the star. There will be hydrogen accompanying the oxygen, of course, and no doubt helping to produce the complicated dark line spectra which appear in the early days; but by the time the nebular stage is reached, this hydrogen will be completely ionised. The hydrogen that is actually seen then must have come from deep down in the star, where the density was much higher than in the reversing layer.

This explanation unfortunately undermines Elvey's argument, for once we admit that the shells of gas come from different regions of the star, we have no means of assigning the initial density of any of them.

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Scientific Terminology and its Annexation.

NATURE has so consistently maintained the purity and accuracy of English scientific nomenclature, and its occasional leading articles on the subject have been of such great interest and assistance, that I venture to point out the insidious annexation of scientific terms to denote a commercial product.

'Ethyl' is the latest offender; the article in question being a petrol or benzol mixture to which is added a small proportion of an anti-knock substance purporting to be lead tetra-ethyl.

I presume there is not a practicable legal remedy, and one would hesitate to adopt the Shylockian tactics of obtaining a stamped agreement to deliver a quantity of substance at the price of the 'commercial' (misnamed) article, and then holding them to their chemical bond; yet one feels that such a lesson would be richly deserved by those who produce 'Radium' tooth powder, 'Ozone' liquids, or even call the impure, evil-smelling napthalene (after deleting the 'albo') by the name of carbon.

One would of course not wish to be arbitrary, but such barbarisms as 'saltrates,' etc., are a deliberate counter to our expensive educational schemes.

As regards scientific terminology, one would wish, *pace* the Oxford Dictionary, that 'revolution' and 'rotation' could be logically distinguished. I have always tried to restrict each term to cases where the centre of movement was either outside or inside the body moving, but there are many borderland cases.

The late Prof. Perry, in his usual pungent way, once rejoiced that there was no name for the time fluxion of acceleration. The term 'crement' (from increment or decrement of force) almost suggests itself.

There seems some doubt as to whether the term 'applement,' denoting the difference between a given angle and four right angles, is suitable to take its place with 'supplement' and 'complement' in their usual connotations. Here, I suppose, the criterion is between the relatively few people who might find the term useful, and the many who would be plagued by it. The same applies to 'cyclon' for a pendular vibration, which is shorter than (or almost an abbreviation of) the late Lord Kelvin's 'cycloidal vibration.'

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Eyeglasses and the Microscope.

MICROSCOPISTS who are hampered by wearing eyeglasses (that is, pince-nez) often find that when their work requires reference to books or other objects on the table, the incessant business of taking their glasses off and putting them on wastes time, and is apt to become wearisome. There is a simple way of getting over the difficulty. When the glasses are taken off in order to make way for the microscope, they should not be laid down but should be kept on the head, in which position, being near the fine adjustment and the hand resting on it, they can at once be replaced when wanted. To attach the eyeglasses in this way nothing more elaborate is necessary than a piece of ordinary elastic, the two ends of which are tied, or fastened with hooks, to the frame, preferably the bridge, of the glasses. With the elastic loop round the head, the eyeglasses can be raised on the forehead out of the microscope's way or brought into position for reading with a minimum expenditure of time and trouble.

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The Sligo Artefacts.

WE, the under-signed, have examined a representative series of the limestone specimens collected by Mr. J. P. T. Burchell in Sligo, Ireland, and, after a study of the type of flaking and of the forms of these specimens, we are of the opinion that they are of human origin. This view is based upon the various criteria applied to universally accepted implements, and has been reached only after the explanation of the Sligo specimens being due to natural forces has been considered and rejected. This statement is without prejudice to their cultural age.

A. LESLIE ARMSTRONG.
M. C. BURKITT.
HENRY DEWEY.
D. A. E. GARROD.
REGINALD A. SMITH.

The Present State of Some Problems in the Theory of Numbers.[1]

By Prof. L. J. MORDELL, F.R.S.

THE theory of numbers, which was called the queen of mathematics by Gauss, the originator of the modern theory, still remains supreme. The present era is pre-eminently one in which she dominates the mathematical world. Her willing, loyal, and devoted subjects include the foremost mathematicians in every land. Their recent achievements bear comparison in difficulty and significance with those of any other period. Their propaganda in the last few years includes a surprisingly large number of thrilling treatises, which deal with most aspects of her conquests, and far exceed in number and importance those dealing with any other advanced mathematical subject. There is no lack of effort to present the most recent developments in as inviting and attractive a form as possible. One need only mention recent books in the last few years by Bachmann, Hecke, Landau, and Feuter. No small part of their subject-matter is closely related to or perhaps had its foundations in one or more of the six problems I have selected for discussion, which are associated with such distinguished names, namely:

1. Euler's Three Biquadrate Problem.
2. Fermat's Last Theorem.
3. The Cubic Indeterminate Equation.
4. Gauss' Class Number Problem.
5. Dirichlet's Divisor Problem.
6. Minkowski's Theorem on the Product of Linear Forms.

Some of these problems are comparatively new, such as (5) and (6), and testify to the wonderful freshness and vitality of the theory of numbers. The age of the others can be measured in centuries, particularly (3), special examples of which have been known for about two thousand years.

Their solutions are in every state of completion or rather incompletion, except perhaps for (3), which I solved a few years ago. Although some progress has been made with most of the others, except (1), they present difficulties which severely tax and seem beyond the powers of present-day mathematics. The slightest advances are made only by the most venturesome and heroic efforts, how much so can be easily appreciated by those who have even the slightest interest in the subject. These advances prove both useful and stimulating in many other fields, and it is difficult to exaggerate their importance and influence in the history of mathematics.

There are many striking features about these problems which have been noticed by all workers in this field. A simplicity of enunciation is combined with the fact that many of its most beautiful and startling results are proved originally in most unexpected and complicated ways. It is generally after many years that the simple and apparently natural method is discovered. It is only then that the proofs can be appreciated by greater numbers, just perhaps as the rough diamond only reveals its beauty after it has been polished and cut.

[1] A lecture given to the Manchester Literary and Philosophical Society on Nov. 15, 1927.

EULER'S THREE BIQUADRATE THEOREM.

This states that the sum of three biquadrates cannot be another biquadrate unless two of them are zero; *i.e.* if integers a, b, c, d satisfy the equation,

$$a^4+b^4+c^4=d^4,$$

then two of a, b, c must be zero.

It is truly remarkable that this simple theorem, the truth of which was conjectured by Euler more than 150 years ago, has neither been proved nor disproved. Further, it has been found absolutely impossible to make any headway with this problem. Indeed, it would be difficult to mention any other which has yielded so little to the efforts of those who have attempted its solution. Hence only some half-dozen references are to be found in the mathematical literature to papers dealing with it. The most important result known is a numerical verification by Aubry, in 1912, that the theorem is true for $|d| < 1040$.

The theorem cannot be extended to four fourth powers, as Norrie in 1911 showed that

$$30^4+120^4+272^4+315^4=353^4.$$

The particular case when one of a, b, c is zero, so that the equation is

$$a^4+b^4=c^4,$$

dates back from Fermat. It is proved by his method of infinite descent, *i.e.* if this equation or the less restricted one

$$a^4+b^4=c^2,$$

admits of integer solutions where abc is not equal to zero, then it must have other integer solutions a_1, b_1, c_1 where $a_1b_1c_1$ is not equal to zero, and where c_1 is numerically less than c. By continuing this process we are led to the existence of a solution wherein c is not zero and is numerically less than some definite number (here 1), and it can be easily verified by trial whether this is so. This example is a particular case of the second problem.

FERMAT'S LAST THEOREM.

This states that if integers x, y, z satisfy the equation

$$x^n+y^n=z^n,$$

where n is a given integer greater than 2, then x or y equals zero.

This theorem was discovered about 1637 by Fermat, who wrote upon the margin of his copy of the works of Diophantos, "I have discovered a truly remarkable proof which this margin is too small to contain." The theorem has attained world-wide celebrity because of the Wolfskell prize of 100,000 marks established in 1907 for the first demonstration of its proof. The prize has not yet been won.

The most important results are due to Kummer

who spent a great part of his life upon it. Assuming that n is an odd prime p, which involves no loss of generality, he proved the truth of the theorem for values of n included in certain general classes, *e.g.* when n is not a divisor of the numerator of one of the first $\frac{n-1}{2}$ Bernouillian numbers, B_r being defined as the coefficient of $(-1)^{r-1}x^{2r}/2r\,!$ in the expansion in ascending power of x of $x/e^x - 1$, and in particular for $3 \leq n \leq 100$, though his proof was not complete for a few values of n. It is not known whether the values of n for which Kummer proved his results are infinite in number. Though his papers were written about the middle of the last century, no further important results were obtained until 1909. Kummer and his successors in the discussion of the problem divided it into two cases, according as xyz is not or is divisible by p. The first case is the easiest, and for the theorem to hold for this one, Wieferich showed in 1909 that $2^{p-1} \equiv 1 \pmod{p^2}$, that is, $2^{p-1} - 1$ is exactly divisible by p^2.

The first value of p for which this is true was shown by Meissner in 1913 to be 1093. But Wieferich's theorem is a particular case of the more general one that if r is any prime less than p, then $r^{p-1} \equiv 1 \pmod{p^2}$ if the equation $x^p + y^p = z^p$ holds with xyz prime to p. This was proved for $r = 3$ by Mirimanoff, for $r = 5$ by Vandiver, and by Frobenius for $r = 11$, 17, and when $p \equiv 1 \pmod 6$, for $r = 7$, 13, 19. The proofs except when $r = 2$ or 3 are very complicated and suggest that the real source of these results is still to be found.

Fermat's last theorem is the most important of all the problems that I shall mention, as the efforts made in attempting its solution led Kummer to discoveries that marked the beginning of the theory of algebraic numbers. This discovery later revealed wonderful and beautiful relations between the theory of numbers, elliptic functions, automorphic functions, and many other parts of the theory of functions of a complex variable.

In no other part of the theory of numbers as in Fermat's last theorem are the investigator and reader called upon to deal with such abstract conceptions, such involved results, many of which are arrived at by a long chain of reasoning; and such general theories, *e.g.* laws of reciprocity, which have their foundations deep in the arithmetical theory. No other problem has been attempted by so many distinguished mathematicians, and very few can have led to such remarkable developments.

CUBIC INDETERMINATE EQUATIONS.

This problem is to find the rational values of x, y, satisfying the general equation of the third degree in x, y with rational coefficients, namely,

$$ax^3 + bx^2y + cxy^2 + dy^3 + ex^2 + fxy + gy^2 + hx + ky + i = 0,$$

i.e. to find the rational points on this cubic curve which it is supposed has no double point, as then the problem is comparatively simple.

It is the oldest of those with which I am dealing, and particular cases of this question have been considered so long as two thousand years ago. Its solution proved intractable until six years ago, when I discovered the general solution, which is now so obvious that it is given in lectures at some universities.

A great deal of what was done on this question for many years can be explained in a few sentences. Any straight line meets the curve in three points. If two of these points are rational, the third is found from a simple equation, so that its co-ordinates will certainly be rational. In particular the tangent to the cubic at a rational point will meet it in another rational point.

Now suppose we have already found, perhaps by trial, n rational points on the curve say P_1, $P_2 \ldots P_n$, *e.g.* if $x^3 + y^3 = 9$, $x = 2$, $y = 1$ is an obvious point. The tangent to the curve at P_1 will meet it again in another rational point P'_1, distinct from P_1 unless P_1 is a point of inflexion. So the tangent at P'_1 meets the curve in general in another point P''_1, etc., and we may expect to find an infinite number of rational points starting from P_1, though it is conceivable that we may find only a finite number of points forming a closed polygon. Similarly, we may expect to find an infinite number starting from P_2 if P_2 is not included in the group arising from P_1, and so for P_3, etc. But we can find another rational point, $Q_{1,2}$ from the intersection of the line $P_1 P_2 \ldots$ and the curve. We may now either draw a tangent to the curve at $Q_{1,2}$, or draw the secants joining $Q_{1,2}$ and the points P_2, P_3, etc., and find their intersections with the curve.

Clearly, in this way, we can find in general an infinite number of other rational points by starting from n known rational points, say primary points for short. From the time of Fermat onwards, mathematicians had to content themselves with doing little more than deriving for special equations explicit formulæ for the co-ordinates of the points found from one or more given ones, *e.g.*: for

$$ax^3 + by^3 = c,\ y^2 = px^3 + q.$$

Even prizes established by learned societies led to no solution.

Finally, I showed that all the rational solutions of the general equation could be found from a finite number of primary ones by drawing tangents and secants as above. In other words, the method of infinite descent gives all the solutions; and there is now no theoretical difficulty in finding them.

GAUSS' CLASS NUMBER PROBLEM.

Let $-D$ be a given negative number and let $ax^2 + bxy + cy^2$ be any quadratic form of determinant $-D$, *i.e.*, a, b, c are any integers for which $b^2 - 4ac = -D$. This requires that $D \equiv 0, 1 \pmod 4$, and then an infinity of integers a, b, c, can be found, and so an infinite number of quadratic forms of given determinant $-D$. It is a classic and elementary theorem that all these quadratic forms can be derived from a finite number, $H(D)$ say, by means of a linear transformation with integer coefficients and determinant unity. It was conjectured by Gauss more than 125 years ago that there are only a finite number of values of D for a given $H(D)$. This

has not yet been proved, though a formula and many recurring formulæ are known for H (D). Hecke, making use of an unproved hypothesis about the zeros of a function analogous to the Riemann Zeta function, has given a simple proof. But I wish to deal more particularly with what would appear to be the very simple case when H $(D)=1$. This is so for $D=3, 4, 7, 8, 11, 12, 16, 19, 27, 28, 43, 67, 163$. It is easily verified that for any others, D must be a prime of the form $8n+3$. It was shown in 1911 by Dickson that there is no other value of D less than 1,500,000.

It may seem surprising that the truth of the conjecture about H $(D)=1$, is equivalent to the fact that the formula $z^2+z+2n+1$ gives only prime numbers for the integers z satisfying $0 \leqq z \leqq 2n-1$ as was proved by Rabinovitch (Rainich), and this is easily verified for $D=43, 67, 163$, when $n=5, 8, 20$.

It is also equivalent to the statement that the only solutions in non-negative integers of

$$yz+zx+xy=D=8n+3$$

are given by

$$(x, y, z)=(0, 1, 8n+3), (1, 3, 2n), (1, 1, 4n+1),$$

and those derived from these by permuting x, y, z.

Neither of these simple facts has, however, proved of use in proving the theorem.

DIRICHLET'S DIVISOR PROBLEM.

The number of divisors d (n) of a given integer n is a function of n which changes very irregularly with n, and is really the number of positive integer solutions of $xy=n$. If n is a prime number d $(n)=2$, while if $n=p^aq^br^c$ . . . where p, q, r . . . are different primes

$$d(n)=(a+1)(b+1)(c+1) \ldots .$$

But though $d(n)$ does not depend so much upon the magnitude of n as upon its form, it is different with

$$d(1)+d(2)+ \ldots d(n).$$

This really represents the number of positive integer solutions of $xy \leqq n$, *i.e.* the number of points with positive integral co-ordinates lying in the area bounded by the rectangular hyperbola $xy=n$ and the lines $x=1$, $y=1$, including the boundary in the area. The irregularities are smoothed out as it were, in the sum. Dirichlet showed in 1849 that $d(1)+d(2)+ \ldots d(n)=n \log n+(2\gamma-1)n+R(n)$ where $\gamma=0{\cdot}577$ . . . is Euler's constant, and $R(n)$ the remainder or error term is less numerically than a constant multiple of $\sqrt{n}$. This is expressed by $R(n)=O(\sqrt{n})$. For many years this was thought to be the best approximation to $R(n)$. Voronoi proved, however, in 1903, that $R(n)=O(\sqrt[3]{n}\log n)$. Van der Corput showed next that $R(n)=O(n^a)$ with $a=\frac{1}{3}$. This result was arrived at in many different ways, arithmetical, geometrical, by the real variable, and by the complex variable. These all led to $a=\frac{1}{3}$ and seemed to suggest that $O(\sqrt[3]{n})$ was the best approximation to the error term; though it was known from Hardy's work of 1915 that in the error term, the index $a \geqq \frac{1}{4}$. Wonderful to relate, Van der Corput showed in 1922 by an exceedingly difficult and complicated method that $a<33/100$. Simpler proofs have since been given by Littlewood, Walfisz, and Landau for the slightly less precise result $a \leqq 37/112$.

This extraordinary result appears not to be final; but to have arrived at it is one of the most startling achievements of the present day. The problem is one which has made the greatest demands upon many branches of mathematics. The most delicate questions of convergence, of the theory of functions, and the most adept manipulation of inequalities are all required.

In this problem, as opposed to the others, it is the methods of the analytical theory of numbers which have proved most successful. The most important stage in the proof depends upon Weyl's method of finding upper limits for large values of n to sums such as

$$\cos(f(1))+\cos(f(2))+ \ldots \cos(f(n)).$$

These approximations have also played a vital part in Waring's problem and in the recent theory of the Riemann Zeta function.

MINKOWSKI'S THEOREM ON THE PRODUCT OF LINEAR FORMS.

This is the most recent of these problems, but it has features that mark it out as a worthy companion to those that have preceded it.

Let

$$\begin{aligned} L_1 &= a_{11}x_1+a_{12}x_2+ \ldots a_{1n}x_n-c_1, \\ L_2 &= a_{21}x_1+a_{22}x_2+ \ldots a_{2n}x_n-c_2, \\ &\ldots\ldots \\ L_n &= a_{n1}x_1+a_{n2}x_2+ \ldots a_{nn}x_n-c_n, \end{aligned}$$

be n linear non-homogeneous forms where the a's and c's are any real constants subject to the restriction that the determinant $|a_{rs}|=1$, which it may be noted in no wise detracts from the generality of the following theorem. Then it is supposed that there are integer values for $x_1, x_2, \ldots x_n$, for which the product $|L_1L_2 \ldots L_n| \leqq 2^{-n}$.

The proof for $n=2$ was first given by Minkowski. Remak has given another, and I am now publishing one which proves it in a very simple way. But a different state of affairs arises for $n=3$. Remak gave in 1921 an extraordinarily complicated and intricate proof in fifty pages. It depends upon the arithmetic theory of the definite ternary quadratic, and involves ideas closely allied to those occurring in the problem of the closest packing of spheres. Unfortunately, it appears to be exceedingly difficult to extend the proof to the case $n=4$, and it is not known whether the theorem is true for $n \geqq 4$, although it seems very likely. It is very rarely that the proof of the generalisation of a question to n dimensions proves so unattainable, especially when in similar questions, for example, in dealing with linear forms in which $c_1=c_2= \ldots c_n=0$, the results for n variables are proved as easily as for two.

It is fairly certain that in due course a very simple general proof will be found, making the truth of the theorem almost intuitive. Such a one could be found by generalising to n variables the simple theorem that if $|a| \leqq 1$, $|b| \leqq 1$, there is a range of values of width at least two for x for which

$$|ax^3+bx| \leqq 1.$$

Neanderthal Man a Distinct Species.[1]

THE fossil crania of the extinct members of the human family have been described and measured by many investigators; but it has long been recognised that there were important lacunæ in our information that had to be made good, and a lack of uniformity in the methods of measurement. Dr. Morant has rendered a very useful service to anthropology by himself measuring all the available crania and providing a complete and uniform treatment of the series in accordance with the refined mathematical methods of Prof. Karl Pearson.

How valuable and important such statistical investigations can be was shown in Dr. Morant's first memoir in this series, in which he provided a mathematical confirmation of Testut's opinion that the Chancelade skull (found in the Magdalenian deposits in the Dordogne thirty-eight years ago) conformed to the racial type of the modern Eskimo, a view that has been so vigorously championed in recent years by Prof. Sollas, and many years ago, in the face of vigorous opposition, by Sir William Boyd-Dawkins.

The second memoir, dealing with the series of Neanderthaloid skulls, is particularly valuable—for providing exact data and the careful investigation of the measurements and interpretation of their meaning. At the present moment, when doubt is once more being cast on the validity of the species *neanderthalensis*, it is important to get Dr. Morant's emphatic corroboration of our morphological conclusions. He informs us that the available measurements of the skulls associated with the Mousterian phase of culture in Europe and Palestine indicate a remarkable homogeneity of type, between which and all modern racial types there is a distinct hiatus, which may be taken to indicate a specific difference. "Some modern races resemble the Neanderthaloid type more closely than others do, but there is no race, or group of races, which is particularly distinguished in that way." "The working hypothesis that Mousterian man is equally related to all races of *H. sapiens* would seem to be the safest to adopt in the present state of our knowledge. In that case it is impossible to decide whether *H. neanderthalensis* has been a stage in the direct line of descent or not."

With these conclusions most anatomists would agree, with the qualification that the many signs of specialisation in the skull and teeth as well as in the limb bones are fatal to the suggestion that *H. neanderthalensis* could have been in the direct line of descent.

In his recent Huxley lecture, however, Dr. Aleš Hrdlička has questioned (NATURE, Nov. 19, p. 750) the validity of the specific distinction of Neanderthal man, an issue which most anatomists imagined to have been definitely settled by the investigation of Schwalbe in 1899, and the corroboration afforded by the work of Boule and a host of other anatomists. It will be remembered that when the original Neanderthal skull was found, Prof. William King (in 1864) suggested it was a distinct species, if not even a distinct genus, but Huxley opposed this claim and got his way. Thirty-five years later Schwalbe, with ampler material and modern criteria, made out a good case for the reality of the specific distinction, which the discoveries of the skeletons at La Chapelle-aux-Saints, La Quina, La Ferrassie, and elsewhere in 1908 and the succeeding years seemed to put beyond all question.

It is the way of true science constantly to submit to scrutiny the foundations of its theoretical views —a discipline to which a restive anthropology is not always willing to submit. The only justification for re-opening the problem of the status of Neanderthal man would be afforded by new evidence or new views, either of a destructive or constructive nature. I do not think Dr. Hrdlička has given any valid reasons for rejecting the view that *Homo neanderthalensis* is a species distinct from *H. sapiens*. Dr. Morant's important memoir comes at a very appropriate time to buttress the generally accepted view against such criticisms as Dr. Hrdlička's.

G. ELLIOT SMITH.

[1] "Studies of Palæolithic Man. By G. M. Morant. II. A Biometric Study of Neanderthaloid Skulls and of their Relationships to Modern Racial Types." *Annals of Eugenics*, vol. 2, Parts III. and IV., October 1927. Issued by the Francis Galton Laboratory for National Eugenics, University of London. 35s. net.

Obituary.

MR. LEON GASTER.

WE record with great regret the death of Mr. Leon Gaster, who passed away after a brief illness on Jan. 7. Mr. Gaster's chief work was the founding of the Illuminating Engineering Society, of which he had been honorary secretary since its birth in 1909. A year earlier he had founded the *Illuminating Engineer*, the official organ of the Society, which he edited up to the date of his death. A very sad feature was the fact that his death occurred shortly before the issue of a special number of his journal, celebrating its twentieth anniversary.

Mr. Gaster was a member of many scientific and technical committees, amongst which may be mentioned the Home Office Departmental Committee on Lighting in Factories and Workshops, the Illuminating Research Committee working under the Department of Scientific and Industrial Research, and various committees of the British Engineering Standards Association concerned with illumination. But his wide interests and enthusiasm led him into many other fields of work. He was keenly interested in the National Safety First Association and in the Association of Special Libraries and Information Bureaux. He was a fellow of the Institute of Journalists, and was in turn honorary secretary and chairman of its Scientific, Trade, and Technical Circle. He was also the honorary secretary of the British

International Association of Journalists, and as such was mainly responsible for the organisation of the International Press Conference in London last year.

Even this list does not exhaust the record of Mr. Gaster's activities. He used to affirm that he was a member of no less than thirty different scientific and technical committees. To every piece of work he undertook he brought boundless enthusiasm and indomitable perseverance. He delighted in meeting and disarming opposition, and few could resist his diplomacy and personal charm. It was, perhaps, in international activities that his special gifts found their chief application. Born in Rumania, educated in Switzerland, and with a wide knowledge of foreign countries, he was at once at home in any international gathering. This knowledge stood him in good stead in connexion with his work on the International Commission on Illumination, and in his conduct of the affairs of the British International Association of Journalists.

Mr. Gaster's foresight and sagacity, especially displayed in connexion with illuminating engineering, were remarkable. He had a genius for the correlation of different fields of scientific work and for discovering opportunities for joint effort which few would have perceived. He used to describe his occupation humorously as a 'committee promoter,' but he also found time for a considerable consulting engineering practice, where his knowledge of the world and powers of diplomacy proved quite as valuable as his technical skill. He was a man who made friends by instinct, and was equally well known in journalistic and scientific circles. It is no exaggeration to say that his name was known all over the world. His early death—in spite of his achievements he was only fifty-five years of age—will be widely regretted and his loss severely felt.

WE regret to announce the following deaths:

Dr. Emil Böse, formerly of the Geological Survey of Mexico and the author of numerous contributions on the Mesozoic of Mexico and the Permian of western Texas, on Nov. 8, aged fifty-nine years.

Prof. C. Diener, professor of palæontology in the University of Vienna, and a foreign correspondent of the Geological Society of London, well known as the editor of the "Fossilium Catalogus," on Jan. 6, aged sixty-five years.

Sir Dyce Duckworth, Bart., president of the Clinical Society of London from 1891 until 1893 and *correspondant étranger* of the Paris Academy of Medicine, on Jan. 20, aged eighty-seven years.

Mr. E. Kay Robinson, well known as a writer and lecturer on natural history topics, on Jan. 20, aged seventy-two years.

Prof. F. L. Washburn, professor of entomology at the University of Minnesota, and State entomologist from 1902 until 1918, on Oct. 15, aged sixty-seven years.

Dr. Israel C. White, State geologist for West Virginia since 1897, in which year he was a vice-president of the American Association for the Advancement of Science, on Nov. 24, aged seventy-nine years.

News and Views.

PROF. ARTHUR HUTCHINSON, who has been elected Master of Pembroke College, Cambridge, to fill the vacancy caused by the sudden death of Dr. Hadley, shares with Prof. Seward the honour of combining the offices of Master of his College and professor of a department of science in the University. Prof. Hutchinson was educated at Clifton (1879) and Christ's College, Cambridge (1884), graduating in 1888 with a first class in both parts of the Natural Sciences Tripos, having taken chemistry as his subject in Part 2. His first paper, published in 1889, was the result of work in collaboration with M. M. Pattison Muir "On a Cubical Form of Bismuthous Oxide." He next studied in Germany at Munich and at Würzburg, taking his Ph.D. at the latter University and carrying out research under Emil Fischer on the reduction of aromatic amides. Returning to Cambridge, he worked with W. Pollard on "Lead Tetra-Acetate and the Plumbic Salts," publishing the results in 1893 and 1896. In 1895, the professor of mineralogy appointed him demonstrator of mineralogy, and under this title for many years he gave almost all the lectures for the first year course in mineralogy and crystallography. It was not until 1923 that the University appointed him lecturer in crystallography. He eventually succeeded to the professorship after the death of Prof. Lewis in 1926.

PROF. HUTCHINSON'S connexion with Pembroke College dates from his election to a fellowship in 1893. He held the office of assistant-tutor from 1900 until his election as president of the College in 1926. In the meantime he had served the University on many boards, and was secretary of the General Board of Studies from 1920 until 1925. During the War, he carried out tests for the Admiralty on gas helmets, and for this and other services was awarded the O.B.E. He was president of the Mineralogical Society from 1921 until 1924, and was elected a fellow of the Royal Society in 1922. Lectures and college work left little time for scientific research, yet from 1900 to 1910 no year passed without his making some notable contribution to mineralogy, and in addition he prepared the section on mineralogical chemistry for the *Annual Reports of the Chemical Society* from 1905 until 1913. His first purely mineralogical paper, "On Stokesite, a New Mineral Containing Tin, from Cornwall," was a remarkable example of a complete chemical and physical determination made on a minute amount of material. This was followed by papers on the chemical composition and optical characters of chalybite, a study of the diathermancy and optical characters of antimonite, and on the composition of lengenbachite. More recent important contributions are on the stereographic and gnomonic projections and on

various graphical methods for solving problems which arise in the course of mineralogical determinations. The stereographic protractor and the 'universal' goniometer, both of which Prof. Hutchinson designed, have proved of very great utility in the many laboratories in which they have been introduced.

AT the recent meeting of Council of the Royal College of Veterinary Surgeons, a signal honour was conferred on Sir John McFadyean, late Principal of the Royal Veterinary College, London, when he was awarded the diploma of honorary associate of the Royal College of Veterinary Surgeons, an honour only once before conferred on a British veterinary surgeon. In making the presentation, the president, Lieut.-Colonel J. W. Brittlebank, referred to the fact that Sir John, who qualified as a member of the College in 1876, and had taken the degrees in medicine and science at Edinburgh shortly afterwards, had been Principal of the Royal Veterinary College since 1892, and a member of the Council of the Royal College of Veterinary Surgeons since 1893, being now the 'father' of the Council. He was a member of the Royal Commission on Tuberculosis appointed in 1901, which refuted Koch's contention that bovine tuberculosis was rarely if ever communicable to man to any serious degree. He also served on the departmental committee appointed to inquire into contagious abortion, 1905, and on many similar inquiries. Specialising at first in veterinary anatomy, McFadyean turned to the study of pathology, and his reputation as a veterinary pathologist and bacteriologist is now world-wide. His special method of staining blood films for the diagnosis of anthrax came into universal application, and his contributions into the elucidation of the problems raised by such diseases as tuberculosis, blackquarter, contagious abortion, and Johne's disease have made his name famous. He is the editor of the *Journal of Comparative Pathology and Therapeutics*, and the author of text-books on the anatomy of the horse and comparative anatomy. In 1905 he was knighted for his outstanding services to veterinary science and was also made an honorary LL.D. of the University of Aberdeen. He was president of the Royal College of Veterinary Surgeons from 1906 until 1910, and of the tenth International Veterinary Congress held in London in 1914.

THE Council of the Institution of Electrical Engineers has made the seventh award of the Faraday Medal to Prof. J. A. Fleming, who has recently retired from the chair of electrical engineering in the University of London. This Medal is awarded by the Council of the Institution not more frequently than once a year, either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science, without restriction as regards nationality, country of residence, or membership of the Institution. Prof. Fleming is well known as the inventor of the first thermionic valve, and has played a notable part in the development of many applications of electrical science.

TWO distinguished octogenarian men of science—Sir Robert Elliott-Cooper, K.C.B., and Sir John Isaac Thornycroft, F.R.S., on the civil and marine sides of engineering respectively, celebrate their birthdays next week. The former enters on his eighty-fourth year, having been born at Leeds on Jan. 29, 1845. Many railway and allied projects have engaged his activities both at home and overseas, establishing notable progress in the Victorian era. Sir Robert succeeded Prof. Unwin in 1912 as president of the Institution of Civil Engineers, and a portrait of him hangs there.

SIR JOHN THORNYCROFT, the eldest son of Thomas and Mary Thornycroft, was born in the Via Felice, Rome, on Feb. 1, 1843, and thus enters on his eighty-sixth year. Educated in early life at private schools, he derived much mechanical training at home, as well as skill in the drawing arts. When eighteen years old he constructed a small steam launch, the *Nautilus*, the first steam craft on the Thames that attained enough speed to keep up with racing crews. A period of intensive training and study followed at Jarrow-on-Tyne, in the engineering department of the University of Glasgow, and at Govan. In business at Chiswick, he became a builder of torpedo-boats, and is justly regarded as the pioneer in the construction of that form of high-speed craft. In 1903 Messrs. Thornycroft and Co. transferred their shipbuilding yards to Southampton, whilst later, important motor works were set going at Basingstoke. Experiments with hydroplanes were begun in 1908, culminating in the remarkable craft known as coastal motor-boats, well remembered in the Navy for their service during the War. Sir John was elected a fellow of the Royal Society in 1893.

ON the occasion of his visit to London to receive the Symons Gold Medal of the Royal Meteorological Society, Dr. Hugo Hergesell, the Director of the Prussian Aerological Observatory at Lindenberg, delivered a brief address, selecting as his subject the observation of cloud with special reference to the safeguarding of aviation. Lindenberg Observatory is not only the central observatory in Germany for the scientific investigation of the upper air, but is also the headquarters of that branch of the meteorological service which is charged with the issue of weather reports and forecasts for aviation. Soundings of the lower 3000 metres are made at the Observatory twice a day as a matter of routine, kites, captive balloons, or kite balloons being used to lift the reading instruments, according to the wind conditions prevailing at the time. These three different methods of levitation make it practicable to obtain soundings under almost all meteorological conditions. From the records of temperature and humidity so obtained, the heights and thicknesses of the various cloud layers can be determined, and information on this point is regularly included in the reports broadcast from the Observatory for the guidance of aviators. The difficulties encountered in interpreting the records of the hair hygrometer, in consequence of the deposition of a coating of ice on the hair, were briefly discussed.

DR. HERGESELL then gave some account of the work of the meteorological flight at Tempelhof, which works under the direction of the Observatory at Lindenberg.

This flight is equipped with a Junkers A 20 machine, and ascents are made as frequently as circumstances permit. The pilots attached to the flight have received special scientific training, and a professional meteorologist is carried on each flight as observer. The aeroplane is equipped with a so-called 'gyrorector' or horizontal gyroscope to enable the pilot to determine the direction of the vertical when flying through cloud, as it is well known that in such circumstances the unaided human sense of equilibrium may be entirely at fault. Whenever possible flights are made through the cloud layers, and the flight already has to its credit a large number of ascents made under these difficult conditions. In conclusion, Dr. Hergesell described the use of the inverting range-finder having a base of six metres for the measurement of the heights and movements of clouds, and showed a number of slides exhibiting cloud waves, on which the heights and wave-lengths as determined by such observations were marked.

JUDGING from reports in the daily press on Jan. 24 of the experiments carried out by the engineers of the Bell Telephone Co. on a new loud speaker, it seems clear that their new instrument has a much greater range than any existing loud speaker. Standing on a hill overlooking Hoboken, the engineers of the Company spoke in ordinary tones into a field telephone which was connected with a loud speaker placed on the top of their laboratories in New York, more than a mile distant. After a few seconds their words came back to them as clearly as they had spoken them. They also spoke in this way to the crews of vessels in the River Hudson, which lay between them and the loud speaker. A lady twenty miles away sang a song into a transmitter connected with the loud speaker, and we are told that every tone was clearly reproduced and transmitted. None of the sounds made by the speaker or singer was in the least distorted. The loud speaker reproduces, with no appreciable distortion, tones having vibrations of from 40 to 8000 cycles per second. The excellence of the results obtained is attributed mainly to the high efficiency of the new arrangement of apparatus. It is claimed that more than 50 per cent. of the electrical energy supplied is converted into wave-energy. The diaphragm used in this loud speaker is thinner than a sheet of gold leaf and is little larger than a watch dial. For broadcasting it has many advantages, and it can fill an auditorium with the same volume of sound that sixty men playing instruments would produce. Doubtless a vast crowd can be addressed by its use, and as 'gigantophone,' 'stentorphone,' 'magnavox,' etc., already describe other loud speakers, it will be difficult to find a suitable word to designate it.

THE increasing use of alternating current for supplying electric energy for light and power in Great Britain has led some engineers to think that in the future there will be a diminishing demand for storage batteries. In a paper read to the Institution of Electrical Engineers on Jan. 5, however, Mr. E. C. M'Kinnon gives several reasons for thinking that the demand will increase. New and novel applications for storage batteries are continually arising. They are used for motor-cars and for industrial electric vehicles, and are of great value for helping supply stations to maintain their pressures during peak loads. They are a necessity for submarine vessels. They are also most useful for alternating current automatic plants, for radio beacon equipments, and for broadcasting. The Post Office, however, is the largest user of storage batteries. The gradual adoption of automatic telephones is rapidly increasing the electric power required for the exchanges. It is estimated that this year the ampere-hour capacities of the batteries in the London area alone will be 627,000, with an estimated discharge rate for a nine-hour day of 2000 kilowatts. An official estimate is that by 1936 the capacity of the batteries installed in Great Britain will have increased from the present value of 28,000 kilowatt hours in nine hours to 100,000 kilowatt hours in nine hours. In thirteen or fourteen years there will be about 120 automatic exchanges in London alone, requiring some 21,000 horse-power for six hours to operate them. A very large quantity of lead is used annually in Great Britain for making accumulators. In 1926 it amounted to 247,000 tons, or nearly one-sixth of the total world production of 1,600,000 tons. There is practically no lead in South America and, if we exclude Burma, in Asia. The United States produces 500,000 tons per annum. The combined total annual output of Spain, Mexico, and Canada is about 340,000 tons. Production, however, is largely controlled by demand, and so it is unsafe to assume that the price of lead will rise in the future.

SENSATIONAL claims have recently been made in the *Daily Express* with regard to the possibility of increasing the normal yield of cereal crops from three to five times by means of transplanting the seedlings at a very early stage in development. A machine, invented in Germany, is said to distribute 12,000 seedlings per hour at the rate of about one per square foot, the resulting plants tillering very freely, each producing thirty to forty stems or more. The quantity of seed needed is one-thirtieth or less of that generally used, and the grain is said to be superior in quality to that usually obtained. The method of transplanting has been in use in China for thousands of years, but there hand labour is extremely cheap and circumstances have demanded the most intensive cultivation possible. Under European conditions, labour is so expensive that the saving in cost of seed is negligible compared with the increased labour costs.

THE two main principles underlying this transplanting method are increased root development due to transplanting, and increased tillering allowed by the extra space per individual plant. The former result can be obtained less expensively by the adoption of special methods of surface drilling with machines adapted for the purpose. As regards the second point, it is generally accepted that too thin seeding fails to give maximum crops per acre, and very careful

comparative tests would be necessary to prove whether this is also the case after transplantation or not. One great danger under field conditions in the uncertain climate of England would be in that of drought after transplanting, as a few days of fine weather in the early autumn might be sufficient to ruin acres of plants. As to the effect on the yield, it is quite possible to get a heavy increase on a small area under special conditions of cultivation and soil preparation, but it is far more difficult to maintain the same level of increase over large areas which cannot receive such particular treatment. While it is to be hoped that the method will receive full investigation, it would be unwise to raise the hopes of agriculturists until the experimental results are known.

THE next International Mathematical Congress will be held at Bologna on Sept. 3-10. Since the War, previous congresses have been held at Strasbourg in 1920 and Toronto in 1924, but the Bologna meeting will be the first since the War that will be strictly international in character, its two predecessors having been restricted as to membership to subjects of allied or neutral nations. The Italian Prime Minister takes great interest in the Congress and has accepted the office of honorary president. Arrangements are actively proceeding for the various sections of pure mathematics and applications of mathematics to economics and to scientific and technical problems. In addition, excursions are being proposed for visiting the art treasures of Florence and Ravenna and some of the principal hydro-electric plants of Italy. Prof. Pasquale Sfameni, rector of the University of Bologna, is organising president, Prof. S. Pincherle is president of the executive committee, and the general secretary is Prof. Ettore Bortolotti, Via Zamboni 33, Bologna. This is the second congress held in Italy, the previous one being at Rome in 1908.

THE fifteenth International Geological Congress will be held in South Africa in 1929, and the date of the inaugural meeting in Pretoria is to be during the fortnight following July 29. The special subjects provisionally proposed for discussion are: (a) magmatic differentiation; (b) pre-Pleistocene glacial periods; and (c) the stratigraphy, palæontology, and world distribution of the Karroo system. In the past the Congress has published several economic studies of great value, and on this occasion the subject suggested, "The Gold Resources of the World," is particularly appropriate. It is proposed to organise two long excursions before the session opens: one to illustrate the more attractive features of the geology of the Cape, concluding with a visit to the diamond mines and to the Dwyka glacial deposits near Kimberley; and the other to provide an opportunity of making a detailed study of the diamond pipes and of the Witwatersrand goldfield. During the session itself there will be excursions around Pretoria, to Johannesburg, and to the platinum field of Rustenburg. Three alternative excursions are provisionally proposed to follow the session: (a) to the Vredefort granite dome; (b) to the Drakensberg escarpment and the asbestos deposits of Barberton; and (c) to the Stormberg, for the study of the Karroo system. After the first two of these a long excursion to the Bushveld Complex is to be held, and, if it be possible, an alternative tour will be arranged, bringing in the Victoria Falls, the Wankie coalfield, and the Bulawayo district. Communications should be addressed to The General Secretary, XV. International Geological Congress, P.O. Box 391, Pretoria.

AN International Geographical Congress, under the auspices of the International Geographical Union, will open in London on July 14 and transfer to Cambridge on July 17, where the scientific and business transactions will continue until July 25. General Vacchelli, president of the Union, will preside over the Congress. The meetings in London will be mainly ceremonial, and will include receptions at the Royal Geographical Society, the Science Museum, and, by the Lord Mayor and Corporation of the City, at the Guildhall. At Cambridge there will be a reception by the Vice-Chancellor of the University and a dinner and reception offered by the Government. The work of the Congress is to be divided into six sections: (*A*) mathematical, (*B*) physical, (*C*) biological, (*D*) human, (*E*) historical, and (*F*) regional. Three subjects have been specially selected for discussion: (1) The problem of rural occupation, including the origin and causes of the agglomeration or dispersion of rural habitation, and the influence of natural conditions and racial traditions. (2) The International map on a scale of one to a million, which is making steady progress in many countries. (3) The study of pliocene and pleistocene coast and river terraces with the object of determining the existence of constant levels, if they exist, and of fixing their succession. The Committee will also welcome communications on any subject, and particularly the following: (4) Variation of climates, (5) flora and fauna of high mountains, (6) the map of internal drainage areas on which M. E. de Martonne is preparing a memoir for the basis of a discussion.

FIVE mornings will be devoted to meetings of the sections of the Congress, and several afternoons to more general geographical topics. Exhibitions are being arranged of the Carte du Monde Internationale au Millionème, the maps of the Ordnance Survey, and the Geographical Section of the War Office. At the end of the Congress a number of excursions, of two to five days' duration, will be arranged. These will be by motor coach, and will enable foreign visitors to see various parts of England and Wales. Arrangements have been made for reduced fares for members travelling to London and Cambridge to attend the Congress. The chairman of the executive committee is Sir Charles Close and the secretary is Mr. F. Debenham. Applications for membership (£1) and all inquiries should be addressed to The Secretary, International Geographical Congress, Caius College, Cambridge.

IN 1600 the reindeer was to be found in all parts of the Scandinavian peninsula. Now it is extinct as a wild animal in Sweden and Finland. In *Naturen* for for November, Carl Schulz tells the melancholy tale of the war of extermination that has been waged

against it in Norway. Successive "inventions of the devil," as various true sportsmen have called them, from the flint-lock to the latest long-distance rifle, have gradually diminished the numbers of this interesting creature. At the beginning of this century a complete close time was enacted from 1902 to 1906. The herds increased and the slaughter began again, so that to-day the situation is as in 1901. There is no economic reason for this destruction: 72 per cent. of Norway is uninhabitable fell. Surely there is room enough for the wild deer. New laws, says the author, are useless so long as they are neither obeyed nor enforced.

COMMDR. R. E. BYRD, U.S.N., who in 1926 flew from Spitsbergen to the Pole, is planning an expedition to the Antarctic. The *Geographical Journal* for January states that he proposes to enter the Ross Sea in December this year and to make his base at the Bay of Whales on the Ross Barrier, where relatively calm weather may be expected. Dog teams will be used to lay out four or five bases 100 miles apart towards the Pole. These will be used in case of mishap on a polar flight which is to be one of the main features of the expedition. Ten scientific workers will accompany the expedition, and the remainder of the party will consist of men with previous Arctic experience. Eskimo-dogs, aeroplanes, and snow tractors will be taken. The flying machines will include one large tri-motor monoplane, similar to that used in Com. Byrd's recent trans-Atlantic flight, and one or two single-engine monoplanes. The hope of taking off from the open sea off the Barrier is a doubtful project since ice will almost certainly form on the floats. A trans-Continental flight to the Weddell Sea will probably not be attempted on this expedition, but aerial photography is proposed in the region of Edward Land and in the unknown region to the east of it, where no ship has been able to penetrate.

THE Galton Anniversary Dinner will be held at the Rembrandt Hotel, Brompton Road, on Thursday, Feb. 16, at 7.15 P.M. The Galton Lecture will be delivered by Mr. C. J. Bond, who will take as his subject, "The Distribution of Natural Capacity in the Population and the Need for National Stock-taking."

AT the ordinary meeting of the Institution of Electrical Engineers to be held on Thursday, Feb. 2, at 6 P.M., a portrait in oils of Mr. Ll. B. Atkinson, past president of the Institution, will be formally presented to the Institution by the Cable Makers' Association. The portrait was painted by Mr. G. Harcourt, R.A.

IT is announced in *Science* that Dr. H. J. Muller, professor of zoology at the University of Texas, has been awarded the 1000 dollars prize of the American Association for the Advancement of Science for his paper on "The Effects of X-radiation on Genes and Chromosomes," read at the recent Nashville meeting of the Association.

THE King has conferred the rank of Honorary Knight Commander of the Order of St. Michael and St. George on Dr. A. Castellani, Director of Tropical Medicine at the Ross Institute and Hospital for Tropical Diseases, Putney Heath. Dr. Castellani is well known for his discoveries in connexion with sleeping sickness, yaws, and other tropical diseases, and is at present in the United States at Tulane University, New Orleans. He is also to be congratulated on the announcement made last week that the King of Spain had conferred on him the Grand Cross of the Order of Civil Merit.

THE following have been elected officers of the Royal Meteorological Society: *President*, Sir Richard Gregory: *Vice-Presidents*, Sir Gilbert T. Walker, Col. A. J. H. Maclean, Mr. R. Arnison, Mr. I. D. Margary; *Treasurer*, Mr. F. Druce; *Secretaries*, Dr. C. E. P. Brooks, Commander L. G. Garbett, Dr. A. Crichton Mitchell; *Foreign Secretary*, Mr. R. G. K. Lempfert; *New Members of Council*, Mrs. C. J. P. Cave, Mr. F. Entwistle, Lieut.-Col. Ernest Gold, Dr. J. S. Owens, Mr. W. M. Witchell.

THE following have been elected officers of the Royal Microscopical Society for the ensuing year: *President*, Mr. J. E. Barnard; *Vice-Presidents*, Dr. R. S. Clay, Dr. W. E. Cooke, Dr. J. W. H. Eyre, Dr. James A. Murray; *Treasurer*, Mr. Cyril F. Hill; *Secretaries*, Prof. R. Ruggles Gates, Dr. Clarence Tierney; *New Members of Council*, Dr. J. D. Coales, Dr. G. M. Findlay, Mr. J. Rheinberg, Mr. E. J. Sheppard; *Librarian*, Mr. S. C. Akehurst; *Curator of Instruments*, Mr. W. E. Watson Baker; *Curator of Slides*, Mr. E. J. Sheppard.

THE Report of the Council of the Zoological Society of London states that the number of visitors to the Society's Gardens during the past year reached the record total of 2,158,208, an increase of 101,062 as compared with the previous record in 1924 (the year of the British Empire Exhibition at Wembley). The receipts for admission for the year amounted to £68,433, actually showing a decrease of £793 as compared with the receipts for 1924. This is partly due to the increased number of fellows, who were responsible for the admission of 39,964 visitors by their signatures and the distribution of their tickets; also 40,192 children were admitted free under an arrangement with the *Daily Sketch*. The number of visitors to the Society's Aquarium during the year was 458,936, and the receipts amounted to £18,293, an increase of £1050 as compared with the previous year.

PROF. HENRY FAIRFIELD OSBORN, president of the American Museum of Natural History, has been elected president of the American Association for the Advancement of Science for the present year. Vice-presidents of the various sections have been elected as follow: Section A (mathematics), Dr. K. C. Archibald, of Brown University; Section B (physics), Dr. P. W. Bridgman, of Harvard; Section C (chemistry), Dr. C. E. K. Mees, of the Eastman Kodak Laboratory; Section D (astronomy), Dr. J. S. Plaskett, of the Dominion Astrophysical Observatory, Canada; Section E (geology and geography), Dr. Frank Leverett, University of Michigan; Section F (zoology), Dr.

M. F. Guyer, University of Wisconsin; Section G (botany), Dr. C. E. Allen, University of Wisconsin; Section H (anthropology), Dr. Fay-Cooper Cole, University of Chicago; Section I (psychology), Dr. H. C. Warren, Princeton; Section M (engineering), Dr. R. L. Sackett, Pennsylvania State College; Section N (medicine), Dr. A. J. Goldfarb, College of the City of New York; Section O (agriculture), Dr. C. A. Mooers, University of Tennessee; and Section Q (education), Dr. Truman L. Kelley, Stanford University. The 1928 meeting of the Association will be held in New York City.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A research student in the department of protozoology of the London School of Hygiene and Tropical Medicine—The Secretary, London School of Hygiene and Tropical Medicine, 23 Endsleigh Gardens, W.C.1 (Feb. 11). A professor of physiology at Presidency College, Calcutta—The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (Feb. 11). An assistant on the higher technical staff of the library of the Science Museum, South Kensington—The Director and Secretary, Science Museum, South Kensington, S.W.7 (Feb. 18). Three assistant lecturers in mathematics in the University of Manchester—The Registrar, University, Manchester (Mar. 1). The Radcliffe Crooker travelling scholarship in dermatology at University College Hospital Medical School—The Dean, University College Hospital Medical School, Gower Street, W.C.1 (Mar. 31). An engineer in charge of workshops in the Research Department, Woolwich Arsenal—The Chief Superintendent, Research Department, Woolwich, S.E.18.

Our Astronomical Column.

SKJELLERUP'S COMET.—Science Service, of Washington, has distributed with a recent *Daily Science News Bulletin* a remarkable photograph of this comet taken at the Lowell Observatory, Flagstaff, in daylight. According to *Popular Astronomy*, it was taken in infra-red light. The coma is very conspicuous, being large and bright, and a fan-shaped tail may be traced for some distance. Dr. C. Hoffmeister at Sonneberg was able to trace the tail to a length of 40° on several mornings at the end of December. The head was invisible, being too near the sun (*Beobach. Zirk.*, No. 2). Mr. R. A. McIntosh, of Auckland, N.Z., sends some interesting drawings of the telescopic aspect of the comet on the morning of Dec. 6. They closely resemble those of Coggia's comet of 1874. There is the same dark space in the middle of the tail, and intersecting paraboloid envelopes. These combine to give the aspect of a bright fan opening out on the sunward side of the head. Stars being shown in the picture, it is possible to deduce a position. This comes out R.A. $16^h\ 26^m\ 51^s$, S. Decl. 51° 9′, at U.T. Dec. 5·646.

BRIGHT METEORS.—Mr. W. F. Denning writes: "Between Jan. 16 and 20, several bright meteors were observed at Bristol by an assistant. It is desirable to obtain duplicate records, as the objects were of decidedly interesting character. The particulars were as follow:

Date.	
Jan. 16, $10^h\ 3^m$ P.M.:	equal to Jupiter. Path from 61° + 72½° to 38° + 44°, slow motion, bright streak.
Jan. 19, 6 14 P.M.:	equal to Sirius. Path from 353° + 63° to 10½° + 50°. Slow. Probable radiant at 314° + 48°.
Jan. 19, 6 48 P.M.:	equal to Jupiter. Path from 26° + 44° to 31° − 4°. Slow, bright train. Probable radiant, 195° + 58°.
Jan. 20, 6 40 P.M.:	equal to Venus. Path from 300° + 76° to 300° + 36½°. Slow. Long flight. Probable radiant, 120° + 0°."

PHOTOGRAPHIC STELLAR PHOTOMETRY AT ALLEGHENY.—The 31-inch Thaw refractor of Allegheny observatory was designed principally for the purpose of parallax observations, but as it was possible to undertake this work during only a part of each night, the remaining hours of darkness have been utilised for other purposes in order to make the best use of this fine instrument. The most important work which has been carried out is photographic photometry by the extra-focal method. This is especially interesting in view of the fact that hitherto no large telescope has been devoted to this work, since reflectors can conveniently utilise only sharp focus images for this purpose, and extra-focal work has mainly been performed by small refractors uncorrected for photographic rays. The large aperture of the photographic telescope at Allegheny renders it especially useful for photometric work on short period variables, where great speed in exposure is essential. An account of the instrument and methods of work is given in the *Publications of the Allegheny Observatory*, vol. 7, No. 1, together with the results so far obtained for 29 faint Cepheid variables. Details of all the observations are given in each case, as well as light curves based on normal places.

THE ANCIENT ASTRONOMY OF THE MAYAS.—The attempts that have long been made to gain some insight into the scientific knowledge of the Mayas are beginning to bear fruit. Dr. H. J. Spinden contributes an article to the *Scientific American* for January on their system of astronomy, which presumably was derived independently of any systems hitherto known. The zodiac was for them also an 'Animal Circle,' but the animals were quite different from ours; the Pleiades were in the Rattlesnake; the Turtle occupied part of Gemini; they had a Scorpion, but it was adjacent to Gemini.

The Maya gained a considerable knowledge of the planetary movements, and obtained useful cycles, after which configurations repeated themselves. They found the 8-year Venus cycle so far back as the sixth century B.C., and later found the very exact 243-year cycle. Their zodiac is stated to have contained 13 signs, and their year 13 months of 28 days each, a device which many calendar reformers wish to adopt now. It is not stated how they arranged the odd day.

The article states that the Maya adopted in their astronomical records a continued count of days, starting with 613 B.C., similar to the system of Julian days; such a count is of great utility in tracing cycles of recurrence, which were much more difficult to detect among nations that used a lunar calendar. Their instruments for pointing on the stars had V-shaped sights like those used on rifles. Further contributions are promised, and it is evident that these records are of a character likely to repay all the trouble that has been taken in their decipherment.

Research Items.

HESPEROPITHECUS.—The attention of our readers is directed to an interesting statement on this animal published by Dr. W. K. Gregory in a recent number of *Science* (Dec. 16, 1927). As is well known, the specimen is a much worn tooth and therefore very difficult to decipher. Its original description as being a primate was received in many quarters with considerable scepticism. The authorities of the American Museum of Natural History, not content to leave the question in doubt, have made every effort to set it at rest by careful search for further material. As a result it now appears practically certain that the animal is not primate at all and that the tooth in question belongs to a peccary, Prosthenops. Dr. Gregory has paid great attention to the problem, and his considered opinion carries the greatest weight.

STONE CELTS FROM INDIA.—Two recent finds of stone implements are recorded in vol. 22, N.S. No. 3 of the *Journ. and Proc. of the Asiatic Soc., Bengal*. The first is a celt from the Naga Hills which is described by Mr. J. H. Hutton. It is remarkable in that the material, instead of being 'Indian jade,' olivine, serpentine, or similar material, as is almost always the case, is made of fossilised wood. It was found by Mr. G. Heseldin early in 1926 when making a road at Nichuguard at the foot of the Naga Hills. Its measurements are: maximum length 4⅞ in., max. breadth 2⅜ in., max. thickness ⅝ in. It is slightly shouldered—the usual form. As this silicified wood is abundant a few miles north-west of Dimapur, it may fairly be inferred that it was made locally. The second find consisted of two neolithic implements discovered when a tank was being dug at Jamalpur (Monghyr). They are described by Upendra Nath Brahmachari and Shyama Charan Brahmachari. The first implement was found at a depth of ten feet. It is an unpolished celt with sharp, round, cutting edge, both sides of the edge being ground and polished up to a depth of one inch. There is a prominent ridge on one side on the unpolished portion. The second specimen was found at a depth of 15 ft. It is an unfinished celt with a cutting edge slightly curved. One side has been hammered into shape and there is a groove for hafting broken at the top. Both implements are made from the same rock, a fine grained schistose phyllite which occurs about two miles away.

CANCER.—Cancer of the uterus is one of the chief causes of death in middle-aged and elderly women, and the Departmental Committee of the Ministry of Health has issued a useful memorandum (Circular 826) which summarises the present position in respect of diagnosis and treatment. The natural duration of the disease from the first symptom to death is on the average rather less than 2 years. About half the cases when first seen by medical men have already advanced beyond the stage at which surgical operation is possible. Of these inoperable cases, some 10 per cent. can gain some considerable prolongation of life and perhaps be cured by the local application of radium. Of those in whom it is possible to attempt the removal of the growth by operation, at least 10 per cent. die from the necessary severity of the procedure, and about 40 per cent. survive for at least 5 years, most of whom may be looked upon as cured. Cases which are operable can also be treated with radium, which gives no operation mortality and presumptive cure in 40 per cent. On the average, therefore, about 1 woman in 5 who comes to a doctor with symptoms of uterine cancer has a fair prospect of being cured—a position bad enough, but a good deal better than it used to be. The natural progress of the disease being so rapid, it is imperative that the slightest sign of irregular uterine hæmorrhage should be taken seriously and expert advice obtained.

THE FOOD-FISHES OF ST. ANDREWS BAY.—Prof. W. C. M'Intosh ("The Food-Fishes of St. Andrews Bay") has brought together his notes which were published in the *Fishing News* from Aug. 13 to Oct. 29, 1927. These notes were made by the author at intervals over a period of about forty years, and, as he states in the preface, the Bay and its fisheries have been familiar to him for more than eighty years. The actual records begin in 1885 and extend to 1922, but few are made in each year, even at times only a single entry. It is interesting to follow these casual notes, which show the nature and magnitude of the catches at various times. These include plaice, herrings and sprats, cod, haddock, skate and young dabs, lemon-dabs and flounders. Often the contents of the fishes' stomachs were examined. At times sharks, porpoises, and large numbers of sea-birds were caught and duly noted. Apparently there are still many young fishes in St. Andrews Bay, and it is to be hoped that the writer is not too optimistic in his confidence in the permanent abundance of food-fishes in that area.

NORTH AMERICAN DIATOMS.—The second part of "A Synopsis of the North American Diatomaceæ," by Charles Boyer (*Proc. Acad. Nat. Sci. Philadephia*, vol. 79, 1927, Supplement), is now published, the first part having appeared in 1926 in the same publication (vol. 78). This first part contained, in addition to the introduction and classification, the Centricæ and the first division of the Pennatæ (Fragilariatæ). The present part contains the remainder of the Pennatæ (Naviculatæ and Surirellatæ), and as in this group are included the majority of the fresh-water and littoral forms which are more easily collected and more frequently studied than those from the open sea, it is much more complete than the first part. Welcome additions are a good index, and an appendix recording several of those planktonic marine species omitted before. Most of these latter are recorded from La Jolla, California, and from the Gulf of Maine. The two parts together form a valuable guide to North American diatoms, and the author is to be congratulated on the completion of his arduous task, the number of species and varieties in the synopsis being upwards of nineteen hundred.

THE GOLGI APPARATUS OF PROTOZOA.—At least five different types of supposed Golgi bodies have been described in Protozoa and a useful review of them is given by Dr. S. D. King (*Jour. R. Micr. Soc.*, **47**, part 4, 1927). Hirschler (1914) first recorded a Golgi apparatus in Protozoa in the form of osmiophile rings and crescents in the cytoplasm of *Monocystis ascidiae*, and Golgi elements have since been described in other gregarines and coccidia. In all these Sporozoa the Golgi apparatus is in the form of discrete rods and granules, often clumped near the nucleus in the early stages but later spreading through the cytoplasm. Its function is probably secretory, there being evidence to indicate that the lipoid granules of the gametocyte are derived from the Golgi elements. The work of Duboscq and Grassé (1924–27) points to the homology of the Golgi apparatus of herpetomonads and other flagellates with the parabasal apparatus (kinetonucleus). It is suggested that the clear 'space' around the kinetonucleus, which can

be stained *intra-vitam* and is therefore not an artefact, may correspond to the chromophobe substance. Grassé considers that the stigma of the euglenoids, which may or may not be coloured, represents the parabasal apparatus. After reference to lipoid cell constituents believed to represent the Golgi apparatus in Opalina and Anoplophrya, a résumé is given of Nassonov's work (1924–25) on the contractile vacuole of ciliates. Nassonov assumes that the permanent osmiophile membrane which surrounds the vacuole secretes the osmotically active substance necessary to the working of the vacuole and pours it into the latter after each successive systole—a secretory activity which is compared with that of Golgi bodies in the gland cells of Metazoa. He figures a ring-shaped Golgi apparatus in relation to the contractile vacuole. Dr. King points out that investigations are required on flagellates such as Bodo and Euglena in which both parabasals and contractile vacuoles are present.

PRAIRIES AND TREE GROWTH.—Various theories have been advanced to explain the lack of tree growth on the prairies. Prof. J. E. Weaver, of the University of Nebraska, has re-examined the problem, and the results of his experiments, as communicated to the American Association for the Advancement of Science, are summarised in a *Daily Science News Bulletin* issued by Science Service, Washington, D.C. His work in tree planting on densely vegetated prairie confirms the observations of other workers in the same field (see Ewing, *Jour. of Ecology*, vol. 12, No. 2, p. 238). The climatic prairie is overcrowded, and there is never enough water and soil nutrients for all species, and consequently the dense mat of vegetation makes the chances of the newcomer very poor. Even when planted in a strip 12 inches wide from which the sod has been removed, trees make little headway. After three years, Weaver found that the trees were only 18 inches high, but with roots 7 feet deep and widely branched. None of the roots extended into the grass sod. In a second row the sod was unbroken, but the grasses were kept cut back, giving the tree seedlings full sunshine but not enough water. Here again most of them were greatly dwarfed. In other rows the trees were left unaided in their struggle with the grasses, and only a few sickly specimens survived. Watering made conditions even worse for the trees, for the resulting vigorous growth of the grasses caused greater overshadowing of the tree seedlings.

THE MISSISSIPPI FLOODS.—A study of the floods of 1927 in the Mississippi basin is the subject of a recent memoir by Mr. H. C. Frankenfield (*Monthly Weather Review*, Supplement No. 29). The lower Mississippi floods, which were disastrous in the spring of 1927, are caused by a wide distribution of rains over the central plains. The waters of the Missouri River above the mouth of the Platte, and of the Mississippi above the mouth of the Wisconsin, do not materially add to the strength of the floods. In comparison with 1922, the previous year of great floods, there was little difference in the rainfall during January and February, but in 1927 there were heavy falls in April in the lower Arkansas valley, while a heavy fall in the Ohio basin in the previous December contributed a good deal to the floods. The probability of such high waters occurring in the near future is not great, although the last great flood was only five years ago. At the same time, Mr. Frankenfield believes that last year's floods did not attain the possible maximum. He calculates the maximum levels as follows, compared with the 1927 level: Cairo, 58 ft. (1927), possible 66 ft.; Memphis, 47 ft. (1927), possible 55 ft.; New Orleans, 27·5 ft. (1927), possible 30 ft. At New Orleans the effect of tides and winds may also be felt. The monograph contains full statistical data and is illustrated with rainfall and other maps.

THE DIFFRACTION OF ELECTRONS.—The experiments of C. Davisson and L. H. Germer on the elastic reflections of electrons from a single crystal of nickel, which were the subject of correspondence in NATURE last year (April 27), are described in detail in the December number of the *Physical Review*. They are remarkable both for the complicated nature of the apparatus and for the significance of the results. The experimental tube contained an elaborate piece of metal-work, consisting essentially of an 'electron gun,' a nickel target, and a Faraday cylinder to collect the reflected electrons, and although the whole was maintained at a pressure which was probably less than 10^{-8} mm. mercury, the constituent parts were capable of movement which allowed the scattered electrons to be examined for distribution both in latitude and azimuth. Those electrons which lost little energy in the process behaved as if they were equivalent to pencils of radiation, except that it was necessary to suppose that the crystal was effectively contracted normal to its surface by an amount depending on the speed of the particles. The corresponding wave-lengths agreed with those required by wave mechanics. It has also been found possible to deduce the structure of the adsorbed films of gas which are present when the crystal is not scrupulously clean, from the additional diffracted pencils to which they give rise, but it appears from a subsequent paper read by the authors at the December meeting of the American Physical Society that there is here some uncertainty in the interpretation of the results.

GAMMA-RAYS FROM POTASSIUM SALTS.—In determinations of the residual radiation of his instruments in the Berlepsch shaft at Stassfurt, Prof. Werner Kolhörster has found an appreciable γ-radiation from 'Hartsalz' ($NaCl$, $MgSO_4.H_2O$, KCl) (*Die Naturwissenschaften*, **16**, 28; 1928). Preliminary measurements with iron of mean thickness 3·75 cm. gave a value of $\mu_{Fe} = 0{\cdot}19$ cm.$^{-1}$, so that the rays are harder than those from radium C after filtering through 4 cm. lead, in which case $\mu_{Fe} = 0{\cdot}356$ cm.$^{-1}$ (Kohlrausch). Further measurements with large quantities of sylvine yielded the following values of μ_{Fe} for the thicknesses of iron given in brackets: $\mu_{Fe} = 1$ cm.$^{-1}$ (up to 8 mm.), $= 0{\cdot}35$ cm.$^{-1}$ (8 to 16 mm.), $= 0{\cdot}19$ cm.$^{-1}$ (16 to 60 mm.). The intensity of the radiation per gram of sylvine was equivalent to that from at least 10^{-11} gm. of radium, but separate measurements of the amount of radium in the sylvine showed that the radiation could not be attributed to radium contamination. The investigation of the thorium content of sylvine is being carried out, but there seems little doubt that the γ-radiation is due to potassium. The radiation is proportional to the potassium content, and its hardness suggests the existence also of a very penetrating β-radiation, hitherto unknown, from potassium. The work is being continued, and rubidium and cæsium are also being investigated. There appears to be also a γ-radiation emitted by rubidium.

ACTIVE NITROGEN.—The November issue of the *Journal of the Chemical Society* contains a further account by E. J. B. Willey of his investigations of active nitrogen. This modification of the element has been considered to be atomic, molecular and metastable, and triatomic by various workers, and a brief summary is given in the above paper of each of these views. It was suggested that the luminous phenomena observed with active nitrogen are due, not to the chemically active constituent, but to the

recombination of a small proportion of nitrogen atoms produced simultaneously, and Willey has carried out four series of experiments which support this view. The luminosity was destroyed both by heat and by an auxiliary electrical discharge, and it was found that chemically active nitrogen was still present. Willey considers that the non-luminous form of active nitrogen is probably a metastable diatomic or acetylenic molecule with a heat of formation of approximately 45,000 cal./gm.-mol., while the heat of formation of the atomic form is 200,000 to 250,000 cal./gm.-mol. These new views explain satisfactorily various observations which previously appeared to be contradictory.

THE SURFACE TENSION OF LIQUID CARBON DIOXIDE.—The surface tension of liquid carbon dioxide has been determined by E. L. Quinn over the temperature range 25° to − 52·2°, and the results are given in the *Journal of the American Chemical Society* for November. The capillary rise method was the only one that could be employed owing to the very high vapour pressure of carbon dioxide at ordinary temperatures. The capillary tube was enclosed in a Pyrex tube of 1 cm. diameter, the carbon dioxide being distilled in before sealing off. The observations were corrected for the quantity of liquid in the meniscus and for the capillary effect of the narrow outer jacket. The surface tension was then calculated, using density values for the liquid obtained by Behn and Jenkin, and extrapolations of Amagat's values for the vapour, an equation being derived for calculation of the density of the saturated vapour between 25° and 0°. From the surface tension results the internal pressure of liquid carbon dioxide was calculated and found to be about the same as that of carbon tetrachloride, toluene, and chloroform, and hence, according to Hildebrand's view of solubility, carbon dioxide probably resembles these liquids in its solvent properties.

ELECTRICAL DISTURBANCES IN CABLES.—Very little progress has been made since Kelvin's time in explaining the curious effects produced by sudden electrical and magnetic storms in the working of submarine cables. All these cables are worked by an earth return circuit. Hence external disturbances can enter the circuit directly from the earth connexions. Some of these disturbances are doubtless due to currents in the earth caused by natural phenomena. Others are artificial and due to the working of other cables and to the earth currents caused by electric railways, tramways, and power stations. The cable companies give much more thought to methods of alleviating these disturbances in their lines than to detecting the causes of them. They have found that the best remedy is to make the earth connexion in deep water at a depth of about 100 fathoms. This is done by taking the earth connexion to a special core insulated inside the cable and connected with the sheath at the desired earthing point. All the high speed Atlantic cables now use sea 'earths' at a suitable distance from the end of the cable. The remaining disturbances, when troublesome, can be swamped by increasing the current. Magnetic storms, however, seem to act on the cable directly by induction. Very h gh voltages have been observed during these storms between the cable end and the earth. Work is quite impossible during a bad magnetic storm and the cable is earthed at both ends for protection. Fortunately, such storms are rare, and seldom last for more than a few hours. Not infrequently, however, after a severe storm, they recur for several days in succession. Kelvin thought that these storms would give splendid opportunities for scientific observation. But as Mr. Hughes in his paper on submarine cable design, published in the January number of the *Journal of the Institution of Electrical Engineers*, points out, the cable engineers are then very busy and have no time to take observations and make measurements of the disturbances.

ARC TYPE ELECTRO-STEEL FURNACES.—A large number of electro-steel furnaces of the arc type are used in industry. The discovery of stainless iron and steel has given a large and rapidly extending use for electric steel furnaces. One of the difficulties that has to be overcome is to maintain the electrodes at a constant distance apart, notwithstanding the continuous alterations which occur in the circuit. These are mainly due to the alterations that occur during the melting period in the position of the iron and scraps. The liquid charge also bubbles and the electrodes continually burn away. To compensate for these changes the electrodes have to be continually moved. The efficiency of these furnaces and the time required for each charge depends largely on the electrode regulating devices. In *A.E.G. Progress* for November, two types of regulator are described. The first method is the Leonard-Tirrel System. As these furnaces generally employ a three-phase arc, three direct current lifting motors are used to move the electrodes. These motors are controlled in a way similar to that used to keep the voltage of an ordinary alternator constant by means of a voltage regulator. In the second method hydraulic cylinders are employed, the pressure being controlled by means of valves. A water supply under a pressure of about four atmospheres is required and, if necessary, this can be obtained from a special plant. Both these methods are found satisfactory in practice. The position of the electrodes can be controlled by hand at any distance from the furnace; they produce a constant current automatically, and in the event of a failure of the supply voltage both electrodes remain in a fixed position.

HARMONIC CURVES.—Donkin's harmonograph, designed and constructed in wood by Mr. A. E. Donkin in 1873, was presented by him in 1925 to the Science Museum, where it is exhibited with the mathematical instruments. It is described in the *Proceedings of the Royal Society*, 1874, vol. 22, pp. 196-199. Prof. Tyndall was much interested in the instrument, and at his suggestion Mr. Donkin had a similar instrument constructed by Messrs. Tisley and Spiller. This was exhibited at the Special Loan Collection at South Kensington in 1876. The harmonic curves are drawn by a pen on a paper secured round the surface of a cylinder. By means of two eccentrics, simple harmonic motions are given to the pen and cylinder respectively, the relative number of vibrations being variable by the use of change wheels. Since both pen and cylinder move at once, the curve drawn shows the combination of the two motions. In the second edition (1884) of the book on acoustics written by his father, Prof. W. F. Donkin, previously Savilian professor of astronomy at Oxford, Mr. Donkin added an article on compound harmonic curves (pp. 50-54), illustrated by 21 examples of the curves drawn by his instrument. Some of these curves are included in a printed sheet of 15 curves now issued by him. Expressed in terms of musical intervals, the curves represent: simple tone, octave above, the two combined, fifth, fourth, major third, minor third, major tone, minor tone, sixth, semitone, twelfth, comma, octave out of tune, twelfth out of tune. Copies of the sheet may be obtained at 2s. 6d. per dozen, post free, from Mr. A. E. Donkin, 5 Sion Hill Place, Bath.

The N.P.L. Primary Standard of Mutual Inductance.

UNDER the heading "British Scientific Gift to Japan," the *Times* recently gave a brief account of a ceremony some fuller details of which may be of interest to readers of NATURE. An absolute standard of mutual inductance was constructed at the National Physical Laboratory in 1907–8 from the designs of Mr. Albert Campbell. The standard was described by Mr. Campbell in 1912, and the value of the coefficient of mutual inductance as found by calculation was given by him as 10017·83 microhenries.

In the early part of 1914, Dr. Giebe, of the Reichsanstalt, visited the National Physical Laboratory in order to make an inter-comparison of various standards. The paraffin wax was dissolved off the standard inductance and the coils remeasured. Some slight variations from the original dimensions were observed, and the value of the mutual inductance coefficient when recalculated was found to be 10017·78 microhenries. The coils were not rewaxed.

In 1913 a similar standard, ordered by the Japanese Government, was under construction by Mr. R. W. Paul. This was sent to the Laboratory to be wound and measured with the view of the calculation of its coefficient. The work was delayed by the War, and in 1920 the grooves to hold the wire were recut in the Engineering Department and the standard completed and sent to Japan. It had only just arrived when it was destroyed by the earthquake of 1923. Soon afterwards the Japanese Government placed an order for a new standard. It was then suggested, and the suggestion was welcomed by the Lord President of the Council, Lord Balfour, that the new standard should be constructed at the National Physical Laboratory, and presented by the Lord President to the Japanese Government as a token of sympathy for the losses sustained by the earthquake; this standard is the scientific gift referred to in the *Times* notice.

A full description of the standard will appear shortly in the Collected Researches of the N.P.L. in

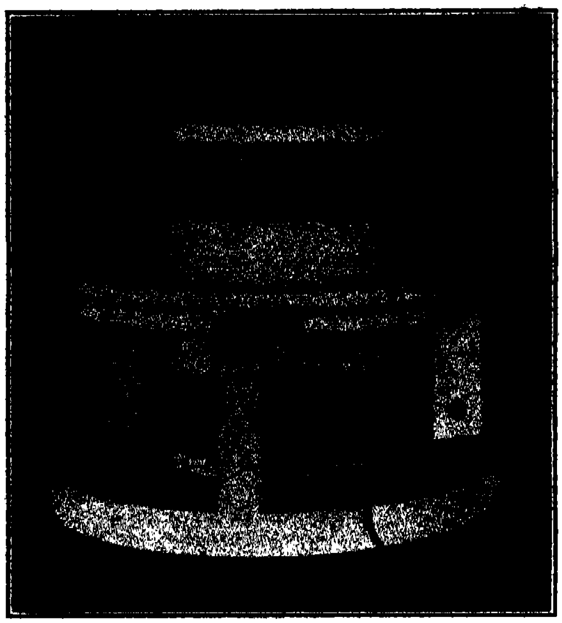

FIG. 1.—Photograph of the Japanese standard mutual inductance, consisting of the inner marble cylinder upon which are the upper and lower single layer primary windings and the outer ring-shaped secondary winding in the channel turned in the ring. The ring is supported on levelling and centring screws attached to the three marble pillars fixed to the base.

a paper by Messrs. Dye and Hartshorn of the Electricity Department of the Laboratory. Fig. 1 is a reproduction of a photograph of the standard. The interest for physicists, however, lies in the fact that its construction has enabled a very careful comparison to be made of the values of the N.P.L. standard since 1914. The recent results are given in the accompanying table taken from the paper in which the method of comparison is described.

It thus appears that the value of the N.P.L. standard in terms of the new Japanese standard of 1927 is 10017·86 microhenries. In 1921 its value was found by Dr. Dye by comparison with the first Japanese standard to be 10017·83 microhenries. As already stated, its calculated value found in 1914 was 10017·78 microhenries.

COMPARISON OF NEW JAPANESE STANDARD WITH NATIONAL PHYSICAL LABORATORY STANDARD.

Temp. Jap. Standard.	M_J. Calculated.	$M_{N.P.L.} - M_J$. Observed.	$M_{N.P.L.}$ by Difference.	Temp. N.P.L. Stan.	$M_{N.P.L.}$ at 15°.	Deviation from Mean.
	μH.	μH.	μH.		μH.	μH.
15·6	10010·03	7·81	10017·84	15·2	10017·84	0·02
15·0	10010·02	7·86	10017·88	14·3	10017·90	0·04
15·5	10010·03	7·84	10017·87	15·0	10017·87	0·01
15·0	10010·02	7·79	10017·81	14·2	10017·84	0·02
16·2	10010·04	7·83	10017·87	15·4	10017·86	0·00
16·2	10010·04	7·86	10017·90	15·9	10017·87	0·01

Mean Value of N.P.L. Standard at 15° C., 10017·86 μH.

Insulin and Synthalin.

TO elucidate the chemical constitution of a compound of the nature of insulin, two main lines of approach may be followed; methods may be devised for the isolation of the substance in a state of chemical purity, preferably, if possible, in crystalline form, or the problem may be tackled from the opposite direction, by the synthesis of bodies possessing an insulin-like action, one of which may ultimately be found to be identical with insulin itself. In the following account, brief reference is made to certain of the investigations recently carried out with the view of determining the properties and constitution of insulin.

PURIFICATION OF INSULIN: CRYSTALLINE INSULIN.

In a series of publications, Abel and his collaborators have described methods by means of which solutions of insulin may be made to yield crystals of the active principle. The original method was first described by J. J. Abel in the *Proc. Nat. Acad. Sci.*, vol. 12, p. 132; 1926, and involved the use of a purified insulin as a starting-point. To obtain this purified insulin, material of a unitage of about 10-15 units per mgm. was dissolved in weak acetic acid and precipitated by means of pyridine, the whole process being repeated a number of times: by this means, 35-40 per cent. of

inactive matter was removed. The material was then extracted in 90 per cent. phenol, the insulin passing into solution, from which it was precipitated by the addition of a large excess of water. The pyridine precipitation in acetic acid solution was then repeated several times, but with a sodium chloride precipitation between the first and second pyridine treatment. The material thus obtained contained 40 units or more per mgm., and was used as the starting-point for preparing crystalline insulin (J. J. Abel and E. M. K. Geiling, *Jour. Pharmacol. and Exper. Therap.*, vol. 25, p. 423; 1925).

To a solution of the purified material in acetic acid was added an acidified solution of brucine, by means of which impurities were precipitated. By the addition of pyridine to the clear solution of insulin, the compound was precipitated, largely in a crystalline form, and could be recrystallised by the same means or by dissolving in disodium hydrogen phosphate, adding acetic acid to slight permanent turbidity and setting aside for crystallisation to take place. The crystals obtained were doubly refracting, and belonged to the rhombohedral division of the hexagonal system.

More recently Abel and his collaborators have described a simpler method of obtaining crystals (J. J. Abel, E. M. K. Geiling, C. A. Rouiller, F. K. Bell, and O. Wintersteiner, *Jour. Pharmacol. and Exper. Therap.*, vol. 31, p. 65; 1927). The brucine method was applied directly to material of a unitage of 13 per mgm., and the use of the tedious phenol purification was found to be unnecessary. The material now used gave only a slight precipitate on the addition of the acidified brucine solution, but the addition of pyridine brought down the impurities, together with some of the insulin, provided the reaction was kept well to the acid side of the isoelectric point of the latter. The addition of ammonia to the clear filtrate now brought down crystals, or more usually, they appeared on setting aside to crystallise. The crystals were either rhombohedral and doubly refractive or rhombic dodecahedrons. Tested against the international standard of insulin, the crystalline material showed a unitage of 40 per mgm., and the activity was unchanged on recrystallisation.

Before discussing the chemical properties of the purified material, reference may be made to the work of Dodds and his collaborators (F. Dickens, E. C. Dodds, W. Lawson, and N. F. Maclagan, *Biochem. Jour.*, vol. 21, p. 560; 1927). By entirely different methods from those used by Abel, these workers have succeeded in obtaining an insulin of a unitage of about sixty to the milligram, but they were unable to crystallise their product, using Abel's first method. The steps in the purification were as follows: the insulin, in aqueous solution, was precipitated by the addition of trichloracetic acid to 2 per cent., leaving some of the impurities in solution. The precipitate was dissolved in dilute hydrochloric acid and the potency again precipitated, this time by means of one-third saturation with sodium chloride. The precipitate was again dissolved, in slightly acid water at *p*H 4·0, and an oxalate-oxalic acid mixture of similar reaction added. After standing, the precipitate was centrifuged off, re-dissolved in dilute acid, precipitated as the picrate, and regenerated as the hydrochloride by Dudley's process, which consists in precipitating the hydrochloride from an alcoholic hydrochloric acid solution of the picrate by means of acetone. The purest material was prepared by the use of five oxalate precipitations.

Examination of the chemical properties of the products obtained by these two groups of workers shows that they are of protein nature, thus confirming the conclusions of other investigators. The biuret, Millon's, Pauly's and ninhydrin tests are positive and the tests for tryptophane negative: Molisch's test is also negative. The nitrogen content is about 15 per cent. or somewhat less. Abel suggests the formula $C_{45}H_{69}O_{14}N_{11}S$. Dodds finds that the arginine, histidine, and especially the lysine fractions are lower in the more purified specimens of his material. The results obtained agree in general with those published by other workers, although there are discrepancies as regards the percentages of the various fractions found on hydrolysis, and in some cases also as to the presence or absence of a particular amino-acid.

Abel has raised the question as to the relationship between the sulphur of the molecule and the physiological activity. He found that boiling the insulin with $N/10$ sodium carbonate for a short time resulted in loss of potency together with a change in the condition of a portion of the sulphur, such that subsequent treatment with dilute acid led to the liberation of hydrogen sulphide. His experiments suggested that the amount of this 'labile' sulphur present was directly proportional to the potency of the particular sample under examination, the proportion of both total and 'labile' sulphur increasing with increase in potency. About one-third of the sulphur of the molecule appears to be liberated by the dilute alkali in the case of the crystalline preparation. Dodds, however, states that there is no relationship between the sulphur content and the physiological activity, the former being the same in the purest as in relatively impure material. Whether the sulphur in the molecule plays a dominant rôle in relation to the physiological activity, must, then, be left to future work to decide.

The investigations into the chemistry of insulin appear to indicate that it is either itself of the nature of a protein or, as extracted from the pancreas, is always associated with protein material. The fact that products of varying physiological activity can be obtained seems to suggest that the insulin molecule is of a simpler nature than that of any of the compounds hitherto prepared, but is associated with protein material of varying amount and composition, depending upon the particular processes of extraction and purification adopted.

SYNTHALIN.

The synthesis of certain compounds with an insulin-like action has been described by Frank, Nothmann, and Wagner, one of which, 'synthalin,' has been subjected to extensive clinical trial in cases of diabetes mellitus. The starting-point of this work was the well-known observation that guanidine and its compounds produce, on injection into animals, symptoms resembling tetany in human beings, and even convulsions. The authors found that a dose of 0·3 gm. per kgm. body weight, injected subcutaneously into a fasting rabbit, produces convulsions, accompanied by a fall in the blood sugar to 0·035-0·05 per cent. (E. Frank, *Naturwissenschaften*, vol. 15, p. 213; 1927): the administration of sugar or adrenalin can postpone the onset of the hypoglycæmia, given with the guanidine; but once the convulsions have commenced, sugar cannot relieve them. Smaller doses producing no symptoms also cause no fall in blood sugar. Methyl and dimethylguanidine produce convulsions independently of the blood sugar level: the authors therefore turned to a different type of guanidine compound, namely, agmatine, which was first extracted from herring-sperm by Kossel, but can now be prepared synthetically by a process devised by Heyn. Agmatine is amino-butyleneguanidine, and has the formula

$$HN=C\begin{matrix} \diagup NH_2 \\ \diagdown NH\,.\,CH_2\,.\,CH_2\,.\,CH_2\,.\,CH_2NH_2. \end{matrix}$$

In doses of 0·08 to 0·1 gm. per kgm. body-weight, this compound produces a fall in the blood-sugar of 30 per cent. without any obnoxious symptoms: larger doses cause a primary hyperglycæmia, followed by a fall in the blood-sugar and convulsions. The next higher homologue of agmatine, amino-pentylene-guanidine, has a more powerful hypoglycæmic action than the former compound: 0·2 gm. per kgm. body-weight is a convulsive dose, and the symptoms are similar to those produced by insulin, which was not the case with the other compounds investigated. Further, both substances resemble insulin in that the symptoms can be relieved by administering glucose.

Synthalin is closely related to the last two guanidine derivatives, being a diguanidyl derivative of a long chain aliphatic hydrocarbon, but the exact constitution has not yet been published. The toxic effects have been still further dissociated from the hypoglycæmic, doses as low as 0·003 gm. per kgm. body-weight producing a definite decrease in the blood-sugar. In applying these results to cases of human diabetes, Frank found that 20-25 mgm. constituted a suitable dose, and that up to 150 mgm. could be given in the course of four days. Such a dosage resulted in the utilisation of 40-50 gm. of glucose, which would otherwise have been excreted in the urine. If 125 mgm. cause the utilisation of 160 gm. of glucose in four days, 1 mgm. is equivalent to 1·24 gm. glucose, or, roughly, to one unit of insulin. Weight for weight, synthalin is therefore considerably less potent in causing a fall in the blood-sugar than the best samples of insulin.

The use of synthalin has in its favour the facts that it can exert its action after oral administration, and that this action, although slower in onset than that of insulin, is much more prolonged: to its disadvantage is the fact that unpleasant symptoms may be produced by it in many patients. The probable mode of action of the drug throws some light on the origin of these symptoms. Workers at the National Institute for Medical Research in London have found that synthalin only produces a decided fall in the blood-sugar in the normal animal in doses which also exert a definitely toxic action on the liver (*Lancet*, vol. 2, p. 517; 1927). This effect on the liver presumably results in a depression of the new formation of glucose which occurs in that organ, and also explains in part the unpleasant symptoms of nausea, anorexia, etc., frequently encountered in patients taking the drug: these symptoms have been found by Continental observers to be mitigated by the administration of a bile salt derivative, sodium dehydrocholate, to stimulate bile secretion, during the period of action of the synthalin: the toxic effect of the latter on the liver is believed to be counteracted by the simultaneous increase in the activity of the organ.

Apart from its action on the liver, synthalin also accelerates the disappearance of glucose from the circulation in the eviscerated spinal preparation, although the sugar vanishing is not laid down as glycogen in the muscles as is the case with insulin: moreover, large toxic doses of synthalin are necessary to demonstrate this effect. It therefore appears that the two main actions of insulin, depression of new formation of glucose in the liver and accelerated metabolism of sugar present in the blood, are represented in the effect of synthalin, but the fate of the sugar disappearing, which, in the case of insulin action, is partly laid down in the muscles as glycogen and partly burnt to carbon dioxide and water, is not absolutely similar in the two cases.

The clinical usefulness of the compound appears then to depend on how far its insulin-like action can be dissociated from its toxic effects: and this seems to occur to a different degree in different people. In Great Britain, the Medical Research Council has set on foot clinical investigations in a number of different centres, preliminary reports of which have recently been published (*Lancet*, vol. 2, p. 517; 1927): the same journal also contains a paper by E. G. B. Calvert on the treatment of diabetes by the drug (*ibid.*, p. 649). The results of these investigations show conclusively that synthalin is not a complete substitute for insulin. In certain patients, roughly one-third of the cases so far treated, it exerts a definitely toxic effect, the symptoms suggesting intestinal irritation, although a hepatic element may also be present. In a certain number it appears to be without action, but in others it enables the dosage of insulin to be reduced, although very rarely can its use be abandoned altogether. It has more effect in reducing the glycosuria than in reducing the blood-sugar.

The difficulties of estimating the value of synthalin, or that of any similar therapeutic agent, are considerable: thus, in a case in which synthalin has exerted a favourable influence, the patient may remain well, after withdrawal of the drug, on simple dieting alone; or if symptoms of gastro-intestinal irritation supervene, the accompanying loss of appetite, by reducing the food intake, may suffice to reduce the glycosuria and ameliorate some of the symptoms of the disease. Finally, since synthalin has a toxic action on the liver, it is possible that apparently good results may be due to a mild degree of this toxic action, in which case only time can disclose its real value even in the cases which appear to react successfully to it at the present moment.

Synthalin, then, is not a substitute for insulin: its real usefulness lies rather in the encouragement its discovery brings to the further investigation of synthetic compounds having an insulin-like action.

The Control of Plant Diseases.

"*Be ye ashamed, oh ye husbandmen; howl, oh ye vinedressers, for the wheat and for the barley; because the harvest of the field is perished. I have smitten you with blasting and mildew.*"—Joel i. 11 and Amos iv. 9.

In opening the discussion between Sections K and M on the control of plant diseases, at the Leeds meeting of the British Association, Mrs. N. L. Alcock chose the above text, and passing lightly over the superstitions of the past regarding disease, she turned to the problem of control as seen to-day by the pathologist and agriculturalist. From the practical point of view, the first full recognition of the importance of plant diseases came with the epidemic of American gooseberry mildew. In 1905, Prof. Salmon, of Wye Agricultural College, while Ireland alone of the British Isles was definitely affected by the disease, gave a clear warning of the need of legislative control of both American gooseberry mildew and of potato wart disease. In another direction the warning was spread in 1909 by Prof. Sommerville in his references to the white pine blister rust, *Cronartium ribicola*, which he stated was still unknown in America, though it was to be feared that the day was not far distant when its footing in North America would be secured. To-day the losses in America due to this disease are credibly reckoned as enormous.

Neither the spread of American gooseberry mildew in Britain, however, nor the ravages in American

forests by pine blister rust, served to awaken fully the British people to the need of strict control. The full awakening came with the spread of wart disease, which, though described as a new malady of the potato in England by Prof. Potter and Mr. Massee in 1902, was not recognised as a menace to our food supplies until some years later. Happily, the lesson had been partly learned from the spread and havoc of mildew and blister rust, and legislation was initiated, at first haltingly, in an effort to devise rules for disease control, and later, as experience widened, amendments followed and mildew was lessened generally. The credit for the decline of mildew may be given to legislation, but it must not be forgotten that as in human infectious diseases, so also in plant diseases, there is probably an ebb and flow, not yet fully understood.

At first little was heard of wart disease, though a further warning of the dangers which it created was given by Prof. Salmon, but its spread led in 1907 to the Destructive Insects and Diseases Act, which may be considered the first important step in legislation for the control of plant diseases, and served to bring the subject of control into prominence. The establishment of inspectors to administer the control, and of mycologists and entomologists to recognise and to teach others to recognise plant pests, followed naturally.

In 1909 a further landmark was reached with the discovery that certain varieties of potato were immune to wart disease. With the work on this discovery the names of Mr. Gough and Mr. Snell will always be associated. Little is yet known as to the nature or degree of permanence of this immunity, but so far the latter has generally been maintained. Here geneticists have helped greatly, since there is cause for the belief that immunity may be a Mendelian character which, through breeding, may yield increasing crops of disease-resisting plants. But in this field of research there is still much to do before our crops are immune to disease, mature quickly, are hardy and produce acceptable fruit in abundance, and until the possibilities of success on these lines are assured, effort must be centred largely on the control of existing disease. At the present moment the English Phytopathological Service consists of three sections—official, inspectorate, and advisory respectively—and comprises entomologists, mycologists, an administrative unit forming part of the Horticultural Division of the Ministry of Agriculture, the Ministry's inspectorate—all members of which have received training in pathology—a corps of advisers—consisting of an entomologist and a mycologist in each agricultural province—and research workers on both entomology and mycology, who are stationed at Rothamsted Experimental Station, Long Ashton Fruit Station, Bristol, the Imperial College of Science, London, the Fruit Station at East Malling, the Lee Valley Station, Cheshunt, the London School of Tropical Medicine, and other institutions.

For the full effectiveness of such a service the convinced and willing co-operation of the grower is an essential factor, for not only must the grower play his part in an advisory council, but he must also take his part in the framing and enactment of agricultural legislation. The business value of measures of control must never be forgotten. The knowledge of those who are to administer control must be accurate and wide, and above all practical. Thus, for example, in some parts of Scotland the spraying of gooseberries against American gooseberry mildew with washing soda is cheap and effective; in other parts of Scotland such spraying is harmful and destroys all hope of a crop. The use of weights and measures familiar to the grower, the need of clear and simple language in the exposition of the facts of the grower's problems, and moderation in policy in the framing of rules and regulations for the guidance of the grower, are vital to the successful co-operation of the administrative body and the producer.

There is to-day great need of a full investigation of common seed-borne diseases; for wheat may bear bunt spores, flax-seed may carry the resting mycelium of *Colletotrichum linicolum*, and both the pycnidia of *Phoma betæ* and the sori of the rust *Uromyces betæ* may be transmitted by the seed of the sugar-beet. At least some seventy common diseases are thus carried. On this aspect of control there is much need for chemical research with the view of the elimination of disease before the seed is sown.

It may be considered fortunate that Great Britain has not yet been faced by a disastrous plant-disease epidemic, but in America the loss by wheat-rust alone is reckoned at not less than 100,000,000 dollars. Nevertheless, the constant and steady toll taken from our food resources is formidable and must amount annually to tens of thousands of pounds. It may, however, be held that the greatest available field for the exercise of control of disease lies in horticulture, for here the margin of profit is relatively broad, labour is adequate, there is no lack of interest on the part of the grower, and much good can be done. Here also is wide scope for the exercise of plant sanitation, for clean cultivation, the destruction of diseased plants, the removal of weeds and moribund tissues, and the destruction of refuse by fire. The incidence of disease may also be lessened by careful selection of site, while much may be gained by closer co-operation between growers and the staffs of our botanic gardens. Both for horticulture and forestry the importance of nurseries calls for fuller recognition, for while in horticulture many diseases may be fought with reasonable hope of success in adult plants, to avoid disease in the nursery is better than to control it in later life. With forestry the matter of nursery control is more urgent, for in many cases there is little hope of disease control other than by the elimination of the cause in the nursery itself.

Dr. W. B. Brierley, who spoke from the point of view of agriculture, dealt at length with the training and supply of workers, the financing and staffing of laboratories, and the field and administrative services for research on disease control, and strongly urged the need for careful gradation from pure to applied research, without which the full integration of investigation could not be realised. In urging the claim for extended research foundations in our universities and for crop stations, he held that by the enlargement of such foundations and stations the work of control could now be best advanced. There is still great need for the popularisation of knowledge regarding the nature and dangers of plant diseases, and he held that by oral instruction to the grower, and by the wider use of clear and concise printed matter, disease control would be materially promoted. In his opinion there was, however, a danger that the training of plant pathologists might remain a function of pure botany rather than become one of agriculture, and this he considered a matter for regret and correction.

Miss E. Welsford, who followed, spoke from her experience of the control of the diseases of the clove in Zanzibar, and urged the need for improvements in the methods of cultivation and plant hygiene for all crops. In her experience the practical sides of healthy plant physiology were of greater importance in the battling of disease than cure; for while the latter would ever be essential, the primary duty of the plant

pathologist must increasingly become the avoidance of disease by assuring healthy growth for crops as a whole.

Some of the difficulties in control were referred to by Sir Daniel Hall, who discussed the breeding of plant varieties immune to disease. In his opinion such breeding must be slow in securing satisfactory results, since the starting-point is immunity to known diseases in a few varieties which may still be prone to, and may be even more prone to, other diseases than they were before immunisation to one. He warned all who must deal with the practice of agriculture that progress in one line of control would not assure immunity for crops as a whole, and that step by step the problem must be probed until a sound knowledge of the effects of environment on immune varieties has been attained. With a widened understanding of the advantages and defects of a known environment for a known crop would come a surer foundation on which all could co-operate in the elimination of disease.

Dr. Malcolm Wilson strengthened the plea of Sir Daniel Hall for the extended study of environment, and while laying emphasis on the need for fuller knowledge of the condition of individual crops at the time of infection, he held that the plant pathologist could best be fitted for the practical work of agriculture relating to the cure of disease by the fullest possible training in both healthy physiology and pathology.

Mr. W. A. Millard discussed the processes of green manuring as preventive of scab on potatoes, and described experiments which threw light on the beneficial effects of such treatment.

Dr. W. G. Smith discussed the differences between the work of the adviser and that of the agricultural inspector, and while admitting that the present system of administration was advanced and enlightened, he urged the need for the fuller study of plant diseases on the spot, for by such study the complications of the problem of disease could often be more fully appreciated and approached than by other means.

Prof. Link spoke of the close parallelism between the problems of disease control in Britain and the United States of America, and stated that the work of control in America was still hampered by the inadequate training of plant pathologists in pure botany. On the other hand, there are other directions in which improvements are indicated, and in particular it must be assured that a closer relation is established between the research worker and the grower. By such a relation the work of both the investigator and the grower would be accelerated.

In conclusion, Mr. Stoughton discussed the methods of propaganda against plant disease, and emphasised the importance of the personal factor for both the investigator and the grower, by which investigation could be stimulated on one hand and knowledge accepted on the other, to the benefit of all concerned and the assurance of unbroken progress.

J. McL. T.

University and Educational Intelligence.

CAMBRIDGE.—Prof. A. Hutchinson, professor of mineralogy, has been elected Master of Pembroke College.

Sir Arthur Shipley, late Master of Christ's College, left £5500 to Christ's College for the endowment of a fellowship, along with various other bequests, including some relics of Darwin. As we announced in our issue of Oct. 29, p. 640, parts of his library are going to the Molteno Institute of Parasitology, the Balfour Library, and the Cambridge Philosophical Society.

THE Education Committee of the West Riding of Yorkshire announces in its report for 1926–27 a new departure in regard to provision of education for the adolescent: the inauguration at Castleford of a "centre for social and physical training" at an estimated cost of £500. Nine other similar centres are to be established in the course of the years 1927–1930, under the direction of a juvenile organisations committee, representative of all the local organisations engaged in social work amongst the young. Fifty-one scholarships tenable in universities were awarded in 1926–27, the average value being £78 a year. The field of selection of candidates (now 250 annually) has been widened by the grant of 'continuation' scholarships covering tuition, travelling, and maintenance expenses of preparation for the Higher School Certificate examination. Eighty per cent. of the pupils above sixteen are scholarship holders. Secondary school entrance scholarships were awarded to 2030 out of 5·5 times that number of candidates. Technical exhibitions numbered 3291.

THE Rockefeller Foundation has issued another, the eighth, series of "Methods and Problems of Medical Education." Of the 37 articles in this series, 7 deal with British practice and institutions. Sir Lenthal Cheatle discusses "English Surgery: Practice, Teaching, and Research," and Sir Archibald Garrod the "Teaching of Clinical Medicine in England." The medical and surgical 'units' of St. Bartholomew's Hospital are described by Prof. Fraser and Prof. Gask respectively. Details are given of the Electrocardiograph Department, Edinburgh Royal Infirmary, by Dr. W. T. Ritchie, and of the Department of Surgery, University of Edinburgh, by Prof. Wilkie. The new obstetric hospital, University College Hospital, is described by Sir George Blacker and Prof. Browne. The remaining articles mostly deal with special medical departments of institutions in America and Europe, including a useful one on medical postgraduate work in Germany, by Prof. Curt Adam. The volume is profusely illustrated with photographs and plans and contains useful information on staffing and finance.

THE appointments to Ramsay fellowships in chemical science for this session, British, Dominion, and foreign, are practically completed. At the present time ten fellowships are being held in the universities and colleges of Great Britain. The list of awards for the present session is as follows, the institution selected by the fellow for his research being given: *British Fellowships*: Dr. R. F. Hunter, Imperial College of Science and Technology, London; Mr. A. M. Taylor, University of Cambridge; *Glasgow Fellowship*: Mr. James D. Fulton, University of Manchester; *Canadian Fellowship*: Dr. W. H. Barnes, Royal Institution, London; *Danish Fellowship*: Miss Augusta M. Unmack, University of Oxford; *French Fellowship*: M. Robert le Guyon, University College, London; *Italian Fellowship*: Dr. Gastone Guzzoni, Royal School of Mines, London; *Japanese Fellowship*: Dr. Yohei Yamaguchi, University College, London; *Spanish Fellowship*: Senor Fernando Calvet, University of Oxford; *Swedish Fellowship*: Mr. H. Liander, University College, London. The total value of the annual amount of the fellowships that is awarded is approximately £4000, of which about £3000 is provided by grants from Dominion and foreign sources.

Calendar of Customs and Festivals.

February 1.

ST. BRIDGET.—Next to St. Patrick the most important of the Irish saints, the patroness of arts and culture. She, with seven virgin companions, the first nuns in Ireland, founded a church which stood under an ancient oak on what is now the site of the city of Kildare. The popularity of the saint, as indicated by the frequent use of Bridget as a Christian name, together with the survival of many pagan elements in relation to her, point to the pre-existence of a widely diffused and important cult. Her shrines are frequently associated with oak or ash groves, and she herself is connected with fire. This is shown by the story told by Giraldus Cambrensis of an ashless undying fire sacred to her, which was tended by twenty virgins in an enclosure taboo to men, as well by other of her attributes.

Popular custom points to a connexion of St. Bridget with fertility. On Jan. 31, the eve of her feast, it was the custom in the Isle of Man to cut green rushes and, standing at the door, to invite the saint to enter as the rushes were strewn on the floor to make a bed or carpet. The meaning of this practice is made clearer in the Western Isles of Scotland, where on the night of Feb. 1 a sheaf of oats was dressed in woman's clothes by the mistress and her maids, and placed in a basket with a stick beside it while saying, "Bri'id is come, Bri'id is welcome." In the morning, if the mark of the stick was found in the ashes, it portended a prosperous year. The custom of making rush crosses in honour of St. Bridget in association with a more or less solemn feast, widespread in Ireland, has suggested a connexion with sun-worship.

Like St. Agnes, St. Bridget, a virgin saint, has come to be associated with fertility by a process of synthesis. Her cult has absorbed that of the pagan goddess Brigid, goddess of fertility, of fire and of the arts of civilisation, who is identified with the goddess Dann (Welsh Dón) of the Tuatha de Danaan. She was the most important of the Celtic goddesses and belongs to that stage of Celtic religion when goddesses were more important than gods. In Gaul, Cæsar equates her with Minerva. In Britain she was the eponymous goddess of the Brigantes. One of her shrines was situated at Bath.

February 2.

CANDLEMAS.—"The Purification of the Virgin Mary," also called "Christ's Presentation" and the "Holiday of St. Simeon." It is also known in the north of England as the "Wives' Feast."

The ceremony of purification after childbirth, perpetuated in the modern 'churching of women,' now, of course, a service of thanksgiving, is a necessary accompaniment of the idea of taboo involved in the great crises of life, such as birth and death, in primitive thought. Among most primitive peoples, women after childbirth are regarded as unclean and dangerous, and as such are subject to certain prohibitions. In Korea, for example, they must veil themselves from the sun for a period of varying length according to their rank. The uncleanness may be removed by various means; in the New Hebrides by washing in new coconut milk or by stroking the limbs with branches which remove the pollution. In the Malay Peninsula mother and child are laid on a platform under which a brisk fire is lit, sometimes with fatal results.

The Church celebrated the feast by a solemn procession, in which candles were borne in procession. According to some authorities, all candles for use during the year should have been blessed on that day. The observance was continued in England up to the Reformation and was forbidden by statute in the reign of Edward VI.

The custom and name have been derived from Simeon's naming of Christ as "the Light of the World"; but ecclesiastical tradition is probably nearer the truth when it states that the ceremony was instituted because the pagans on that day carried lighted candles in honour of Pluto and Proserpine or, according to another account, Mars and his mother Februa—a function of Juno as presiding over the purification of women. In order to divert the Christian from these pagan practices, it was enjoined on all to carry candles in honour of the Virgin and Christ. The feast therefore perpetuated the cult of male and female chthonic or fertility deities and was connected with the purification of women. It is significant that in Britain St. Bridget has come to be associated with Candlemas.

In popular lore "on Candlemas Day throw candle and candle-stick away," said to mean that the use of tapers at Vespers and Litanies which had continued through winter, now ceased until All Hallow Mass. It certainly marks a period in a tradition older than the ecclesiastical. On Candlemas Eve the Yule brand was kindled and allowed to burn until sunset, when it was quenched and set aside to light the Yule log in the next season. The distinctively Christmas decorative foliage, the rosemary, bay, ivy, holly, and mistletoe were taken down and replaced by the box. In the Scottish Highlands St. Bridget's Day (Feb. 1, O.S.) was the first day of spring. It was the custom in Scotland for school children to make a present to the schoolmaster on Candlemas Day, the boy and girl giving the most becoming king and queen with certain privileges, such as asking for a weekly half-holiday and the remission of punishments over a certain period. It was also customary in some towns for a football match to be played. Both customs are significant in this connexion.

February 3.

ST. BLAISE.—Bishop and Martyr, born at Sebaste, Armenia, martyred by Agricola, A.D. 316.? His legend records his fondness for and control over animals. At his command a wolf gave up a pig stolen from a poor woman. The woman brought the head and feet and a candle made of the pig's fat to the saint when he was in prison. Hence the custom of burning a candle to him for the animals of the household. He healed a youth dying through having swallowed a bone. Anyone in a similar state invoking the saint and commanding the bone to pass down or up in his name would be healed. Several Christian women were martyred with St. Blaise. When ordered to sacrifice to the heathen gods, they asked to be allowed to wash the idols that their offering might be the purer; but they threw them into the lake. This suggests a customary ritual, otherwise consent would scarcely have been given so readily.

St. Blaise was tortured with a sharp comb like that of the wool-comber, and is credited with having invented wool-combing. He was, therefore, the principal figure in the procession of the wool-combers of Bradford, which took place on this day, Jason with the Golden Fleece being the next in importance. By folk etymology he is associated with a custom whereby country women making a holiday on his festival burnt the flax and distaff of any woman found working, and also with the hill-top fires it was customary to light in some parts of the country on this date.

Societies and Academies.

LONDON.

Royal Society, Jan. 19.—**E. S. Horning** and **A. H. K. Petrie**: Enzymatic function of mitochondria in the germination of cereals. In the resting stage of maize, wheat, and barley, mitochondria occur in the scutellum and endosperm. During germination they become numerous in the scutellum, and are secreted in large numbers from epithelial cells into adjacent starch-containing cells of endosperm. These secreted mitochondria aggregate round starch grains prior to their corrosion; as corrosion commences the associated mitochondria seem to disappear. Throughout the period of endosperm depletion, mitochondria are thus secreted and migrate through the emptied cells to the zone of active hydrolysis, where they become associated with the starch grains. In isolated endosperms, mitochondria of intracellular origin effect starch hydrolysis and depletion at a slower rate corresponding to their lesser numbers. There is no evidence for secretion of mitochondria from the aleurone layer or of depletion being affected by secretion of an enzyme therefrom.

S. Dickinson: Experiments on the physiology and genetics of the smut fungi. No infection of oat or barley seedlings by pure cultures of smut fungi occurs when one gender (sex) is present; but when two genders are present, 90 per cent. infection is obtained.

P. H. H. Gray: Formation of indigotin from indol by soil bacteria. Oxidation of indol to indigotin can be effected by bacteria. Two new species have been isolated from soil. *Pseudomonas indoloxidans* oxidises in solution cultures and on agar media; *Mycobacterium globerulum* produces very small amounts, on agar media only. A new species of Micrococcus can also produce crystals on indol agar. Indol does not act as a source of energy; of the carbon compounds tested, glycerol appears most readily to act as energy-source to the oxidation. Bacterial numbers and amount of indigotin produced increase with higher ratios of carbon to nitrogen. Indol is oxidised only by young growing cultures, and can be oxidised in the absence of other nitrogen compounds; it depresses multiplication of bacteria.

R. A. Fisher: Triplet children in Great Britain and Ireland. Results of measurements, and of genealogical inquiries on three years' data from recipients of the Royal Bounty, are given. Six physical measurements taken on 117 children show correlation between pairs of unlike sex conformable with that obtained by the author from Lauterbach's measurements on twins, and with that between adult brothers and sisters. Pairs of like sex are more highly correlated, the results being well fitted by the supposition that about 54 per cent. of the surviving like-sex pairs are monozygotic in origin, and that these have a correlation 0·94. Relationship data confirm paternal influence, and sex distribution of related twins strongly suggests that this is confined to causation of di-embryony. If maternal influence conditions both dizygotism and di-embryony, the slightly higher values obtained from these and other data for maternal influence indicate that di-embryony is the more strongly inherited phenomenon.

J. W. H. Harrison: A further induction of melanism in the lepidopterous insect, *Selenia bilunaria* Esp. and its inheritance. By administering food containing manganese chloride to a strain of *Selenia bilunaria*, known by the use of adequate controls to be free from heritable melanism, melanic insects have been developed. This melanism is inherited as a Mendelian recessive. Certain mosaics were obtained in the critical treated brood, but these, from experimental tests, seem to represent cases of somatic induction, the germ plasm being apparently unaffected. The effect is not of the Lamarckian type, but rather illustrates a new evolutionary principle, that heritable variations may be induced by means of the food supplied. The metal seems to be the active agent.

J. W. H. Harrison: Induced changes in the pigmentation of the pupæ of the butterfly, *Pieris napi* L. and their inheritance. The pupæ of *Pieris napi*, when developed from larvæ exposed at the critical time to lights of different colours, are influenced in their pigmentation, like those of their congeners *Pieris brassicæ* and *P. rapæ*. As Dürken and Brecher found in the case of *P. brassicæ*, the green pupal colour, acquired under the influence of orange light, is inherited.

F. G. Gregory: The differential effect of the ions of three-salt solutions on the growth of potato plants in sand culture. A method of statistical analysis is developed enabling assessment of the effect of single ions on growth of plants in culture solution consisting of a mixture of salts, and has been applied to data published by E. S. Johnston. The kations in the solution have for each relative ionic concentration (ionic proportion) a greater effect than any of the anions used.

Sir Kenneth Goadby: Bacterial proteins: presence of alcohol-soluble proteins in bacteria. By a method, shown to produce minimum change on protein constituents, an alcohol-soluble protein, having many of the characters of the similar proteins of cereal seeds, has been extracted from Streptococci, Staphylococci, *Bacilli Hoffmann, typhosus, coli com., paracoloides*, and *Micrococcus catarrhalis*. The Molisch-reacting substance seems to form an important constituent of bacterial structure.

F. W. R. Brambell: Development and morphology of the gonads of the mouse. (Part 2.) The paper deals with 64 animals irradiated during pregnancy or lactation. Degenerative changes in corpora lutea start at the same age in the sterile as in the normal ovary. They proceed slowly, and the old corpora lutea become practically permanent components of the sterile ovary. This is attributed to absence of competition with maturing follicles and new corpora lutea.

R. C. Punnett: Linkage groups and chromosome number in Lathyrus. A fundamental requirement of the chromosome heredity-theory is that the number of linkage groups and characters showing independent assortment in a species should not exceed the haploid number of chromosomes. This holds good for the only species—Drosophila—hitherto tested adequately. Experiments over twenty years and involving 19 characters have shown that in a plant also (*Lathyrus odoratus*) the number of linkage groups and characters showing independent assortment is 7, the same as the haploid number of chromosomes in this species.

S. Ochoa: Action of guanidins on the melanophores of the skin of *Rana temporaria*. The guanidin hydrochlorides cause contraction of skin melanophores in frogs. This is a direct action, either on the melanophores or the nerve endings in them. Calcium salts antagonise the effect, as they do many of the other effects. It is probable that Collip's parathyroid hormone also antagonises the action of guanidins.

E. J. Maskell: Experimental researches on vegetable assimilation and respiration. (Parts 17 and 18.) In cherry-laurel leaves, at limiting concentrations but under *constant* lighting, there is marked diurnal rhythm of apparent assimilation, falling to

very low values at night and rising in morning. At any point in the diurnal march, assimilation can be increased by increasing carbon dioxide up to the limit set by the light-intensity used. Diurnal rhythm of assimilation is due to a rhythm of stomatal opening. At small opening, assimilation rate is approximately proportional to porometer rate; as the stomata open and the porometer rate increases, the assimilation rate approaches asymptotically to a level determined by non-stomatal resistances in the diffusion path of the carbon dioxide.

PARIS.

Academy of Sciences, Dec. 19.—**A. Lacroix**: The hyperalkaline quartziferous rhyolites and trachytes, with reference to those of Korea.—**P. Villard**: The law of absorption of the X-rays by matter. The total absorption coefficient is regarded as the sum of two terms, a diffusion coefficient taken as independent of the wave-length and the true absorption coefficient, $C\lambda^3$ (Bragg and Pierce). C is considered as a function of the wave-length $C_0\phi(\lambda)$, and from a study of the experimental curve $C=C_0\phi(\lambda)$ it is recognised as a Bjerknes resonance curve, and a formula is developed based on this view. The calculated and experimental figures for zinc are compared.—**Gabriel Bertrand** and **Jules Labarre**: The acetolysis of mannocellulose. The preparation of new sugars, tetramannoholoside and pentamannoholoside. These sugars were produced by the controlled acetylation of mannocellulose by a mixture of sulphuric acid and acetic anhydride, the acetates being afterwards saponified by alcoholic potash and the potassium removed as perchlorate. Details of their chemical and physical properties are given.—**E. Mathias**: Magnetic measurements in the Hautes-Pyrénées, Gers, and Haute-Garonne.—Sir Ernest Rutherford was elected a foreign associate in the place of the late C. Walcott, and Joseph Auclair, *correspondant* for the section of mechanics in succession to Torres Quevedo, elected foreign associate.—**André Weil**: Arithmetic on an algebraic curve.—**Paul Mentré**: The projective displacements of two plane pencils with a common right line.—**Lainé**: The equations $s=f(x, y, z, p, q)$ which are of the first class.—**Paul Flamant**: The development of a linear transmutation in series of powers of the finite differentiation.—**J. Favard**: The normal meromorph functions of the group of translations.—**Henri Milloux**: The theory of integral functions of finite order.—**Georges Valiron**: Some properties of integral functions.—**A. Véronnet**: The evolution of the figures of equilibrium of a heterogeneous fluid mass. The impossibility of a breaking up.—**Belzecki**: A case of critical velocities in the movements of a locomotive on rails.—**G. Rougier**: Observations of the third satellite of Jupiter. A drawing of the spot on the third satellite, previously seen by Antoniadi, is given. From observations of this spot it is concluded that the period of rotation of the satellite equals its time of revolution round Jupiter.—**A. Levêque**: An attempt at an approximate theory of the transmission of heat by convection in a circular cylindrical tube through which is flowing a real fluid in turbulent motion.—**Cordonnier** and **Guinchant**: Inductive capacity in the gaseous state. The results of measurements of thirty-three gases and vapours are given, and their relationship with the refractive indices and chemical constitution discussed.—**Rouelle**: The demultiplier of ferromagnetic frequency.—**Georges Déjardin**: Spectra of phosphorus for different degrees of ionisation. The study of the variations observed in the electrodeless discharge leads to the separation of the spectra characteristic of the different degrees of ionisation of the phosphorus atom. The whole of the results obtained may serve as a starting-point for the development of the classification outlined by Millikan and Bowen. The presence in the photographs of a large number of new lines shows that the spectrum of phosphorus is still imperfectly known, particularly in the ultra-violet, below 2700 A.—**Georges Simon**: Superposition fringes between two half-silvered plates formed by media of different refractive indices.—**Pierre Leroux**: Study of the pleochroism of tourmaline.—**E. Brylinski**: The velocity of the earth. The author holds that the results obtained by A. Piccard and E. Stahel on the Rigi in September 1927, do not disprove Miller's results.—**Edmond Bayle, Henri George, Augustin Mache**: The identification of works of art. The finger-print of the artist placed on some part of the work has been proposed as a remedy against a forged signature on pictures and other works of art; but it is pointed out that this would be insufficient, since the finger-print could be copied by photomechanical methods. The method suggested as more trustworthy is a combination of photography and radiography.—**A. Dauvillier**: An X-ray tube with an effective wave-length of 8 Angström units. The important feature of the tube proposed, a detailed description of which is given, is a window of very thin cellophane, 0·02 mm. thick, 20 sq. cm. surface, with a support of metallic gauze.—**Henri Belliot**: An attempt at the interpretation of the phenomena of photographic inversion and solarisation.—**W. H. Keesom** and **M. Wolfke**: Two different liquid states of helium. In a series of measurements of the dielectric constant of liquid helium, with diminishing temperatures, at a certain temperature this constant undergoes a sudden change. Earlier observations have given similar indications based on the variation with the temperature of density, specific heat, latent heat of evaporation and surface tension. The change from one state to the other takes place when the pressure of saturated helium vapour is about 38 mm. of mercury.—**B. Bogitch**: Some properties of electrolytic nickel. Measurements of hardness, density, and velocity of solution in hydrochloric acid are given for specimens of nickel of varying degrees of purity. Analyses of the samples are appended: nickel bought as electrolytic is not necessarily pure.—**René Delaplace**: Study of the gas, obtained by cracking oil, for lighting for coast beacons. Analyses of original gas, liquefied gas and residue after rectification of liquid are given.—**I. N. Longinescu**: A new additive property of liquids.—**A. Colani**: Study of the systems uranyl nitrate—alkaline nitrate—water at 25° C.—**R. Locquin** and **R. Heilmann**: The mechanism of the oxidation of the pyrazolines. The basic compounds isolated included the pyrazol corresponding to the pyrazoline oxidised, azines and pyrazoline compounds of the same molecular weight as the azines.—**L. Palfray** and **Mlle. Th. Duboc**: 1, 3, 4, Metaxylenol and some of its derivatives.—**Albert Kirrmann**: The reactions of the α-bromaldehydes. Besides normal aldehyde reactions, other reactions are obtained suggesting an acid bromide. It is shown that with α-bromœnanthol there is no tautomerism, and a probable explanation of the abnormal reactions is suggested.—**W. Ipatief** and **B. Dolgof**: The catalytic hydrogenation of *p*-oxytriphenylcarbinol and *p*-oxydiphenylmethane under pressure. The first step in the reduction of *p*-oxytriphenylcarbinol (catalyst nickel, pressure 80 to 100 atmospheres) is *p*-oxytriphenylmethane and 50 per cent. of this decomposes into phenol and diphenylmethane at 220° C., and pressure 100 atmospheres. The remainder is converted nearly quantitatively into tricyclohexylmethane.—**James Chappuis** and **A. Pignot**:

The compression of town gas. Town gas may contain from 1 to 4 per cent. of oxygen, and at ordinary atmospheric pressure this is outside the limit of inflammability. Experiments are described showing that mixtures of coal gas and oxygen, compressed to 150 to 200 kgm., are not inflammable if they contain less than 10 per cent. of oxygen.—**R. Lantz** and **A. Wahl**: The action of the primary amines on nitroso-β-naphthol.—**Robert Gibrat**: The focal structure of smectic bodies.—**M. E. Denaeyer** and **Jacques Bourcart**: The chemical composition of the lavas of Ahaggar, Central Sahara (Jacques Bourcat Expedition, 1922–1923).—**Pierre Bonnet**: The characters of the south Transcaucasian geosynclinal.—**Henri Schoeller**: The Embrunais layer and the outside edge of the Briançonnais layer, traced from France into Switzerland.—**Paul Fallot**: The geology of the region of Antequera (Andalusia).—**J. Thoulet**: The double oceanic circulation and the abyssal volcanic columns.—**M.** and **Mme. A. Chauchard**: The variations in salinity of estuaries measured *in situ* by the electrical conductivity.—**Marcel Mascré**: The action of some fixing reagents on the nucleus of the plant cell.—**A. Maige**: Observations on the phenomena of chloroplastogenesis and plastidal regression in the cotyledons of various Leguminoseæ.—**A. Guilliermond**: The cytology of the Nematospora.—**A. de Puymaly**: A fixed Spirogyra, perennial and multiplying by layering.—**M. Bridel** and **Mlle. M. Desmarest**: A method permitting the extraction from the oil cake of bitter almonds of amygdaloside (amygdalin) and emulsin.—**E. Carrière** and **Brunet**: Contribution to the study of grape pip oil.—**G. Guittonneau**: The influence of sulphur and the products of its solvation in the soil on nitrification.—**J. Legendre**: The battle between mosquitoes by the larval concurrence between zoophiles and androphiles.—**Maurice Azéma**: The excretion *in vitro* of methylene blue by the renal vesicles of an ascidian.—**Edouard Fischer**: The relation between the reducing power of sea water and the distribution of the organisms of the coast line.—**Chevey, L. Roule**, and **Mlle. Verrier**: The interruption of the movement of salmon up rivers by the reduction of the amount of dissolved oxygen in the water course. If the dissolved oxygen in a river falls below 6 c.c. per litre, salmon will not ascend. Salmon appear to be more sensitive in this respect than other fish.—**René Fabre** and **Henri Simonnet**: Contribution to the physiological study of glutathione by the method of perfusion.—**P. Delauney**: The biochemical synthesis of β-5, bromosalicylglucoside. An attempt at the synthesis of β-3-5-dichlorosalicylglucoside.—**Marcel Labbé, Roubeau**, and **F. Nepreux**: The influence of nickel and cobalt on the hypoglycæmic action of insulin in the rabbit.—**G. Lavier**: The structure of the parabasal body in trypanosomes.—**Mme. Phisalix**: Properties of the serum of snakes belonging to the genus Coluber.—**Daniel Florentin**: The composition of the air of the streets of Paris. A series of determinations of the proportions of carbon monoxide and dioxide. The amount of impurity diminishes rapidly as the height above the ground increases.—**P. Lassablière**: The biological and therapeutic effects of the serosity of blisters.—**Jules Amar**: Mass action and vital defence.

Official Publications Received.

British.

The Association of Special Libraries and Information Bureaux. Report of Proceedings of the Fourth Conference held at Trinity College, Cambridge, September 23rd-26th, 1927. Pp. xiv+170. (London.)

The Quarterly Journal of the Geological Society. Vol. 83, Part 4, No. 332, December 15th. Pp. 551-652. (London: Longmans, Green and Co., Ltd.) 7s. 6d.

Madras Fisheries Department. Administration Report for the Year 1925–26. By Dr. B. Sundara Raj. (Report No. 1 of 1927, Madras Fisheries Bulletin, Vol. 21.) Pp. v+94+6 plates. (Madras: Government Press.) 2.4 rupees.

The Physical Society Proceedings. Vol. 40, Part 1, December 15. Pp. 36. (London: The Fleetway Press, Ltd.) 7s. net.

Aeronautical Research Committee: Reports and Memoranda. No. 1059 (Ae. 241): Experiments on a Model of a Fokker (F. VII) Monoplane Wing. By A. S. Batson, D. H. Williams and A. S. Halliday. (A.3.a. Aerofoils-General, 167.—T. 2324 and a.) Pp. 21+19 plates. 1s. 3d. net. No. 1106 (Ae. 288): The Theoretical Pressure Distribution around Joukowski Aerofoils. By W. G. A. Perring. (A.3.a. Aerofoils-General, 178.—T. 2496.) Pp. 18+11 plates. 9d. net. (London: H.M. Stationery Office.)

Proceedings of the Malacological Society of London. Edited by G. C. Robson. Vol. 17, Parts 5 and 6, December. Pp. 175-254+plates 15-35. (London: Dulau and Co., Ltd.) 20s. net.

Royal Botanic Gardens, Kew. Picture Postcards. Nos. 85-91, Ornamental Geese. (Set 18.) 1d. each; 6d. per set of 7. Nos. 97-102, Ornamental Waterfowl. (Set 17.) 2d. each; 1s. per set of 6. Nos. 103-108. 2d. each; 1s. per set of 6. (Kew.)

Chemists and Dividends. By S. M. Gluckstein. Pp. 24. (London: Institute of Chemistry of Great Britain and Ireland.)

Indian Central Cotton Committee, Bombay. Annual Report for the Year ending 31st August 1924. Pp. iv+73. 2 rupees. Annual Report for 1926. Pp. iv+169. 2 rupees. Annual Report for the Year ending August 31st, 1927. Pp. ii+116+14 plates. 2 rupees. (Bombay.)

Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 14, No. 8: Pennisetum Typhoideum, Studies on the Bajri Crop. i: The Morphology of Pennisetum Typhoideum. By S. V. Godbole. Pp. 247-266+10 plates. (Calcutta: Government of India Central Publication Branch.) 12 annas; 1s. 3d.

Amgueddfa Genedlaethol Cymru: National Museum of Wales. Twentieth Annual Report, 1926-27, presented by the Council to the Court of Governors on the 27th October 1927. Pp. 54+11 plates. (Cardiff.)

Guide to the Seventh Congress of the Far Eastern Association of Tropical Medicine, Calcutta, December 5th to 24th, 1927. Pp. vi+115. Seventh Congress of the Far Eastern Association of Tropical Medicine: Abstracts of Papers and Programme of Scientific Sessions. Pp. iv+176. (Calcutta.)

Foreign.

Department of the Interior: Bureau of Education. Bulletin, 1927 No. 28: Nursery-Kindergarten-Primary Education in 1924–1926. By Mary Dabney Davis. Pp. 46. (Washington, D.C.: Government Printing Office.) 10 cents.

Mitteilungen des Geologischen Instituts der Landbouwhoogeschool, Wageningen (Holland). No. 11: Düne und Moor bei Vogelenzang; Beiträge zur Frage der quartären Niveauveränderungen an der holländischen Nordseeküste. Von Prof. J. van Baren. Pp. 89+10 Tafeln. (Wageningen: H. Veenman en Zonen.)

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 79, 1927, Supplement. Synopsis of North American Diatomaceae. Part 2: Naviculatae, Surirellatae. By Charles S. Boyer. Pp. 229-583. (Philadelphia, Pa.)

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 19, Part 2: On the Difference in Physico-Chemical Properties of various Proteins in Plant Seeds. Second Report: On the Differences in the Physico-Chemical Properties of the Four Kinds of Rice Proteins which vary in their Iso-Electric Points, by Tetsutaro Tadokoro, Taro Tsuji and Shukichi Watanabe; Chemical Studies on Sex Differences of Proteins in Animals and Plants. First Report: Sex Differences of Muscle and Serum-Proteins, by Tetsutaro Tadokoro, Makoto Abe and Shukichi Watanabe. Pp. 93-184. Vol. 21, Part 2: On the Alcohol-Soluble Proteins of Naked Barley. By Eiji Takahashi and Kiyoshi Shirahara. Pp. 43-62. (Tokyo: Maruzen Co., Ltd.)

Bulletin of the National Research Council. No. 59: Chemiluminescence. Report of the Subcommittee on Chemiluminescence. Pp. 62. (Washington, D.C.: National Academy of Sciences.) 1 dollar.

Proceedings of the American Academy of Arts and Sciences. Vol. 62, No. 5: Ionization in Nebular Matter. By B. P. Gerasimovič. Pp. 155-171. 45 cents. Vol. 62, No. 6: Astrophysical Aspects of the General Field of Penetrating Radiation. By B. P. Gerasimovič. Pp. 173-185. 45 cents. (Boston, Mass.)

Proceedings of the Imperial Academy. Vol. 3, No. 8, October. Pp. xix-xx+477-578. (Tokyo.)

Geofysiske Publikasjoner utgitt av det Norske Videnskaps-Akademi i Oslo. Vol. 5, No. 3: On Periodic Variations in Terrestrial Magnetism; Studies based upon Photographic Records from the Polar Station Gjøahavn. By K. F. Wasserfall. Pp. 33. (Oslo: A. W. Brøggers Boktrykkeri A.-S.) 4.00 kr.

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 20, Part 3: Studies on the Inheritance of Sterility in Rice. By Junichi Ishikawa. Pp. 79-201+plates 5-8. (Tokyo: Maruzen Co., Ltd.)

Institute scientifiques de Buitenzorg, "'s Lands Plantentuin." Treubia: *recueil de travaux zoologiques, hydrobiologiques et océanographiques.* Vol. 9, Livraison 4, Août. Pp. 293-472. (Buitenzorg.) 2.50 f.

Bulletin of the American Museum of Natural History. Vol. 57, Art. 3: The Fishes of the Rio Chucunaque Drainage, Eastern Panama. By C. M. Breder, Jr. Pp. 91-176+5 plates. Vol. 56, Art. 5: A Study of the Crystallography of the Calcites of the New Jersey Diabase Region. By Herbert P. Whitlock. Pp. 351-377. (New York City.)

Bulletin of the National Research Council. No. 60: Industrial Research Laboratories of the United States, including Consulting Research Laboratories. Third edition, revised and enlarged. Compiled by Clarence J. West and Ervye L. Risher. Pp. 153. 1 dollar. No. 61: Transactions of the American Geophysical Union, Eighth Annual Meeting, April 28 and 29, 1927, Washington, D.C. Pp. 297. 3 dollars. (Washington, D.C.: National Academy of Sciences.)

Methods and Problems of Medical Education (Eighth Series). Pp. iv+372. (New York City: The Rockefeller Foundation.)

Ministero dell' Aeronautica, Aviazione Civile e Traffico Aereo: Ufficio Presagi. Sondaggi aerologici eseguiti nei giorni stabiliti dalla Commissione per la esplorazione dell' alta atmosfera. 1: Gennaio 1926, maggio 1926, settembre 1926. Pp. ii+30. 2: Febbraio 1927. Pp. ii+11. Annali dell' Ufficio Presagi. Vol. 1. Pp. 104. (Roma.)

Bernice P. Bishop Museum. Bulletin 41: Report of the Director for 1926. By Herbert E. Gregory. Pp. 45. (Honolulu, Hawaii.)

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 34: Higher Education, Biennial Survey, 1924-1926. By Arthur J. Klein. Pp. ii+46. (Washington, D.C.: Government Printing Office.) 10 cents.

CATALOGUES.

Verlagskatalog 1811-1927. Pp. xxx+86. (Leipzig: Wilhelm Engelmann.)

Apparatus for Ultra-Violet Polarimetry as used by Prof. T. M. Lowry, F.R.S. Pp. 4. Testing Outfit for Precision Work. (Catalogue No. N.31.) Pp. 4. (London: Adam Hilger, Ltd.)

The New Propaganda in Industry: its Nature and Practice. By J. Bertram Ward and W. K. Crampton Chalk. Pp. 28. (London: The Technical Advertising Service, Ltd.)

Diary of Societies.

SATURDAY, JANUARY 28.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—D. W. Baron: Machine Mining at Ashington Colliery.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. R. W. Chambers: Some Tudor Biographers (2).

INSTITUTE OF BRITISH FOUNDRYMEN (Newcastle and District Branch) (at Neville Hall, Newcastle-upon-Tyne), at 6.15.—D. Sharpe: Ramming Moulds by Sand-slinger.

MONDAY, JANUARY 30.

INSTITUTE OF ACTUARIES, at 5.—J. M. Laing: New National Life Tables (1921 Census).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. W. E. M. Wardill: Certain Aspects of Cleft Palate, with Observations on the Causes of Defective Speech and the Remedies proposed for their Treatment.

SOCIETY OF CHEMICAL INDUSTRY (Yorkshire Section) (at Great Northern Hotel, Leeds), at 7.15.—Dr. F. L. Usher and others: Discussion on The Phenomenon of Wetting and its Industrial Significance.

ROYAL SOCIETY OF ARTS, at 8.—Dr. A. E. Dunstan: The Scientific Foundation of the Refining of Petroleum (Cantor Lectures) (III.).

TUESDAY, JANUARY 31.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Meeting), at 4.30.—Lord Lovat: Migration in the Empire.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. A. P. Newton: The Mercantile Empire, 1606-1788 (I.).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Colour Group), at 7.—L. J. Hibbert: Light, Colour, and Colour Filters.

INSTITUTE OF CHEMICAL ENGINEERS.

WEDNESDAY, FEBRUARY 1.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.30—Dr. N. Raw: Medico Legal Problems of Lunacy.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Dr. G. A. Auden: (a) The Gild of the Barber Surgeons of the City of York; (b) Note on an Ancient Medical Manuscript in the Library of York Minister.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. H. S. Souttar: New Methods of Surgical Access to the Brain.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Capt. P. P. Eckersley: The Design and Distribution of Wireless Broadcasting Stations for a National Service.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.—G. S. Evans: The Decorative Value of Electric Light.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 7.—Dr. S. Z. de Ferranti: Electricity in the Service of Man (Faraday Lecture).

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 7.30.—C. H. B. Quennell: House Building through the Centuries.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, at 8.—L. V. Cooke and E. Nightingale: The Determination of Butter in Margarine.—The Deposition of Metals on Copper from Cyanide Solution:—Dr. B. S. Evans: I. A New Method for the Separation and Determination of Small Amounts of Lead.—Investigations into the Analytical Chemistry of Tantalum, Niobium, and their Mineral Associates:—Dr. W. R. Schoeller and A. R. Powell: X. The Separation of Silica from the Earth Acids. XI. The Precipitation of Titanium by Tannin.—Prof. J. Reilly: The Determination of Carvone in Dill Oil.

ROYAL SOCIETY OF ARTS, at 8.—C. H. Wright: Modern Aspects of Rubber Cultivation.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 8.30.—Pathological Evening.

OIL AND COLOUR CHEMISTS' ASSOCIATION.

ROYAL MICROSCOPICAL SOCIETY (Biological Section).

THURSDAY, FEBRUARY 2.

ROYAL SOCIETY, at 4.30.—Prof. A. V. Hill: The Air Resistance to a Runner.—S. M. Manton: On the Embryology of a Mysid Crustacean *Hemimysis lamornæ*.—Dr. R. J. Ludford: (a) Studies in the Microchemistry of the Cell (I.); (b) Cytological Studies on the Viruses of Fowl-pox and Vaccinia.—G. M. Findlay: Immunological and Serological Studies on the Viruses of Fowl-pox and Vaccinia.—G. E. Briggs: A Consideration of some Attempts to Analyse Growth Curves.—Dr. H. M. Leake: Agricultural Value of Rainfall in the Tropics.—C. Forster Cooper: On the Ear Region of Certain of the Chrysochloridæ.—Marion Hines: The Brain of Ornithorhynchus.—F. H. Edgeworth: The Development of some of the Cranial Muscles of Ganoid Fishes.—Dr. F. W. R. Brambell, Una Fielding, and Dr. A. S. Parkes: Changes in the Ovary of the Mouse following Exposure to X-Rays. Part IV.

LINNEAN SOCIETY OF LONDON, at 5.—Major R. W. G. Hingston: Animal Life on Mount Everest.—W. T. Saxton: The Life-History of Lunularia, with special reference to the Archegoniophore and the Sporophyte.—R. S. Adamson: Notes on the Vegetation of Southern Rhodesia.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: From Faraday's Note Books (I.): Ice and Regelation.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—H. B. Poynder: Some Practical Considerations in the Design of the Automatic Equipments for Heavy Traction Substations.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Major H. N. Wylie: The Design and Production of Steel Aircraft.

CHEMICAL SOCIETY, at 8.—J. W. Jenkin and Prof. C. H. Desch: Some Experiments on Diffusion in Solid Metals.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Branch).—Fifth Report of the Steam Nozzles Research Committee.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch).—Prof. C. J. Hawkes: The Marine Oil-Engine (Thomas Lowe Gray Lecture).

FRIDAY, FEBRUARY 3.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 4.30.—Longitude Observations and 'Shortt' Free Pendulum Clocks. Chairman: Sir Henry Lyons. Speakers: Dr. Jackson, Mr. Shortt, A. R. Hinks, and others.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. E. Miles Atkinson: The Pathology, Diagnosis, and Treatment of Abscess of the Brain.

GEOLOGISTS' ASSOCIATION (at University College) (Annual General Meeting), at 7.—Presidential Address: Further Aspects of the Mountain Building Problem.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—Informal Meeting.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—D. Kingsbury: Automatic Substations.

PHILOLOGICAL SOCIETY (at University College), at 8.—Prof. E. Weekley: Philological Notes.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—A. D. Cowburn: Death Occurring under Operation or Before Recovery from Anæsthesia.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. E. C. C. Baly: Photosynthesis.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (jointly with Institution of the Rubber Industry) (at Engineers' Club, Manchester).—S. A. Brazier and Dr. L. R. Ridgway: The Influence of Zinc Oxide on the Coefficient of Vulcanisation.

SATURDAY, FEBRUARY 4.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—H. C. Colles: Musical London from the Restoration to Handel (1660-1759) (I.).

ASSOCIATION OF WOMEN SCIENCE TEACHERS (Annual General Meeting) (at St. Paul's Girls' School), at 4.30.—Sir John Russell: The Growth of Crops: Applications of Botany and Chemistry to Country Life (Lecture).

PUBLIC LECTURES.

SATURDAY, JANUARY 28.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: Proofs of Evolution in Animals and Man.

MONDAY, JANUARY 30.

UNIVERSITY COLLEGE, at 5.—Dr. A. S. Parkes: The Internal Secretions of the Gonads. (Succeeding Lectures on Feb. 6, 13, 20, 27, and Mar. 5.)

UNIVERSITY OF LEEDS, at 5.15.—Prof. E. V. Appleton: Wireless Methods of Investigating the Upper Atmosphere.

GRESHAM COLLEGE, at 6.—G. P. Bailey: Modern Science and Daily Life: Mineral Oils.

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—P. Francis: The Poultry Industry: Developments and Prospects.

TUESDAY, JANUARY 31.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Prof. E. B. Poulton: Recent Discoveries throwing New Light on some of the Commonest Insects.

WEDNESDAY, FEBRUARY 1.

UNIVERSITY COLLEGE, at 5.30.—C. Nowell: The Provision of Commercial and Technical Literature in the Smaller Public Libraries.—At 6.—Prof. A. L. Bowley: Measurement by Index Numbers—Theory and Application to Recent Economic History (Newmarch Lectures). (Succeeding Lectures on Feb. 8, 15, 22, 29, and Mar. 7.)

SATURDAY, FEBRUARY 4.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Mrs. E. Aitken: Village Life in High Castile.

SATURDAY, FEBRUARY 4, 1928.

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Culture and Chemistry.

CRITICISM is an art to which Prof. H. E. Armstrong, as is well known, has given some attention. The opportunity occurring on the occasion of his lecture before the Royal Society of Arts on "Marcelin Berthelot and Synthetic Chemistry"—a full report appears in the *Journal* of the Society of Dec. 30—for the exercise of that faculty, was employed, in the main, in a manner such as cannot fail to arouse appreciation. As Sir William Pope, who opened the subsequent discussion, remarked, it would have been an easy enough task merely to give an account of Berthelot's life and of his manifold scientific activities, but to present a picture which should indicate how that work fitted in with the great scheme of progress and led to the present situation was an entirely different matter. That such a picture should be presented by one who has lived through that great epoch and has himself taken part in many of the big movements to which he necessarily referred, invested the discourse with a special degree of importance.

So much has been said and written in recent months in praise of the undoubtedly tremendous influence of that master-mind on the progress of scientific thought and achievement, that one may be forgiven for welcoming the condiment of informed, if sometimes mordant, criticism and analysis. It is evident that Prof. Armstrong still has no use for our modern system of chemical education—a system which we all freely admit to be far from perfect, but scarcely to be jettisoned on that account. We do not read original literature. We do not strive to shape our style on that of our forefathers. Indeed, we are losing the conception of culture in that domain, he says. There is, we submit, no lack to-day of either genius or philosophy. True, there may be more 'pottering' than yesterday, but may not that be ascribed to a greater abundance of potential potterers, perhaps even more than to the "present low level of academic impotence"?

We should do well, moreover, not to ignore the fact that the outward and visible signs of scientific culture, no less than of social culture, change with the times; they cannot be unaffected by the evolution of socialism (with a small 's') from individualism. More and more, too, such is the luxuriant growth in the garden of knowledge, one is consciously or unconsciously influenced by a mass-effect rather than by an individual plant, however venerable. In assessing the real importance

of Prof. Armstrong's justifiable complaint, one may perhaps be permitted to take passing note of the other extreme of the matter, and to be reminded that there must be a modicum of truth in Mr. Stephen Leacock's amusing confession: "I'd like to take a large stone and write on it in very plain writing—'The classics are only primitive literature. They belong to the same class as primitive machinery and primitive music and primitive medicine,' and then throw it through the windows of a University and hide behind a fence to see the professors buzz!"

However, to return to the main theme of Prof. Armstrong's discourse, namely, Berthelot's pioneering labours at the foundations of our amazing modern edifice of synthetic chemistry. His multitude of thermochemical investigations was considered less worthy: ". . . he ceased to be a constructive artist; grasping the thermometer, he became a thermalist . . . the slave of physical measurement." His work on biological problems and on chemical changes of importance to agriculture received less praise, although not quite so little as agricultural research of to-day. Berthelot's work in this subject ". . . shows him once more, in the main, as a chemist with undeveloped biological feeling." But in another field "it is clear that he set out upon his upward journey advisedly, bearing a banner inscribed with the device then entirely strange—'Organic Synthesis'"; alcohol, mustard oil, methane, acetylene, benzene, naphthalene, and anthracene were among the numerous compounds which were synthesised for the first time, and the idea of 'vital force' behind organic chemistry was disposed of for ever.

The very success of Berthelot's syntheses, suggesting that man may make all things, has done much, we are told, to hasten a debacle. To-day there is an "insensate desire" abroad to synthesise and manufacture everything. Prof. Armstrong becomes quite indignant at the idea of eating "margarine . . . 'improved' with the aid of advitants from the livers of animals all and sundry." Berthelot, he declares, has given manufacturing chemists enough to do for some time to come without interfering with our food. In the discussion at the close of the lecture, however, Mr. Robert Mond put forward a point of view which might well be emphasised from the educational side: that in chemistry one can check one's own errors, and that chemistry *qua* chemistry may therefore be made the best tool for moral training that we possess.

Keeping Abreast—Some Aids for Physicists.

(1) *Radioaktivität.* Von Prof. Dr. Stefan Meyer und Prof. Dr. Egon Schweidler. Zweite, vermehrte und teilweise umgearbeitete Auflage. Pp. x + 722. (Leipzig und Berlin: B. G. Teubner, 1927.) 36 gold marks.

(2) *Thermionic Phenomena.* By Eugène Bloch. Translated by J. R. Clarke. Pp. viii + 145. (London: Methuen and Co., Ltd., 1927.) 7*s.* 6*d.* net.

(3) *Dielectric Phenomena: Electrical Discharges in Gases.* By S. Whitehead. Edited with a Preface by E. B. Wedmore. Published for the British Electrical and Allied Industries Research Association, being Reference L/T 22. Pp. 176. (London: Ernest Benn, Ltd., 1927.) 16*s.* net.

(4) *Institut International de Physique Solvay. Conductibilité électrique des métaux et problèmes connexes.* Rapports et discussions du quatrième Conseil de Physique tenu à Bruxelles du 24 au 29 avril 1924 sous les auspices de l'Institut International de Physique Solvay. Pp. viii + 368. (Paris: Gauthier-Villars et Cie, 1927.) 50 francs.

EVERY physicist must at some time or other have felt some sympathy with the suggestion, coming in the first place from an ecclesiastical source, that research laboratories should take a compulsory vacation of some ten years or so, in order that a breathing space might be given in which it would be possible to assimilate the vast accumulation of knowledge of the past few years, and to consider its bearings and implications not only in science but also in philosophy. In fact, with the slight and obvious reservation that nothing in the bill should be regarded as applying to one's own laboratory, a measure on such lines would undoubtedly meet with considerable support. It is pretty certain that no one in the future will be able to know the whole of physics, as it was possible to know it twenty or thirty years ago, or to keep in touch with all its developments even to the extent of reading, at first hand, the original memoirs in which the new work is described. At the same time, the actions and reactions of different branches of the subject upon each other are as close as, or closer than ever.

The problem is a serious one for the university teacher. It is absurd that a student of physics should go out from the university without some knowledge of the developments of his subject during the last ten or twenty years, and yet one searches in vain through the standard curriculum for some-

thing which can safely be scrapped. The problem for the research worker, who has less time for reading than the student, is equally vital. He knows that some new discovery in some widely different branch of the subject may illuminate his own problems, and yet if he attempts to read all the journals which pour out from the press, he will certainly have little time for experimental work. Some large commercial laboratories, we believe, maintain a member whose sole duty is to digest this mass of material and to distribute the nutriment to the particular parts of the body politic where it is most appropriate. Most of us, however, belong to less highly developed organisms, where functional differentiation has not been carried so far. We must buy our food predigested if possible, and we are very grateful if some specialist, with a reasonable gift for clear exposition, will spare sufficient of his time to tell us what is going on in the particular part of the subject which he has made his own. Text-books and monographs must play an ever-increasing part in the dissemination of knowledge in physics, and the author of a really good book of this kind has earned the gratitude of his fellow-workers.

(1) Meyer and Schweidler's "Radioaktivität," which was first published in 1916, established itself as the standard book on this subject from the moment when it became generally available. After a lapse of rather more than ten years we welcome it again in its second edition. The very large amount of new material which it contains makes it practically a new work. The authors record that the number of entries in the author index has increased from 749 to 1561, and the number of papers cited from 2460 to 4380. It is clear from these figures that a prodigious amount of new work has had to be incorporated in the volume in order to bring it once more up-to-date, and no worker in the subject can afford to remain ignorant of this accumulation of new facts and data.

It may be said at once that the authors have done their work well. They have a talent for selecting the vital part of the work which they describe, and for giving the essence of it in a form which is concise without being obscure. The numerical data are unusually full, and above all, the book is excellently documented, so that the worker has no difficulty in tracing any piece of information to its source, and so obtaining further details if he requires them. The publishers, too, have played their part well. The printing is excellent, and the paper so good that although many of the diagrams are very small, they are quite clear. The book is one which all workers in the subject will need to consult and most of them will wish to possess.

(2) Eugène Bloch's "Thermionic Phenomena," is already well known in its French dress. Many of us have been grateful, in the past few years, for the very valuable series of "Conférences-Rapports," of which the book in its original form was one, and M. Bloch's account of this rapidly growing and important subject is quite up to the high standard of the series. Messrs. Methuen and Co. now provide us with an English translation, which students who are unable to read the original will be very glad to possess. The account of thermionic phenomena in this volume is neither so complete nor so detailed as Meyer and Schweidler's treatise on radioactivity, but it is an excellent introduction (probably the best we have) to the subject. There are fairly numerous references to the original documents, and Mr. J. R. Clarke, who has translated the work into very readable English, has thoughtfully provided two indexes, which were wanting in the original.

(3) "Dielectric Phenomena" is a book of quite a new kind, though we may see more of its type in the future. It might almost be described as a phenomenon in itself. Published on behalf of the British Electrical and Allied Industries Research Association, its object is not only to give but also to seek information. The problem of insulation and insulators is becoming very critical nowadays. Plans for distributing electrical energy throughout the length and breadth of the land by a network of high-tension wires are now reaching maturity, and both for its safety and its efficiency the scheme must look to its insulators. Again, both in pure research and in medical work, there is a demand for higher and still higher voltages. The 100,000 volt apparatus which was practically standard in radiological departments a few years ago, is being replaced by sets capable of producing 200,000 volts, and there is no suggestion that the demand for 'volts' has reached its limits. Here, again, insulation is the vital problem.

The British Electrical and Allied Industries Research Association is clearly very much alive to the situation, and to the very unsatisfactory nature of our present knowledge of the subject. Mr. Whitehead, on behalf of the Association, has made, in this volume, a critical résumé of what is already known, or surmised on the subject, and one can only agree with his conclusion that there is scope for much more work, both experimental and theoretical.

Although our knowledge is admittedly very imperfect, Mr. Whitehead has succeeded in bringing together quite an important mass of data, much of it from periodicals which are not usually consulted by the physicist, and anyone interested either in insulation or in high tension discharge (for the book is mainly concerned with what happens when an insulator, and in particular a gaseous insulator, breaks down) will find here most of what there is to be known on the subject. This is, we believe, the first occasion on which a research association has published one of its précis for the benefit of scientific workers generally. Let us hope that they will reap a harvest of new discoveries.

(4) It is no disparagement to the authors of the volumes just reviewed to say that the most interesting has been reserved until last. Text-books and monographs are our necessary 'bread and butter' in these days; the reports of the triennial Solvay Conferences are real 'jam.' It is not so much the possession as the pursuit of knowledge which fascinates us; and the best written histories cannot rouse in us the same lively interest as a daily paper at a time when great events are afoot. In these Solvay reports we have, as it were, knowledge in the making; we can watch the interplay of experiment and hypothesis; and can even, as uninvited guests, enjoy the fun of speculating as to which, if any, of the numerous suggestions put forward by the eminent physicists present will prove to be nearest to the mark. The subject of the present report, "The Electrical Conductivity of Metals," lends itself particularly to this game, for there is scarcely any part of theoretical physics in which there is more uncertainty. Prof. Lorentz invites us to consider the electrons in the metal as constituting a perfect gas. Prof. Lindemann prefers to regard them as a perfect solid, and puts up a vigorous defence for his hypothesis. Prof. Bridgman, in a very excellent résumé of the subject, invites us to consider some dozen other theories, which have been mooted from time to time, besides suggesting a new one of his own. It is all very exciting, and excellent reading.

We should be wrong, however, if we left the impression that the volume was all 'jam.' Like its predecessors, this Solvay report contains some of the best summaries which we have of the present state of knowledge in the subjects with which it deals. In addition to Prof. Bridgman's report, which has already been mentioned, we have a very illuminating account by Prof. Lorentz of the application of the electron theory to metals, a paper by Dr. Rosenhain on the internal structure of alloys, and an account written by the late Prof. Kamerlingh Onnes of his work on supra-conductors.

The mention of the name of this great pioneer, whose death we had to deplore some time ago, brings me to the one complaint which I have to urge. The present volume does not record the proceedings of the conference held last year, but of its predecessor of 1924. Even admitting that the work of editing a volume of this kind is not light, and that it is not the easiest of tasks to extract corrected proofs from distinguished men, the interval of three years between the meeting of a conference and the publication of its report seems unnecessarily long. It would be a real benefit to science if these reports, which are always looked forward to eagerly, could be published at any rate within twelve months of the date of the conference. It says much for the quality of the work contained in the present volume that it has lost so little interest by the unfortunate delay.

J. A. CROWTHER.

Nature of Cytoplasmic Inclusions.

Symbionticism and the Origin of Species. By Prof. Ivan E. Wallin. Pp. xi + 171 + 4 plates. (London: Baillière, Tindall and Cox, 1927.) 13*s*. 6*d*. net.

IT is now at least eight years since there have been any flutterings in the cytological dovecot. Everyone had settled down to a cell containing a nucleus with chromosomes, karyoplasm, karyosome, and plasmosome, and a cytoplasm with centrosome, Golgi bodies, and mitochondria. If there were malcontents, they had been silenced by the shock effect of the vast and ever-increasing international literature on the cytoplasmic inclusions. In the field concerned with the intra-nuclear bodies, the chromosomes have attained respectability even in the views of those physiologists who cannot understand such a simple thing as the chromosome theory.

Now in this last year there have been ripples in the hitherto calm waters. First, there has been the re-blooming of the Merseyside cytological plant, under the care of Prof. Charles Walker, who, to the admiration of several chemists and at least one palæontologist, has, so to speak, demonstrated, with the aid of a tin of condensed milk and some water, that there is no such thing as a cow (*Proc. Roy. Soc.*, vol. 101, B, 712). Secondly, Dr. Parat has discovered that Golgi, Cajal, Rio Hortega, E. B. Wilson, Da Fano, Ludford, Bowen, Hirschler, Hyman, Doncaster, Voinov, Nassonow, and many

other cytologists and histologists, have mistaken mitochondrial bodies ('lepidosomes') for the true Golgi bodies, and that Dr. Parat's veritable cell vacuole is the true Golgi apparatus; and we have the word of the distinguished human anatomist, Dr. Woollard ("Recent Advances in Anatomy"), that Dr. Parat is correct!

Lastly, we note the issue of the book under review. Dr. Wallin, professor of anatomy in the University of Colorado School of Medicine, does not cry 'artefact' at us, as does Prof. C. Walker, nor does he mention the 'vacuome' of Parat especially —he merely asks us to believe that the mitochondria (and the Golgi bodies possibly also, being modified mitochondria) are bacteria ('symbiotes'). The origin of species has taken place largely owing to the activity of these bacterial symbiotes, and the process is called 'symbionticism,' a new and horrid word. Dr. Wallin, unlike Dr. Walker, is prepared and ready to allow us any cytoplasmic inclusions we like, just so long as we do not forget that they are bacteria. He does not mind whether Golgi's Golgi apparatus is the real Golgi apparatus, or whether Dr. Parat's rival Golgi apparatus is the real Golgi apparatus.

Seriously, however, Dr. Wallin finds that mitochondria may be minute spheres or rods (like bacteria), may stain in fuchsin and such dyes (like bacteria), may divide by binary fission (like bacteria), may grow on media (like bacteria), and, finally, that all stages in the establishment of 'symbionticism' may be found in such organs as cockroach eggs, plant roots, and cephalopod light organs, to mention but a few. 'Symbionticism' is the key, according to Dr. Wallin, to the diversity of animal life.

Now it may be said at once that it is not easy to get a definition of a bacterium which would not equally well apply to a mitochondrion—at least the reviewer has not met the bacteriologist who could give a satisfactory and discriminating definition. This is the strength of Dr. Wallin's position. On the other hand, it is possible for the cytologist to give a definition of a mitochondrion which may exclude all bacteria. For example—a mitochondrion is a minute sheathless intra-cellular body never containing chromatinic particles, and capable of fusing with other mitochondria to form structures such as the uninterrupted tail of a spermatozoon.

Now, Dobell showed years ago that in large bacteria chromatic particles exist. No mitochondria large or small ever contain such particles. Then, too, no bacteria are known to fuse into a mass to form one long structure, like a sperm tail sheath. Dr. Wallin will find that the field of spermatogenesis alone will provide facts which make his position untenable. We believe that the case he makes for the growth of mitochondria on nutrient media is unsatisfactory, though even if the evidence had been complete, this would not convince the reviewer that mitochondria are necessarily bacteria.

The similarity between the techniques for staining bacteria and Golgi bodies and mitochondria can be admitted if at the same time it be pointed out to Dr. Wallin that there never was a case where the two types of structures (symbiotic or parasitic bacteria and mitochondria) could not be differentiated easily by current techniques. No one has ever described any sort of sheath on mitochondria, and the latter are more fragile than the general run of bacteria. The similarity in size and shape between bacteria and mitochondria means little. The case Dr. Wallin tries to make for a similarity of chemical constitution between bacteria and mitochondria is completely unconvincing.

J. BRONTË GATENBY.

The Activated Sludge Process of Sewage Treatment.

The Activated Sludge Process. By Arthur J. Martin. (Reconstructive Technical Series.) Pp. xiv + 415 + 37 plates. (London: Macdonald and Evans, 1927.) 30*s*. net.

THIS book may be described as an amplification and bringing up-to-date of the paper read by Mr. Martin before the Institution of Civil Engineers a few years ago, in which he brought together established facts and results contained in a great number of scattered papers dealing with the subject of the activated sludge process.

Chap. i. details the early work on the forced aeration of filters and various methods of aeration of sewage in tanks, including the Lawrence and Fowler experiments. Chap. ii. is concerned with the experiments of Arden and Lockett, many extensive extracts being given from the papers by these workers. Full-sized working units at Withington and Davyhulme are described in Chap. iii., with drawings and photographs, analyses, and useful data respecting air consumption and volume of sewage treated.

The diffused air system is fully dealt with in Chap. iv., a number of British works being fully described, with plans and sections: a good photograph is given in this chapter, showing an aerial

view of the Coventry works. The next three chapters are devoted to the subject of mechanical agitation; the Sheffield, simplex, spiral flow, and others being described at some length.

A short chapter—Chap. viii.—records the progress the process has made in England, as shown in the annual reports of the Ministry of Health, whilst the next chapter deals with the process in America and Canada, the Milwaukee, Chicago, Houston, Indianapolis, and other plants being fully described and illustrated with plans and photographs.

Chaps. x. and xi. deal respectively with the theory and the requirements of the process, and it may be questioned whether, all things considered, these two chapters would not come in more suitably at an earlier stage. In Chap. x. the sensitiveness of the process to changes in the character of the sewage, as, for example, those brought about by influxes of certain trade wastes, is emphasised. In the latter chapter, the essential requirements of the process, namely, oxygen, suitably conditioned sludge, and effective circulation of the sludge and liquid, are carefully described, frequent quotations from various well-known authorities being made.

Chaps. xii. to xiv. are concerned with need for preliminary treatment, alternative modes of working, and diffusers; whilst Chap. xv. deals with the important question of design of tanks, the Clifford inlet being described and illustrated. The next three chapters treat of air compression, loss of pressure in air mains, and appliances for mechanical agitation. Power required for agitation receives notice in a short chapter (xix.) of three pages.

The rather controversial question of comparison of methods of agitation has eleven pages devoted to it in Chap. x. the advantages and drawbacks of various methods being carefully discussed. The author states that the air-blowing method, being first in the field, has naturally received more attention than mechanical agitation.

Chap. xx. contains eleven pages descriptive of a combination of methods, Imhoff's Essen-Rellinghausen experiments on the use of diffused air in conjunction with mechanical agitation being described and illustrated, together with the Kottwig submerged contact aerator, in which the aerator consists of brushwood, air being supplied by a moving pipe.

Chaps. xxii. and xxvi. deal with position and outlook, cost of process, reduction of cost of process, factors affecting cost of power, and possible lines of advance.

The bugbear of sludge disposal is very fully and usefully discussed in Chap. xxvii., 34 pages being given to this most important question. The author points out that the bulk of activated sludge—owing to its high water-content—is frequently more than 1 per cent., and sometimes as great as 6 per cent. of that of the sewage from which it originates. He considers that if it is found practicable to apply activated sludge direct to land in its wet state, one of the chief obstacles to the adoption of this process of sewage treatment will have been removed.

The final short chapter of six pages deals with latest developments in the process. Six appendices follow, and an exceptionally complete, useful, and well-arranged bibliography relating to the literature of the activated sludge process.

A list of authors cited and a comprehensive index complete the book.

The book is well written and illustrated, and the printing is good. The author may fairly claim to have accomplished what he set out to achieve, namely, "to present the leading opinions on both sides, and so far as possible, in the words of those responsible for them." The labour involved in bringing together in readable form the salient facts and features of the activated sludge process from the voluminous literature relating thereto must have been considerable, and Mr. Martin's book should prove most useful to engineers and others interested in sewage treatment.

G. BERTRAM KERSHAW.

A Ruthless Republic.

The Life of the White Ant. By Maurice Maeterlinck. Translated by Alfred Sutro. Pp. 213. (London: George Allen and Unwin, Ltd., 1927.) 6*s*. net.

IN taking up any work on natural history by Maurice Maeterlinck, we know that we may expect to find a picturesque compilation of facts for the most part well authenticated, recounted in an agreeable style, and diversified by comments of a moralising character which, though not always convincing, are generally not without interest. The present book is in these respects true to type. The author has been to the best sources for his facts; his philosophical deductions bear the impress of a mind which, if somewhat uncritical in method, is yet sound in its estimate of the importance of human life and destiny.

The systematics of the remarkable group of insects here dealt with are but lightly touched upon. The reader will find nothing to replace the treatment of morphological detail which is the concern of ordinary text-books. It is the constitution,

economy, and polity of the termitarium, the extraordinary differentiation of the various descendants of a single pair, the pitiless subordination of the apparent well-being of the individual to that of the community, that principally engage the author's attention. A matter of which he treats at considerable length is the symbiotic relation between termites and their intestinal protozoa, the recognition of which we owe to the recent investigations of L. R. Cleveland.

The architecture of the common habitation is briefly described, and sketches are given of the distinctive characters and behaviour of the workers, soldiers, and royal couple. But the author's speculations on the origin and development of the various instincts that combine to make up the life of the termite society are vitiated by his persistent attempts to attribute foresight and intelligence to its constituent members. The key to the problem is to be found, no doubt, in the comparison of the more or less advanced stages of elaboration reached by the development of different species, under the influence of natural selection. Considerations of this sort, however, do not appeal to M. Maeterlinck, who appears to prefer to have recourse to the supposed "intelligence and will" of the termites. Thus, on the subject of their nutrition he asks, "Why not recognise that they may themselves have found it more convenient, preferable, to install digestive protozoa in their own bodies, so as to be able to give up vegetable mould and eat whatever they choose?" Then again, in reference to the mushroom-cultivating species, he says:

"The termites must have noticed that such mushrooms provided a far richer, more certain and more directly assimilable food than vegetable mould or waste wood, and possessed the additional advantage of helping them to get rid of the embarrassing protozoa whose weight was becoming so oppressive. Thenceforward they proceeded systematically to cultivate these cryptogams."

It is true that M. Maeterlinck adds, "Evidently, or at least probably, all this is due merely to chance"; but his reference in the same passage to the method of cultivation in the neighbourhood of Paris shows that his attribution of conscious ingenuity and method to the termite is deliberate and intentional. It seems, in fact, from this place and from many allusions to the *anima mundi*, that he would not be disinclined to apply to the 'white ants' what Vergil says about the bees:

"his quidam signis atque haec exempla secuti
esse apibus partem divinae mentis et haustus
aetherios dixere."

F. A. D.

Our Bookshelf.

An Introduction to the Scientific Study of the Soil. By Prof. Norman M. Comber. Pp. 192. (London: Edward Arnold and Co., 1927.) 7*s.* 6*d.* net.

The great advance in our knowledge of soil physics and chemistry during recent years has been accompanied by a flood of literature which renders it increasingly difficult for any worker to obtain a comprehensive view of the subject without the expenditure of undue time and labour. Prof. Comber is therefore the more to be congratulated, in that he has succeeded in presenting the salient features of the subject in such a way that not only students (for whom the book is primarily intended) but also advanced research workers will find much illumination and assistance therefrom. His exposition is masterly, a few words conveying the essentials of each point without burdening the reader with details, which can be found when necessary in the original papers, to which an adequate bibliography is provided. One striking feature is the simple explanation of common phenomena which are not often thought about, as, for example, why seeds fail to grow if planted too deeply.

After dealing briefly with the relations between the soil and the plant, the origin and development of different soils are described under the heading "soil genetics," and then the components and attributes of soils are treated individually in more detail. This leads up to an account of various bases of soil classification, from the agricultural and the scientific viewpoints, special attention being given to the work of the Russian school of investigators and to the United States work on soil profiles. Various experimental methods for comparison of the effect of different types of soil treatment in the laboratory and the field are outlined, with indications of their relative value. An unusual feature is introduced in the form of practical suggestions to the student as to the best methods of utilising the literature of the subject, a matter which seems simple at first sight but is apt to involve the inexperienced in a welter of information which obscures the end sought. This book, with its clarity of concentration of a complicated subject, should prove of the utmost value to all who are working on the soil, whether from the biological, chemical, or physical point of view.

The Propagation of Electric Currents in Telephone and Telegraph Conductors. By Prof. J. A. Fleming. Fourth edition, revised and extended. Pp. xv+422. (London: Constable and Co., Ltd., 1927.) 21*s.* net.

The addition of a new chapter to this book has greatly increased its usefulness. The enormous improvements in the design and manufacture of submarine cables, and the advances made in the construction of telephone and telegraph cables, make some account of them essential to the student. The use of powdered iron instead of iron wire in the cores of 'loading' coils has practically

eliminated eddy current loss without lowering appreciably the permeability of the core. The extension of the usefulness of the cable by means of 'phantom' circuits can only be obtained by almost perfect balancing of the various circuits. It was discovered in American research laboratories that an alloy of nickel and iron containing more than 30 per cent. of nickel has remarkable magnetic properties. Permalloy has a composition of nearly 80 per cent. of nickel and 20 per cent. of iron. At vanishingly small magnetising forces permalloy may have a permeability of 13,000, which is more than thirty times as large as that of the best soft iron. Permalloy may even be saturated when subjected to the earth's magnetic field.

It is found that when a submarine cable is suitably covered with permalloy tape, the speed of transmission of the messages can be increased ten times. A brief mention is made of the structure and mode of using thermionic repeaters, the use of which has greatly increased the range of telephony and greatly reduced the cost of the conductors. The development of carrier wave multiple telephony is also described. By its means several independent conversations can be conducted simultaneously on one line. It is satisfactory to note that practically all these inventions are the immediate outcome of the application of theory. To the student especially this book will be of great value.

Die seltenen Erden vom Standpunkte des Atombaues. Von Prof. Dr. Georg v. Hevesy. (Struktur der Materie in Einzeldarstellungen, herausgegeben von M. Born und J. Franck, Heft 5.) Pp. viii + 140. (Berlin: Julius Springer, 1927.) 9 gold marks.

THE discovery by Johann Gadolin in 1794 of the mineral gadolinite opened up a new and difficult field of investigation, which has had an important bearing on the theory of atomic structure. The problem of fitting the rare-earth elements into the periodic system was only partly solved when Moseley's work revealed the total number as well as the positions of members of the cluster. Hevesy shows how Bohr's theory of atomic structure provides a key to their mysterious behaviour, and the well-known fact that, chemically, yttrium lies in the midst of its higher homologues becomes intelligible; for whilst the valency-electrons of tervalent lanthanum are more remote from the nucleus than those of yttrium, and are therefore less firmly bound, other conditions prevail in higher members, where valency-electrons lie at a deeper quantum level.

Amongst other physical properties the paramagnetism of ions is discussed at length, and is shown to exist only where the distribution of valency-electrons is anomalous, but the latter are unusually deep-seated between cerium and lutecium. This is held to account both for chemical similarities and chemical irregularities in the cluster. Now since no satisfactory data are as yet available of ionisation potentials with which to judge the firmness with which these electrons are held, one has to draw conclusions from the molecular volumes of analogous compounds. Though apparently irregular, the results are in agreement with the requirements of Bohr's distribution. Thus a steep rise in value in passing from scandium to lanthanum is followed by a gentle fall from lanthanum to lutecium.

The second part contains a useful account of the chemical properties of compounds and concludes with a historical survey of the subject.

Directing Mental Energy. By Dr. Francis Aveling. Pp. x + 276. (London: University of London Press, Ltd., 1927.) 8*s*. 6*d*. net.

THIS is a peculiarly constructed book. The author seeks to show how we may economise our expenditure of energy, of which we possess only a limited stock, as a partial solution of the problem 'How to make the most out of life'; as if a conscientious application of the proverbial injunction 'to take care of the pence' were an important secret of happiness. Yet, fundamentally, Dr. Aveling is more concerned with the problem of spending wisely than with the rather negative emphasis on economy and on the avoidance of waste from which he starts.

The title and the introduction suggest a much more profound and philosophical treatise than the author has given us. Consequently, in parts, the treatment seems somewhat inadequate; some of the topics, especially those on industrial and vocational psychology, are dealt with too broadly for a work of this kind. Dr. Aveling, however, sees unity in the diversity of our daily life and invokes the laws of energy to explain it. Even such a spontaneous expression of human impulses as is found in play is regarded as having its 'why and wherefore' in the constancy of human energy. The book is decidedly interesting, though the author's thesis will not be acceptable to all psychologists.

Mexican Architecture of the Vice-Regal Period. By Walter H. Kilham. Pp. 223 + 84 plates. (New York and London: Longmans, Green and Co., Ltd., 1927.) 21*s*. net.

HISPANO-AMERICAN architecture is not likely to be a subject with which very many European readers are familiar. It is, however, well worth study, on account of its innate beauty and form. Its period of development extends from the middle of the sixteenth century to the beginning of the nineteenth, when Spanish domination came to an end. Mexican architecture in its main lines followed that of Spain at a time when the Renaissance style was developing in the mother country. It presents, however, a course of independent development of its own, which comes out in many features, but especially in the use of coloured tiles. Of its peculiarities, many are due to the employment of native workmen, Indians, who themselves had an architectural tradition behind them, and considerable artistic taste of their own. It is this which gives Spanish-American architecture an individual interest as a subject of study. Mr. Kilham's informative sketch of its history is clear in its description and exceedingly well illustrated.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Nature and Function of Golgi Bodies.

IN view of Prof. Charles Walker's letter in NATURE of Jan. 21 on the nature and function of Golgi bodies, perhaps I may be allowed to summarise, briefly, the reasons why most cytologists have come to regard the Golgi apparatus as a definite cytoplasmic structure:

(1) The Golgi apparatus can be seen in certain living cells, for example, spermatocytes of Helix (Platner, Murray).

(2) A positive picture of the apparatus can be obtained by the silver and osmic methods (Cajal and Kopsch, and their numerous modifications); also a negative picture results when good cytoplasmic fixatives are employed. Anyone can prove this by trying the osmic and silver methods with cells of the epididymis, or pancreas of the mouse, and comparing the results with material fixed in osmic acid, and counterstained with a plasma stain. In suitable osmic preparations the mitochondria can also be counterstained, and then appear the same as in the living cell, so the argument that cell structure has been distorted by the technique is untenable. It has been shown by Karpova that the Golgi bodies in the spermatocyte of Helix can be stained with Sudan III. after the bichromate treatment of Ciaccio, and Weiner has been able to demonstrate the apparatus by the same method in epithelial cells of the intestine.

(3) The Golgi apparatus has a characteristic form in different types of cells; for example, in most neurones it is a network, while in fibroblasts it forms a compact cluster around the sphere.

(4) It has been shown by a large number of workers (see the reviews of Bowen, *Anat. Rec.*, vol. 32, 1926, and Jacobs, *Ergeb. d. Biol.*, vol. 2, 1927) that there is a definite correlation between the form of the Golgi apparatus and the functional activity of the cell. Thus the form of the apparatus varies during secretory activity in gland cells. In neurones it is altered as the result of injury (Cajal, Penfield); while phosphorus poisoning induces well-marked changes in cells of the pancreas (Cowdry). During gametogenesis, also, it undergoes characteristic changes (Gatenby, Bowen, Brambell).

(5) The secretion granules of gland cells arise in relationship with the Golgi apparatus. Nassonov and Makarov have shown that acid dyes such as trypan blue when injected subcutaneously collect in liver and kidney cells in that part of the cytoplasm where the Golgi apparatus is situated. The droplets of dye accumulate, therefore, in the region of the Golgi apparatus, so the apparatus cannot be a mere condensation of lipoids around droplets as Walker has suggested.

Prof. Walker's argument is based upon a fallacy, that things which look alike are necessarily the same. Every elementary student of physiology knows that models can be set up to imitate amœboid movement, cell division, and growth (artificial osmotic membrane experiments), while cell-like structures with nuclei can be imitated with gelatine solutions. Does this disprove the reality of these vital phenomena? Since Prof. Walker has produced artificial structures, which he says look like Golgi bodies, this no more disproves the existence of the Golgi apparatus in living cells than the production of artificial cells with nuclei disproves the reality of cell structure. Prof. Walker's work seems rather to confirm the view held by most cytologists that the Golgi apparatus is of a lipoidal nature.

R. J. LUDFORD.

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Jan. 21.

The Spectrum of the Corona.

A CORRESPONDENCE, which may be important, has been found between the 'unknown' spectral lines of the solar corona and the spectrum of argon. It has been found possible to connect about two-thirds of the coronal lines given by Campbell and Moore with the argon lines and terms in Meissner's recent investigation.

There are 18 lines directly identified. The lines in the argon spectrum immediately before and after the selected one are, in each case, well removed from the selected line, compared to the discrepancy between the coronal and the argon wave-numbers. In any case this latter discrepancy is within the accuracy to which the coronal lines are known.

Space does not permit of giving the complete tables, but a few typical examples will be quoted:

The average disagreement is 2 wave numbers; the maximum is 5 (allowed only in the cases where the determination of the wave-length is correspondingly uncertain) and there are half-a-dozen lines where the agreement is accurate within one wave-number. On the other hand, the average distance to the nearest line in the argon spectrum is 30 wave-numbers. For example, the coronal line of wave-number 27443 has, corresponding to it, an argon line, 27441. The argon lines closest by, and to either side, are 27391 and 27507. The selected argon line has the designation $1s_4 - 4p_8$. Consider the two coronal lines of wave-numbers 19533 and 17860. It was recognised that the difference in the wave-numbers was the same as the interval between the $2p_8$ and the $2p_3$ terms in argon, and the argon wave-numbers given by $2p_8 - 6s_1'''$, and by $2p_3 - 6s_1'''$ are these two coronal wave-numbers to within 1 wave-number.

The lines directly identified include most of the strong lines of the corona. Ten other coronal lines are found to be expressible as combinations of Meissner's term values. Thus a line of wave-number 24468 may be compared with the wave-number 24470 given by the combination $1S_3 - 4d'_4$. A coronal line at wave-number 18852 is given by $2p_4 - 9s_4 = 18852{\cdot}58$ and by $2p_5 - 7s_1'' = 18852{\cdot}17$. This line, $\lambda 5302{\cdot}9$, is the brightest line in the coronal spectrum; and the fact that its wave-number is given quite accurately by two different combinations of terms (that is, by two different possible changes in the state of the radiating centre), may be connected with this fact.

Because of the presence of Ca II in extremely high levels of the chromosphere, it was thought that the coronal lines might be attributed to this substance or to Ca III as suggested by Pannekoek. However, a comparison with J. A. Anderson's tables of the calcium spectra gave no very suggestive agreement.

The implication that argon exists in the sun is not borne out by other solar observations; but it is to be remembered that a given substance may be abundantly present in the sun, and yet because the external conditions do not bear a certain definite relation to its ionisation potential—as required by the Saha theory—the spectrum may not appear at all. It is not beyond possibility that conditions of temperature

and pressure in certain regions of the corona are favourable not only for the production of the lines of a given element but also for the appearance of groups of lines which are not given by ordinary laboratory methods of excitation.

A more detailed presentation will appear soon in the *Astrophysical Journal*. IRA M. FREEMAN.

Ryerson Physical Laboratory,
University of Chicago.
Jan. 5.

A Simple Rainfall Law.

I HAVE recently prepared statistics giving the maximum total rain falling on any n consecutive days, for selected stations in Ceylon, and over certain periods. These figures, with a discussion, are being published as a paper, "Heavy Rainfall in Ceylon," in the *Transactions of the Engineering Association of Ceylon* for 1927.

In the course of this investigation I discovered a very simple law, which Ceylon rainfall seems to follow very closely, but which, so far as I am aware, has not been pointed out elsewhere.

Consider the maximum value of the total rain falling in n consecutive days during any one year. Let R represent the mean of a number of such values for different years; then, if this mean is taken over a sufficient number of years, we have

$$R = Qn^K,$$

where Q and K are constants for any particular station and period of years, and n is small. This formula holds with remarkable accuracy, when the means are taken over, say, 40 years or more.

In the table below, figures are given for four stations. The first row for each station gives R, the actual mean yearly maximum rainfall, in inches, extracted from the daily records of that station.

STATION.	$n=$	1	2	3	4	5	6	7	8	9	10	Q	K
Avissawella (47 years)	Actual mean maxima	5·89	8·16	9·66	11·20	12·59	13·94	15·17	16·13	17·15	18·09	..	..
	Theoretical mean maxima, $=Qn^K$	5·68	8·05	9·87	11·40	12·75	13·97	15·10	16·15	17·12	18·06	5·68	0·502
	Percentage excess of actual	+3·6	+1·4	−2·1	−1·8	−1·3	−0·2	+0·5	−0·1	+0·2	+0·2	..	..
Haldummulla (40 years)	Actual mean maxima	4·64	6·46	7·97	9·26	10·46	11·46	12·42	13·10	14·08	14·84	..	..
	Theoretical mean maxima, $=Qn^K$	4·58	6·52	8·02	9·29	10·40	11·42	12·35	13·23	14·04	14·83	4·58	0·510
	Percentage excess of actual	+1·3	−0·9	−0·6	−0·3	+0·6	+0·3	+0·6	−1·0	+0·3	+0·1	..	..
St. Martin's (37 years)	Actual mean maxima	10·34	15·38	19·16	21·54	24·31	27·00	29·21	31·34	33·45	34·97	..	..
	Theoretical mean maxima, $=Qn^K$	10·54	15·15	18·74	21·78	24·47	26·92	29·17	31·30	33·27	35·16	10·54	0·523
	Percentage excess of actual	−2·0	+1·5	+2·3	−1·1	−0·7	+0·3	+0·1	+0·1	+0·5	−0·5	..	..
Jaffna (56 years)	Actual mean maxima	5·17	6·95	7·93	8·78	9·53	10·24	10·93	11·42	11·88	12·45	..	..
	Theoretical mean maxima, $=Qn^K$	5·24	6·79	7·91	8·81	9·58	10·26	10·87	11·42	11·94	12·42	5·24	0·375
	Percentage excess of actual	−1·4	+2·3	+0·2	−0·3	−0·5	−0·2	+0·5	0·0	−0·5	+0·2	..	..

The columns headed Q and K give the constants deduced from these straight lines, while the second row for each station gives values of Qn^K, computed from these constants. The third row gives the percentage excess of the first row over the second, and it will be seen that the agreement is remarkably close.

As the stations examined represent a considerable diversity of rainfall types, depressional, north-east monsoon, south-west monsoon, and diurnal local circulation, it seems probable that this is a general law, universally applicable, in which case it affords a means of classifying rainfall by two numbers only. Such a simple numerical classification may be of value in regional studies of precipitation.

I have submitted a paper on this subject to the *Ceylon Journal of Science*, and this will appear in the next issue of Section E, while further investigations on the variations of K and Q, over Ceylon, will be undertaken. H. JAMESON.

Colombo Observatory,
Dec. 27.

The Two Calories.

I HAVE read with appreciation Mr. Marks's letter in NATURE of Jan. 14. May I recall that fifty-seven years ago Thomas Muir, the mathematician (now Sir Thomas Muir), suggested the names therm and kilotherm for them (see NATURE, vol. 1, p. 606). Since then the Gas Companies have appropriated the name therm and defined it as 100,000 British Thermal Units. It seems to me that from the scientific, the engineering, and the practical points of view, the best units for heat are the kilowatt-hour, its multiples and submultiples.

ALEXANDER RUSSELL.

Faraday House,
Southampton Row, W.C.1.

THE confusion between the two calories referred to by Mr. Marks in NATURE of Jan. 14 would be made worse by his suggestion that the kilogram calorie should be written as Kalorie, since it could then be confused with the so-called Ostwald calorie—a unit which should never be used and is now obsolete, because the latter is denoted by K. The matter of differentiating between the gram and kilogram calories was considered by the Bureau of Chemical Abstracts some little time ago, and the chairman of the board, Prof. J. C. Philip, informs me that it was decided to use 'g. cal.' and 'k. cal.' for the two units. It is highly desirable that this method should be generally adopted, since much confusion and even error is undoubtedly caused by the use of 'cal.' and 'Cal.' The question of the unit calorie, whether 15° or 20°, etc., adds a further source of confusion to very accurate work, and when this is known it may be stated as a suffix, say g. cal.$_{15°}$, as is also done by the Bureau of Chemical Abstracts.

The whole matter of physico-chemical symbols was considered some time ago by a small committee of the Chemical Society, of which I was a member, and some trouble was taken with it. The results, however, which were handed over to some international body or other, have disappeared without trace.

J. R. PARTINGTON.

Kingsbury Close,
London, N.W.9.

A Proposed Biological Flora of Britain.

IN the preface to the first edition of the "Students' Flora," published in 1870, Sir Joseph Hooker expressed the hope of being able to undertake a companion volume in which "the physiological and morphological observations" on British species should be recorded. Ever since that time this idea has been in the minds of botanists, but so far no serious attempt has been made to bring the project to fruition.

Such aut-ecological data are of great value, not only

for their own sake, but also for the progress of the study of plant communities, which is greatly hampered by the lack of information respecting the life-histories and biotic relations of their constituent species. Further, until such data are available, it is useless to attempt to unravel the complex tangle of factors involved in the phenomenon of competition.

Much relevant information is scattered through the literature but is comparatively inaccessible; much, too, is known to field naturalists, but perishes with them. The collection of the published data, and such original observations as are available, will not only be valuable in itself, but will also provide the surest means of bringing to the notice of students the many lacunæ that require to be filled.

The council of the British Ecological Society has had the matter under consideration, and at the annual meeting on Jan. 7, the Society decided to undertake the publication of a British biological flora which should embody the available data regarding the biology and ecology of the native and naturalised British species.

The writer, who has been making observations and collecting data of this character with reference to British woodland species for several years past, has undertaken the preparation and editing of the work, but it is manifestly a task that can only be successfully accomplished by the active co-operation of botanists, professional and amateur alike, throughout the country.

A schedule indicating the scope of the projected work has been prepared by the writer and will be sent to anyone willing to assist.

E. J. SALISBURY
(President, British Ecological Society).
University College, London.

Polarisation of Radio Waves.

IN some recent work on this subject carried out for the Radio Research Board, the following interesting results have been obtained in connexion with the propagation of long waves (14,350 metres).

In the course of simultaneous observations over a period from one hour before until one hour after sunrise of the same transmission from St. Assise by two stations, Slough and Aberdeen, roughly 400 and 1000 km. from it and approximately on the same great circle, it has been found that in the period preceding sunrise the wave arriving at the nearer station is plane polarised, with its plane of polarisation rotated in a clockwise direction when looking in the direction of propagation, whereas at the more distant station the rotation is anti-clockwise. By the time of sunrise both these abnormal polarisations have gradually decreased and disappeared, and in some cases at the nearer station the space wave appears to have entirely vanished also. About half an hour later, however, the space wave reappears at the nearer station, but this time with left-handed polarisation.

This persists with varying intensity throughout the day, again disappearing about 15.00 G.M.T., when the right-handed polarisation returns for the night.

It has also been shown that the wave reaching the far station has started from the transmitter at practically the same angle of elevation as the wave to the near station, and that its downcoming angle at the far station is comparatively steep. Internal evidence is strongly against the idea of a twice-reflected wave, mainly because the variations of direction and intensity observed are too great to fit in with the roughly known values of the reflecting power of the layer for a single reflection; and there seems a strong probability that we are here dealing with some form of doubly refracted ray of which one element is being received at each station. The direction of transmission makes an angle of 15° with the magnetic meridian, but owing to the high value of the magnetic dip in these latitudes it is difficult to link up these results with the theoretical formulæ. Further experiments on the subject are in progress.

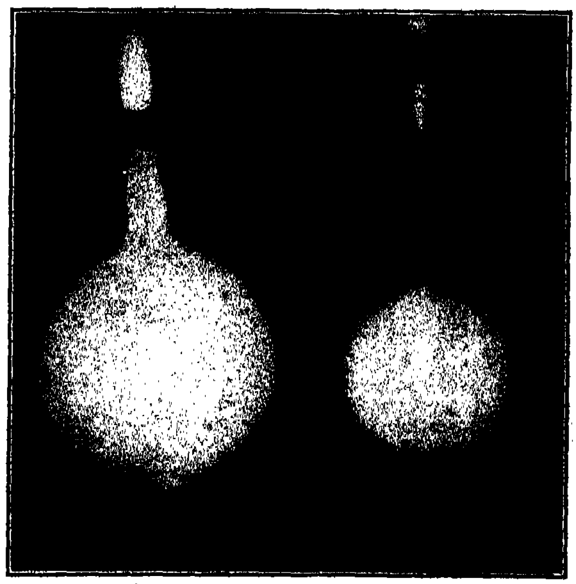
J. HOLLINGWORTH.
R. NAISMITH.

Radio Research Station,
Ditton Park,
Langley, Bucks,
Jan. 13.

A New Form of the High Frequency Electric Discharge.

RECENTLY, we have conducted experiments on the electric discharge through gases at very low pressures with alternating potentials of about 4×10^7 cycles per sec. (7 metre wave). Results were obtained with mercury at pressures of the order of 10^{-3} mm. in a bulb 20 cm. diameter with neck of 2 cm. diameter, and external copper-foil wrappings as electrodes on the neck, and showed that the discharge could take two distinct forms as shown in the accompanying photographs.

In the first type of discharge (Fig. 1, A) the discharge



A B
FIG. 1.

was projected as a visible streamer into the bulb below, which was almost completely filled with the glow. In the second case, with lower exciting power, the discharge (Fig. 1, B) took the form of a spherical glow of uniform luminosity separated from the walls by a dark space. A considerable portion of the neck of the bulb was completely dark, and discharges of the ball type could be maintained with no luminous effects at all in the side tube.

The behaviour of the two types of discharge when subjected to magnetic fields, showed quite diverse effects, and after many experiments with different gases, it was concluded that the bulb discharge was maintained (once initiated) by the stray alternating electric field from the electrodes which is projected down the neck into the bulb.

This new type of electric discharge is analogous

to a uniform electron and positive ion high temperature enclosure, and preliminary results indicate that by its means many spectral and chemical problems may be attacked under conditions not previously realisable. The conditions of excitation are probably similar to those existing in the outer atmosphere of the sun.

JAMES TAYLOR.
WILFRID TAYLOR.

Trinity College, Cambridge.
Jan. 12.

Subsidiary Rectangles as applied to the Formation of Magic Squares.

IN the issue of NATURE of Jan. 14 I gave the smallest 'associated' rectangle, consisting of 3 rows which has the property of the diagonals one way summing to the same as the rows. This was with nonconsecutive numbers. The smallest associated rectangle with consecutive numbers is :

18	20	24	9	5	12	25	7	6
2	1	15	17	14	11	13	27	26
22	21	3	16	23	19	4	8	10

126 × 42

In this associated rectangle, the rows and the diagonals from left to right sum to 126, the columns to 42. But as with order 18 rectangles 6 × 3 the diagonal requirement is not necessary as associated pandiagonals with subsidiary rectangles 9 × 3 can be made otherwise.

This diagonal requirement is necessary for all associated pandiagonals with subsidiary rectangles of 3 rows, except as above, when the number of columns in the rectangle is a multiple of the number of rows (three), such as 6 × 3, 9 × 3, etc. With pandiagonals *not associated* consisting of subsidiary rectangles of 3 rows it is still necessary with all rectangles with an odd number of columns such as 7 × 3, 5 × 3, etc. I give an example of each :

14	17	15	12	4	9	6
1	3	2	11	21	19	20
18	13	16	10	8	5	7

77 × 33

14	12	11	2	1
6	9	8	7	10
4	3	5	15	13

40 × 24

These are with consecutive numbers and not associated. Rectangles with an even number of columns do not require the diagonals one way to sum to the same amount as the rows. Pandiagonal squares can be made by other methods. Such are 4 × 3, 8 × 3, etc.

J. C. BURNETT.

Barkston, Grantham, Lincs.

Production of Bubbles of Selenium.

IT may be of interest to record that bubbles of selenium can be blown from the end of a suitably shaped glass tube, after dipping it momentarily into the molten 'metal.'

I find it best to use for this purpose a glass tube which has an internal diameter of about an eighth of an inch, and to bell out slightly the extremity which is to be dipped into the molten selenium.

The temperature of the selenium should be just below that at which it gives off a faint cloud of condensing vapour. By paying attention to these conditions, I have succeeded in blowing bubbles, usually somewhat irregular sausage-shaped things, as long as five centimetres, and three centimetres in diameter at the largest part.

The walls of these bubbles are extremely thin and show well the beautiful rich colour of selenium when viewed by transmitted light. The method also affords a simple means of obtaining small thin flakes of selenium for various experimental purposes.

Great care is required to regulate the air pressure, which only seems to be possible by blowing with the mouth. Success is obtained only by choosing the right moment when the selenium is so far cooled as to be highly viscous.

An interesting property of these bubbles is that if, even after twenty-four hours, they are brought into very light contact with one another, they seize violently together and cannot be again separated.

CHARLES E. S. PHILLIPS.

Castle House, Shooter's Hill, S.E.18,
Jan. 19.

Inflammable Gas from Plants.

IN reply to Prof. Findlay's request in NATURE of Jan. 14, for information concerning the exhalation of an inflammable gas from the Fraxinella, I have much pleasure in communicating the following items :

(1) From page 336 of vol. 2 of "Chemical Essays," by Dr. R. Watson, Third Edition (London, 1784):

"*Fraxinella* is a very odorous plant ; when in full blossom, the air which surrounds it in a still night may be inflamed by the approach of a lighted candle ; does this inflammability proceed from an inflammable air, which is exhaled by the plant, or from some of the finer particles of the *oil* of the plant, being *dissolved* in the common air of the atmosphere."

(2) From page 107 of vol. 1 of "Elementary Lectures on Chemistry and Natural History." Translated from the French of M. Fourcroy (Edinburgh, 1785):

"The atmosphere which floats round the fraxinella is inflammable from the admixture of some essential oil : and M. Scheele is of opinion that every inflammable air is composed of a very subtile oil."

(3) From "Webster's New International Dictionary of the English Language" (London, 1919):

"Fraxinella. A perennial rutaceous herb (*Dictamnus albus*) with pinnate leaves and white flowers, which exhale an inflammable vapour in hot weather —often called 'gas plant.'"

FREDK. C. SHORT.

The Tower House,
Sutton Road, Walsall, Staffs, Jan. 14.

'Self-Adaptation' in Biology.

"PARACELSUS, the first materialist, proclaimed man to be a chemical compound" (NATURE, Jan. 7, p. 14). No doubt Dr. Fournier d'Albe can give references to confirm this statement. In the meantime may I quote the following detached paragraphs ?

"The life of man is an astral effluvium or a balsamic impression, a heavenly and invisible fire, an enclosed essence of spirit. . . ." ("De Natura Rerum," p. 81; Hartmann's "Paracelsus"). "Man has two spirits, a divine and a terrestrial spirit" ("De Lunaticis," *ibid.* p. 82). "Neither the external nor the astral man is the real man ; the real man is the spiritual soul in connection with the divine spirit" ("De Fundamento Sapientiæ," *ibid.* p. 87). ". . . the organs of the body and the body itself are only form-manifestations of previously and universally existing mental states" ("De Viribus Membrorum," *ibid.* p. 219).

"Man is an instrument through which all the three worlds—the spiritual, the astral, and the elementary world—are acting. In him are beings from all these worlds, reasonable and unreasonable, intelligent and unintelligent creatures. A person without self-knowledge and self-control is made to act according to the will of these creatures" ("De Meteoris," *ibid.* p. 119).

W. W. L.

Jan. 9.

Liquid Stars.

By J. H. Jeans, Sec. R.S.

The view that the stars are gaseous structures has held the field for more than half a century; it is implied in Helmholtz's famous 'contraction-theory' of the source of solar energy as well as in the pioneer researches of Homer Lane. Emden, surveying the subject in his "Gaskugeln," scarcely discussed any alternative possibility, although finding that the centres of the stars must be too dense for the ordinary gaseous state to be possible. This particular contradiction disappeared, and indeed the whole question assumed a new aspect, in the light of a concept I put forward in 1917, according to which the atoms in stellar interiors were in a state of extreme electronic dissociation. For, as Eddington afterwards pointed out, electrons and atomic nuclei are of such diminutive size that if these, and these alone, form the flying units of a quasi-gas, no density observed in astronomy is too high to be compatible with the gaseous state.

In the ten years which have elapsed since I first propounded this view of stellar interiors, much labour has been devoted, particularly by Eddington but also by many others, to investigating the build and properties of the stars on the hypothesis that the flying units are too small to interfere appreciably with one another's motion—on the assumption, in brief, that stellar matter behaves like a perfect gas. As the central temperatures of the stars can be calculated with some accuracy, it might seem a simple matter to estimate the extent to which these temperatures would break up the atoms, and thus to decide whether the gas-laws would be obeyed or not. It is simple if the atomic weight of the atoms is known, but not otherwise; a temperature of 100,000 degrees will break up hydrogen completely, while one of 100,000,000 degrees fails to do the same with uranium. Eddington's discussions usually assumed atomic weights of 40 or 50, and with such atomic weights the atoms would be completely pulverised; on the other hand, with atomic weights five times higher, enough atomic structure would be left to cause the gas-laws to fail, although our ignorance of the effective sizes of highly ionised atoms makes it difficult to estimate the extent of this failure.

The hypothesis that the gas-laws are obeyed has proved disappointing, its consequences obstinately refusing to fit observed facts, and the hypothesis appears to be ripe for abandonment. Eddington and myself have independently investigated the relation which would connect a star's luminosity with its mass and diameter on this hypothesis, and actual stars are all found to be substantially too faint. To put the same thing in another way, if the gas-laws were obeyed in stellar interiors, stellar diameters would be far greater than they actually are. My own latest calculations suggest that the discrepancy is probably represented by a factor of hundreds; Eddington, from different data and different assumptions, got a smaller factor, but even by giving the hypothesis all the benefits of every possible doubt, no one has succeeded in abolishing the discrepancy altogether; at the best a factor of about ten persists.

Further, I have recently shown that a star which behaved like a gas would be unstable, either dynamically or thermodynamically, or both. Some time ago Eddington and Russell found that such a star would be dynamically unstable unless its rate of generation of energy increased somewhat

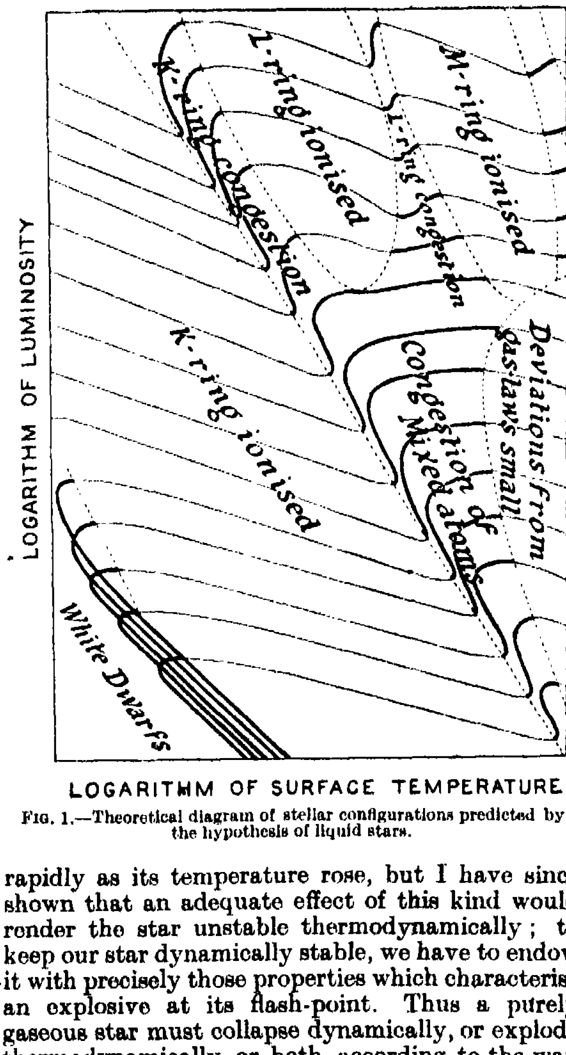


Fig. 1.—Theoretical diagram of stellar configurations predicted by the hypothesis of liquid stars.

rapidly as its temperature rose, but I have since shown that an adequate effect of this kind would render the star unstable thermodynamically; to keep our star dynamically stable, we have to endow it with precisely those properties which characterise an explosive at its flash-point. Thus a purely gaseous star must collapse dynamically, or explode thermodynamically, or both, according to the way in which its rate of generation of energy depends on its temperature; actual stars do neither.

Finally, direct evidence against the gaseous hypothesis is provided by binary stars which, to all appearances, have been formed by the break up of a single star which rotated too fast for safety. Fly-wheels and rotating masses of solid or liquid may break up in this way, but I have shown that a purely gaseous mass cannot; a mass of gas yields and expands, but can never break.

I have recently suggested (*Mon. Not. Roy. Ast. Soc.*, **87**, 400 and 720; 1927) that these various difficulties can be obviated, and a highly satisfactory agreement with observation secured, by supposing the central regions of a star to be liquid rather than gaseous, the outer layers of course remaining gaseous. In the quasi-liquid core the atoms are not completely broken up, retaining one, two, or even three rings of electrons, and as a consequence exerting about forty times the pressure they would if the gas-laws were obeyed. These deviations from the gas-laws secure the dynamical stability of the star, the nearly liquid core forming a firm unyielding base on which the outer layers of the star can rest in safety; thermodynamical stability is ensured by supposing the star's liberation of energy to be of the 'radioactive' type, so that it is approximately uninfluenced by changes of temperature and density.

Imagine a star starting from the low density with which it is born, and contracting through all its possible configurations of equilibrium. As its radius diminishes, its temperature rises as required by Lane's law, and this rise of temperature results in one ring of electrons after another being stripped from the atoms, so that the size of the atoms diminishes concurrently with that of the star. So long as the star is of low density, the gas laws are obeyed in its interior, but calculation shows that on the whole the star shrinks more rapidly than its atoms, so that in time states are reached in which the gas-laws are no longer obeyed. But while the star is shrinking steadily, its atoms shrink spasmodically as one ring of electrons after another is pulled off. If the stellar diameter is the tortoise, the atomic diameter is the hare; its progress is by spurts and rests alternately. The spurts of the hare do not save it from ultimate defeat, but they result in its being alternately in front of and behind the tortoise. Detailed calculation shows that, as the star shrinks, the deviations from the gas-laws will not increase steadily but will fluctuate, being small just after each ring of electrons has been ionised, and becoming large just before the ionisation of the next ring. At these latter stages the atoms are jammed together, a substantial degree of jamming generally being necessary to secure the ionisation of the next ring. Such, at least, are the predictions of theory for massive stars. In stars of small mass, the fluctuations are smoothed out and disappear; the hare goes with a steady gait, but is uniformly less rapid than the tortoise, at any rate until we come to the last ring of electrons, the k-ring. Here the hare makes a tremendous jump, and then has to stop since no further rings of electrons remain.

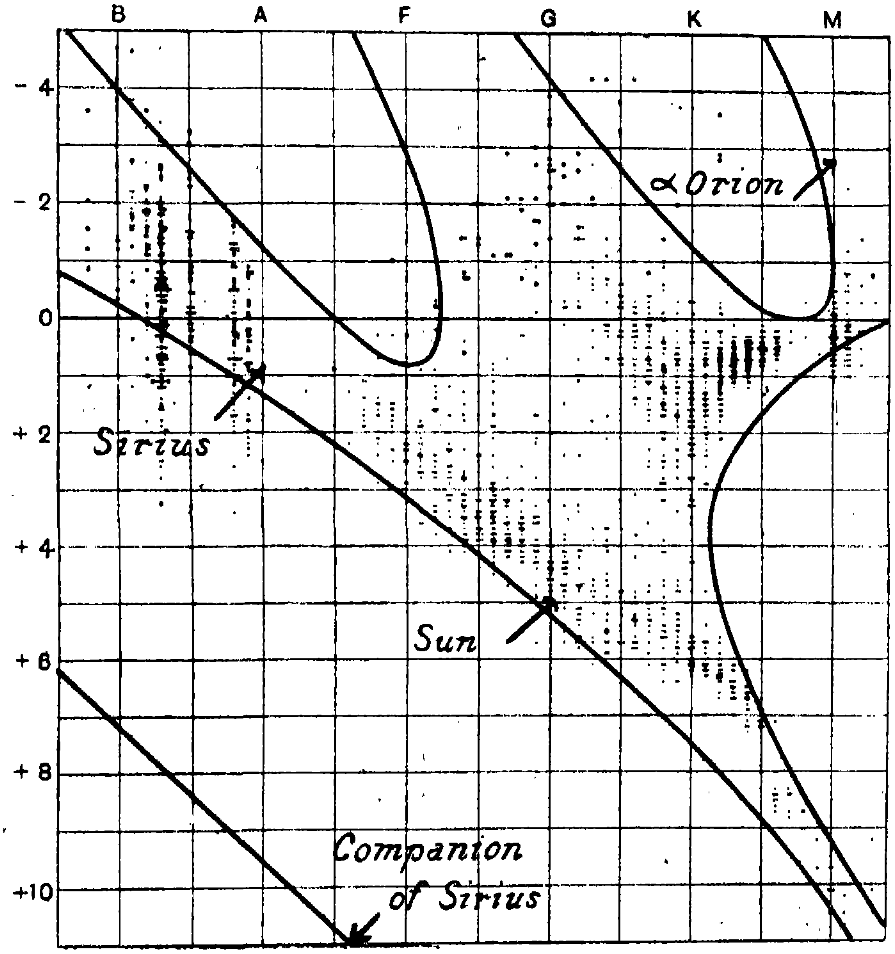


FIG. 2.—Diagram of observed stellar configurations (Mount Wilson Observatory).

Fig. 1 shows the configurations which theory predicts to be possible for stars of different masses. The abscissa is the logarithm of the stars' surface-temperature, hot and therefore small stars being to the left; the stars' diameter increases to the right. The ordinate is the logarithm of the stars' luminosity, bright stars being on top. Each continuous curve represents the theoretically possible configurations for a star of given mass, the curves for the most massive stars being on top. The fluctuations in these curves result from fluctuations in the extent of deviation from the gas-laws, and these in turn entail fluctuations of stability. Theory requires that those parts of the curve which are drawn thick shall represent stable configurations, all others being

unstable. Thus if the hypothesis of liquid stars is true, stars ought to be observed to occur only in those parts of the diagram where the curves are drawn thick.

The background of Fig. 2, taken from the Report of Mount Wilson Observatory (1921), shows the observed distribution of 2100 stars; the thick lines are curves I have drawn to divide the diagram into regions occupied by, and avoided by, stars. The general agreement with the theoretical diagram shown in Fig. 1 is so good that we need scarcely hesitate to identify corresponding areas in the two diagrams.

The belt of stars which runs diagonally across the whole diagram is called the 'main-sequence'; it contains stars of ordinary radius, such as the sun, Sirius, and Procyon. In the stars which occupy the upper reaches of the main-sequence we see that the atoms are ionised down to their K-rings, but the less luminous stars such as the sun must contain all sorts of atoms mixed. Observation shows that the left-hand edge of this sequence is very clearly defined; the stars seem to press against it like flies against a window-pane. This sharp left-hand edge is determined by the condition that the atoms are jammed together almost as tightly as they can be packed; in the configurations there represented the density is the maximum possible, short of the final ionisation of the K-ring. The "white-dwarfs," such as the companion of Sirius, with diameters only about a fiftieth of that of the sun, and densities of about a hundred thousand times that of water, consist mainly of atoms stripped bare to their nuclei, although enough K-rings must survive to build up a firm liquid base at the centre of the star. Stars of huge diameter, such as Betelgeuse (α Orionis), with diameters hundreds of times that of the sun, and mean densities only about a thousandth that of atmospheric air, must have three rings of electrons (K, L, M) left on their atoms.

The upper part of the diagram forms a macrocosm of the atom itself, the great difference between the diameters of the nucleus and the k-ring being reflected particularly clearly in the big empty gulf between the white-dwarfs and the main-sequence. Thus the structure of the atom is blazoned across the heavens, and if the physicists had failed to unravel it, the astronomers might have succeeded—in time. Theory does not fix absolute values for the co-ordinates in Fig. 1 until the atomic weights and atomic numbers of the atoms are given. I have found that the best agreement with the observational material shown in Fig. 2 is secured by taking the atomic number to be about 94. Atoms of lower atomic number would lose their electrons at too low temperatures, while those of higher atomic numbers would grip them too tightly. Thus the main mass of the central liquid regions of the stars appears to consist of a sort of "supra-radioactive" atoms, with atomic numbers just above those of the ordinary radioactive elements such as radium (88) and uranium (92). We are driven back to Newton's conception of the stars as being formed of a special 'lucid' type of matter, and this lucid matter appears to come next in complexity after our terrestrial semi-lucid radioactive elements, of which the lucid elements may well be the parents.

Power Alcohol in Australia.

By Prof. JOHN READ.

THE main sources of organic energy which are at present being utilised in Australia are black coal and brown coal. The Australian deposits of black coal form about 2·2 per cent. of the total coal reserves of the world, being thus only slightly less extensive than the deposits of Great Britain. The chief deposits of black and brown coal occupy very favourable locations in New South Wales and Victoria, respectively; and, in addition, the eastern coastal zone of Australia (including Tasmania) affords considerable opportunities for the development of hydro-electric power. In comparison with Great Britain, therefore, Australia is well endowed with natural sources of energy. At present, however, both these countries are almost wholly dependent upon outside sources for their supplies of liquid fuels, particularly for fuels fulfilling the requirements of the internal combustion engine. A very similar state of affairs exists in South Africa and in various other parts of the Empire; so that a problem of wide significance and extreme economic importance is here manifest.

In Great Britain, as in Europe generally, a good deal of attention is being paid to the Bergius process and the low temperature distillation of coal. Any such investigations directed towards the economic manufacture of liquid fuels from black or brown coal are patently of considerable interest to Australia, particularly as the processes would also furnish lubricating oils. Climatically, however, Australia differs so widely from Great Britain and northern Europe that it is not surprising to find the Australian more disposed than the European to draw upon his lavish current supplies of solar energy and less inclined to encroach unduly upon his limited capital of 'fossil sunshine.' This tendency is noticeable in a report issued recently by the Council for Scientific and Industrial Research of the Commonwealth of Australia, entitled "The Possibilities of Power Alcohol and certain other Fuels in Australia" (*Bulletin* No. 33. By G. A. Cook. Melbourne, 1927). The Australian imports of petrol and other petroleum products are increasing rapidly, the value of imported petrol alone being more than £6,500,000 per annum at the present time. Such a position is characterised as "very unsatisfactory even in times of peace, but in times of emergency it becomes positively dangerous." In 1925, the Joint Parliamentary Committee on Public Accounts took evidence on all phases of the Australian liquid

fuel problem, and came to the conclusion that "the consensus of geological opinion concerning the prospects of flow oil being discovered in commercial quantities in Australia is unfortunately not very favorable." Apart from oils obtainable from coal and shale, power alcohol and related synthetic fuels are recognised in the report under notice as the most likely substitutes for natural petroleum in Australia.

In reviewing possible Australian sources of power alcohol, it is pointed out that the starch-producing cereals are in general too important as foodstuffs to be utilised for other purposes; but in some Australian localities "the fermentation of certain varieties of tubers is by no means commercially unattractive even under present conditions and prices. Cassava, arrowroot, the sweet potato in the warmer climates, and perhaps beet in the milder, are at least worth consideration in this connexion. Some sugar-producing grasses, for example, sorghum, also have prospects." The nipa palm, which has been stated to provide a better source of sugar even than the sugar-cane, is a further raw material of considerable interest, since it grows abundantly in certain regions of Papua and the mandated territory of New Guinea.

Owing to the bulky nature of the raw materials, the conclusion is reached that at present it would be possible at the best to establish distilleries in favoured localities where the production of suitable high-grade materials presents no particular difficulty. In such districts imported petrol might be largely replaced by alcohol, but it appears that a complete replacement is incapable of achievement *in the absence of a successful method for producing* liquid fuels from raw celluloses. "From the point of view of the producer of power alcohol, Australia may be considered to be a favoured field of operation. . . . On the one hand, the local price of petrol is high, and on the other an ample and cheap supply of cellulosic raw materials is available. In view of the possibilities of ultimate success, and in view of the urgent national need, the chemists and bacteriologists of Australia might well cooperate and interest themselves in the problem, the former to develop the most suitable methods of producing large quantities of fermentable materials per ton of cellulose, and the latter to discover the organisms best suited for the subsequent fermentation."

As regards synthetic methods for the production of power alcohol, neither ethylene nor acetylene is held to offer promise as the basis of a satisfactory commercial process in Australia; but a comparison of the prices of petrol in the countries concerned makes it conceivable that some other synthetic process might be capable of successful operation in Australia although perhaps economically impracticable in Europe or the United States.

Technologically, the best raw material available in Australia for manufacturing power alcohol is molasses. In the record season of 1925-26, the total production of crude sugar in Australia exceeded 500,000 tons; of the accompanying 120,000 tons of molasses, however, a large proportion was either used as fuel, cattle food, etc., or wasted. If utilised wholly in the manufacture of power alcohol, this by-product would yield only about one-twentieth (7,800,000 gallons) of the current Australian demand for motor fuels.

The Australian investigations on power alcohol include experiments on the cultivation of sorghum, artichokes, sugar beet, cassava, sweet potatoes, arrowroot, etc.; the preparation of alcohol from the carbohydrates of zamia palms, grass-tree cores, and prickly pear; the hydrolysis and fermentation of common Australian hardwoods (NATURE, Oct. 8, 1927, p. 522); and the use of alcohol as an engine fuel under various conditions. Coming to *actual commercial achievement*, a power alcohol distillery with a capacity of about one million gallons per annum started production in February 1927, at the Plane Creek sugar mill, near Mackay, Queensland. The raw materials are molasses and certain starchy crops, including cassava and arrowroot. The fuel, consisting essentially of a mixture of alcohol and ether, is marketed under the name of 'powrac.' As an extension of this enterprise it is proposed to erect other distilleries in the Cairns district of Queensland.

Obituary.

PROF. C. DIENER.

CARL DIENER, who died in Vienna on Jan. 6, was born in that city on Dec. 11, 1862, there received the whole of his formal education, and there ran his professional career. As a student there was no need for him to go elsewhere, since he had as teachers some of the most eminent men of the age: in geography, F. Simonyi; in geology, E. Suess; and in palæontology, M. Neumayr. But when he had finished his student course in 1883, he at once turned for a wider experience to mountaineering in the Alps, in Dauphiné, and in the Pyrenees. He was among the first to introduce Alpine climbing into Austria itself, and was for seven years president of the Austrian Alpine Club; his membership of the English Alpine Club was, to his deep regret, broken by the War.

Naturally Diener did not leave his scientific interests behind when he sought the high mountains, and on the results he obtained in the Lebanon, Antilebanon, and the region of Palmyra, he habilitated as privat-docent for geography so early as 1886. Geology, however, claimed more and more of his attention, and the turning point of his career came when in 1892 he joined an expedition financed by the Government of India and the Vienna Academy, to examine the Trias of the Central Himalayas. In the first place, the valuable geological results obtained led him to extend his teaching to geology in 1893, and caused him in 1897 to be nominated professor extraordinarius of that science. Secondly, he was associated on the expedition with Griesbach and Middlemiss of the Indian Geological Survey, and this led to an

intimate connexion that ceased only with the War. Thirdly, the rich collections of fossils made by the expedition inevitably involved him more and more in palæontology. Thus in 1903 he became professor extraordinarius, and in 1906 was appointed full professor of palæontology and holder of that chair in the University of Vienna. His academic progress was fitly rounded off by his election as Dean of the philosophical faculty for 1919–20, and as Rector of the University for 1922–23.

Thus, for all his geographical interests and tectonic surveys, it is mainly as a palæontologist that we know and honour Diener. Englishmen are most familiar with the twelve magnificent monographs on Himalayan fossils which he contributed to *Palæontologica Indica* from 1895 to 1915. His most distinctive work in this line was on the Triassic Cephalopoda, where, on the death of Mojsisovics in 1907, he succeeded to the prime authority. The material for his Triassic studies came not only from the neighbouring Alps and the Himalayas, but also from Madagascar, Timor, Tonkin, Siberia, and Japan. His masterly summary, "Die marinen Reiche des Trias Periode" (1915), embodied the results of this work and of his extensive travels to many of the famous Trias exposures of the world. Would that he had given us an equally good summary of his knowledge of the Triassic cephalopods! From this, in his Catalogue (1915), he intentionally refrained, holding that the state of ammonite classification did not permit of it.

As palæontologist Diener was no mere describer, but interested himself in such subjects as the mode of life and distribution of the ammonites, the phenomena of convergence, and more generally in all those relations of fossil faunas to the rocks in which they occur that make up the division of palæontology now known as biostratigraphy. Indeed his "Grundzüge der Biostratigraphie," published in 1925, forms a conspectus of the subject no less admirable for clarity and sanity of treatment than for the wide learning on which it is based. The preparation of this work occupied him during the later years of public distress and of personal suffering from the internal disease to which he has at last succumbed.

Diener had a quiet but attractive personality, and his clear elocution and interesting subject matter made his lectures peculiarly inspiring. He was a member of the Vienna Academy and the recipient of many honours from other learned bodies. In 1913 he was made a corresponding member of the British Association. The Geological Society of London elected him foreign correspondent in 1912 and foreign member in 1926, an honour which he valued highly as a recognition of his long-continued work for the geology of the British Empire. F. A. B.

MR. E. R. WAITE.

THE death is announced of Edgar Ravenswood Waite at Hobart, Tasmania, during the nineteenth meeting of the Australasian Association for the Advancement of Science. Mr. Waite was born at Leeds in 1866, and at an early age took a keen interest in natural science; he was eventually appointed curator of the Leeds Philosophical Society, and was joint author with the late W. D. Roebuck of a work on "The Vertebrate Fauna of Yorkshire." He took an active part in the organisation of the Yorkshire Naturalists' Union, and at one time was joint-editor of its well-known organ the *Naturalist*. In 1892 Mr. Waite was appointed zoologist to the Australian Museum, and shortly afterwards accepted the appointment of Curator to the Canterbury Museum, New Zealand. Afterwards he accepted the directorship of the Government Museum at Adelaide, South Australia. Two years ago he returned to Europe, and after seeing the various museums on the continent and America, he visited his native place at Leeds, and was entertained there by many of his former colleagues.

Mr. Waite specialised in the study of mammalia and fishes, and took several expeditions to the Antarctic, where to-day a mountain bears his name. He described the fishes taken on the Shackleton and Mawson Expeditions, and is the author of the standard work dealing with the snakes of Australia. During the War he did good work by visiting various territories in the Pacific. He also collected extensively in the New Ireland and New Britain areas, and his Museum is considerably richer as a result of his work.

Mr. Waite's early experience as editor of the *Naturalist* and in other ways resulted in his being a prolific writer, and more than a hundred monographs and papers are to his credit. T. S.

WE regret to announce the following deaths:

Prof. José Rodriguez Carracido, for many years Rector of the University of Madrid, who worked chiefly on the action of alkaloids upon organisms and was the author of several text-books on biochemistry, aged seventy-two years.

Mr. J. H. Durrant, who was associated for many years with the late Lord Walsingham's collection of Microlepidoptera at Merton Hall, Norfolk, and afterwards at the British Museum (Natural History), on Jan. 20, aged sixty-five years.

Dr. Harry N. Gardiner, emeritus professor of philosophy at Smith College and president in 1907 of the American Philosophical Association, on Dec. 29, aged seventy-two years.

Prof. R. W. Genese, professor of mathematics in the University College of Wales, Aberystwyth, from 1879 until 1919, on Jan. 21, aged seventy-nine years.

Major-General G. W. Goethals, chief engineer for the construction of the Panama Canal and first civil governor of the Canal Zone, on Jan. 21, aged sixty-nine years.

Mr. M. Longridge, C.B.E., president in 1917 of the Institution of Mechanical Engineers, on Jan. 18, aged eighty years.

Count Meredyth de Miremont, author of well-known star charts and of "Practical Methods in Modern Navigation," on Jan. 21.

Dr. George Muirhead, author of "Birds of Berwickshire" and other works on Scottish natural history, on Jan. 29, aged eighty-two years.

Mr. P. D. Warren, C.M.G., formerly Surveyor-General of Ceylon, on Jan. 28, aged seventy-six years.

News and Views.

It was announced last week that Lord Bledisloe is resigning his post as Parliamentary Secretary to the Ministry of Agriculture to take up the appointment of chairman of the Imperial Grassland Association, which is being formed under the auspices of Imperial Chemical Industries, Ltd., with the object of improving the pasture land of Great Britain and of the Overseas Empire. Lord Bledisloe has rightly earned a great reputation as one who has taken the keenest interest in all phases of agriculture and has devoted so much of his energies to the furtherance of its well-being. Whilst his loss to the Government will be keenly felt, his new position will offer plenty of scope for his great enthusiasm and his wide experience of agricultural matters. The formation of the Imperial Grassland Association, further details of which will be awaited with great interest, is a further step in the developments which have been fostered in recent years by Imperial Chemical Industries, Ltd., through their associated companies, Synthetic Ammonia and Nitrates, Ltd., and Nitram, Ltd. The former company, at its great works at Billingham-on-Tees, now possesses plant with a total output capacity of fixed nitrogen equivalent to about 1000 tons of ammonium sulphate per day, and further big extensions are planned involving the production of a wide range of fertilisers. Nitram, Ltd., besides being responsible for the sale of the ammonium sulphate and other fertilisers produced at Billingham, as well as for most of the by-product ammonium sulphate produced in Great Britain, has recently established an agricultural research and advisory department, under the directorship of Sir Frederick Keeble, and with a strong scientific staff and well-equipped laboratories and experimental farm.

One of the chief directions in which the activities of Nitram, Ltd., have been exercised is in the development of the intensive system of grassland management. This system aims at greatly increasing the productivity of grassland by the application of a complete manure, including nitrogen. Trials have been carried out all over England during the past two years, with most encouraging results. The stock-carrying capacity of pasture land has been doubled or trebled, with a proportionate increase in the milk production per acre. Thus, in one trial the milk produced during the grazing period, from treated pasture, was raised to 713 gallons per acre, which is equivalent in food value to the production of arable land giving a yield of 4½ quarters of wheat per acre. Hitherto the stock farmer has been dependent for a large proportion of the protein in his feeding stuffs on imported concentrates (oilcakes). The price of nitrogen in this form, always high, is now much higher than before the War. Nitrogen in the form of artificial fertilisers, on the other hand, is now actually cheaper than before the War. The new system of grassland management, therefore, holds out to the farmer the possibility of using this cheap nitrogen for the production on his own land of a large proportion of the protein food needed for his stock, and that in the ideal form, as young grass. Moreover, the money paid for that nitrogen remains in the country, instead of going abroad in payment of imported concentrates. Much has still to be done in working out the details and the economics of this system, both in Great Britain, already famous for the quality of its grassland, and in the Overseas Empire, in many parts of which, as for example in New Zealand, grassland husbandry is a major industry, but the prospects are encouraging. The modern developments of the synthetic fertiliser industry make it abundantly clear that the manufacturer and the farmer are united by a common bond of interest in promoting the prosperity of the agriculture of the British Empire both at home and overseas. This bond is notably strengthened by the association of an agriculturist of the eminence of Lord Bledisloe with the great industrial interests represented by Imperial Chemical Industries, Ltd.

Sir James Walker, whose impending retirement from the chair of chemistry in the University of Edinburgh is announced elsewhere in this issue, received his early training in chemistry in Edinburgh under Crum-Brown and at Leipzig under Ostwald. He also carried out research work at Dundee with Carnelley, and then went to University College, London, as an assistant to Sir William Ramsay. In 1894 he was appointed professor of chemistry at University College, Dundee, and in 1908 was appointed to succeed Prof. Crum-Brown at Edinburgh. Sir James has been an indefatigable worker. While his name will always be associated with the development of physical chemistry, his work has covered a great range of subjects—the theory of solution, hydrolysis, the theory of amphoteric electrolytes and the electrolytic synthesis of organic acids, to mention only a few of the problems at which he has worked. As an author of chemical text-books he is equally well known. His "Introduction to Physical Chemistry," originally published in 1899, now in its tenth edition, is still widely used in both Great Britain and the United States; amongst his other text-books may be mentioned his "Organic Chemistry for Students of Medicine," and a most useful introductory work on "Inorganic Chemistry."

During the War Sir James Walker rendered valuable services by erecting and equipping, in conjunction with some of his colleagues in the Chemistry Department of the University of Edinburgh, a factory—acknowledged to be a model of its kind—for the manufacture of T.N.T., which produced this explosive at an exceedingly economical rate. After the War the increase in the number of students and the development of the science made it necessary for the University to undertake the erection of the new chemical laboratories. Sir James had the principal share in the conception and execution of this project, which has resulted in the possession by the University of a Department of Chemistry at King's Buildings which is unrivalled in Britain. The foundation stone

of the Department was laid by His Majesty the King in 1920, and it was opened on completion in 1924 by the Prince of Wales. In addition to his teaching and research work, Sir James has been an active member of the various learned societies connected with his subject. He is a fellow of the Royal Society and is at present serving on its Council. He was president of the Chemical Society (1921–23), and in 1913, at the invitation of the Council, delivered the Van 't Hoff Memorial Lecture. He received the degree of LL.D. from the University of St. Andrews in 1895 and was knighted in 1921.

A thorough trial of geophysical prospecting methods will be carried out in Australia during 1928 and 1929 under an agreement concluded between the Commonwealth Government and the Empire Marketing Board. The Australian arrangements will be in the hands of the Council for Scientific and Industrial Research and the Development and Migration Commission. Mr. Broughton Edge will be in charge of the survey party and, with two of the assistants who have been with him in Rhodesia, will commence his work next March. The rest of the staff will probably be Australian, and will include a gravimetrist, an electrician, two surveyors, and a laboratory assistant. A suggestion that the Department of Scientific and Industrial Research should appoint a physicist to accompany the party has been cordially welcomed in Australia. In order that the best available information may be placed at the disposal of Mr. Edge, a conference is being arranged of the heads of State Departments of Mines, Geological Surveys, and Physics Departments of the universities to discuss the general position, and particularly the question of the most suitable localities for the tests. Later, a smaller body will be constituted to ensure intimate touch with State Government organisations during the progress of the work.

At a meeting of the Surveyors' Institution on Monday, Jan. 9, Mr. C. H. Bailey read a paper on "The Reports of the Royal Commission on Mining Subsidence." In the printed version available he gives a summary of the position and main recommendations contained in the Final Report of the Commission by way of an appendix, whilst his paper was devoted to a discussion of these points. Upon the whole, Mr. Bailey has dealt very fairly with the Report of the Commission, except for the fact that he does not seem to have borne in mind the exact terms of reference. Thus he states that "the questions which are discussed by the Commissioners are these: (1) Can damage due to subsidence be prevented or lessened? (2) Does the existing law bear unfairly on any section of the community?" In actual fact it is only the latter of these two questions which was, strictly speaking, before the Commission, the terms of reference being "To consider the operation of the law relating to the support of the surface of the land . . . and to report what steps should be taken, by legislation or otherwise, to remedy equitably to all persons concerned any defects or hardships that may be found to arise in existing conditions."

The first of Mr. Bailey's questions was only discussed incidentally by the Commission, and therefore no recommendations are made with respect to it. The main recommendation of the Commission referred to small house property, and Mr. Bailey states it in the following terms: "The proposal to restore the right to support or compensation to houses of £40 or less rateable value." This statement involves a somewhat serious error; the Commissioners definitely do not attempt to restore the right to support (where this for any reason has been lost); they limit their recommendation to compensation, and the reason for this limitation is very clearly and fully stated in the Report of the Commission itself, in which it is pointed out that the legal position has been profoundly modified by the Mines (Working Facilities and Support) Act, 1923, which enacts that when property entitled to support is injured, the owner is entitled to pecuniary compensation, but must be content with such compensation, and in view of the very definite terms of the Act the Commission could not attempt to restore any right of support, but could and would only recommend means for awarding pecuniary compensation. The point is rather an important one, but apart from this it may be said that Mr. Bailey's review of the Commission's Report is a very reasonable one.

Ordinary telegraph lines are often seriously affected by auroræ, storms, and floods. A novel way of overcoming these difficulties has been successfully tried in Canada. The offices of the Canadian National Railways at Montreal and Winnipeg, a distance of 1300 miles, are now in direct telephonic communication with one another. Before the line was installed, calls from Winnipeg had to go by Chicago and St. Paul. The telephone messages are transmitted over the same wires that convey telegraph messages in the Morse code, the carrier current system familiar to radio engineers being employed. The telegraph and telephone messages can be sent simultaneously, there being no interference. At the receiving end of the line the messages are sorted out by special apparatus, each tuned to a particular frequency. The telephone messages are practically unaffected by electrical storms which throw the older telegraph services out of commission. Experience has shown that earth currents have no effect whatever on the service. Poles and wires may be submerged without affecting the transmission. Even when one of the wires was cut, it was still possible to work the line successfully.

The nomenclature of disease has at present no principles. Since it was delimited from other vague fevers by the discovery of its causative agent, the fever which prevails round the Mediterranean, and is caused by the *Micrococcus melitensis*, has generally been known as 'Malta fever.' The inhabitants of Malta think that this association is prejudicial to their moral and material interests, and want the term 'undulant fever' substituted. Surely they should rather be proud that their island was the scene of one of the best pieces of modern work in bacteriology and hygiene. They would do better to devote their energy to commemorating the name of Sir David

Bruce by placing the causative organism in the genus Brucella instead of Micrococcus, and in dealing so effectively with their goats (which are the reservoir from which human infections are derived) that the island stands out as the one place where the fever cannot possibly be caught. At present 'Malta fever' is obviously the appropriate name for a disease due to a *melitensis* microbe: to change it would do no good and only create confusion. About the right name of the organism there is fortunately no doubt: *melitensis* is its first and only title.

In the Friday evening discourse delivered at the Royal Institution on Jan. 27 on "Prehistoric Cave Art," Miss D. A. E. Garrod stated that although remains of Upper Palæolithic man are found all over Europe, the artistic impulse which gave rise to the animal paintings of the caves appears to be a local development, practically confined to central and southern France and northern Spain, the three chief centres being the Dordogne, the Pyrenees, and the Cantabric region. Cave art takes the form of painting, engraving, and sculpture. Owing to the fact that the paintings and engravings are often superimposed, it has been possible to work out their relative ages, and to establish a series showing a more or less continuous development from simple outlines, through monochrome shading, to the great polychromes which reach their zenith in the cave of Altamira. Remarkable sculptures in high relief are found in the rock-shelter of Cap Blanc near Les Eyzies, buried in deposits of early Magdalenian age, while in two Pyrenean caves which have been rendered nearly inaccessible by running water, clay models of animals have been preserved. It is clear from internal evidence that the art of the caves was inspired by a double purpose. In some cases it was directed to the promotion of fertility in the animals on whom man depended for his food; in others to ensuring good luck in the chase.

Prof. S. Langdon's report on the work of the Oxford-Field expedition's excavations during the current season at Kish, in his letter to the *Times* of Jan. 28, is of greater interest in its general bearing than for the actual finds recorded. The expedition is now bringing to light from the lowest levels of this city, which tradition says was the first capital of Sumer after the Flood, similar painted pottery and pictographic tablets to those found at Jemdet Nasr, 17 miles to the north-west. The civilisation of the two sites is not that of Sumer; both the pictographic script and the system of numeration are different. The painted pottery also differs from the painted ware of the southern area, that is, Sumer proper; but it is related to that of early Elam. Some of the pictographs are strikingly like those of the seals from Harappa and Mohenjo-Daro in India. This script is one of a group of five independent scripts belonging to the same prehistoric civilisation which spread over Asia from China to the Mediterranean before 4000 B.C., the other members of the group being Sumerian, proto-Elamite, Indus Valley, and early Chinese. The existence of a new branch of this homogeneous culture characterised by monochrome and polychrome ware in the region of Central Mesopotamia, between Babylon and the Tigris, is, Prof. Langdon points out, a new factor in ancient history. The discovery by the expedition of good Sumerian tablets at levels dated at 3500 B.C. proves that this culture ceased to exist at Kish before that date. Numerous seals and shell plaques also testify to the Sumerian occupation after its disappearance.

Much ingenuity has recently been expended in devising a code which would enable any listener anywhere to identify at once the broadcasting station to which he may be listening. Amongst the suggestions are various ways of sending morse signals by bells, hooters, and trumpets. In an article in the *Wireless World* for Jan. 11, Captain Eckersley points out that the vast majority of listeners to broadcasting have no interest in trying to identify the distant broadcasting station, the attenuated waves from which produce a curious noise in a multivalve receiving set. It would be foolish to handicap every item of a performance by a discordant signal merely to enable a few researchers to identify a particular noise. If it is essential that they satisfy their curiosity, then they should use a wavemeter, and look up a list of stations. It is difficult to see what useful purpose is served by identifying a very weak signal received on a large multi-valve set. The ether is full of strange noises, but those due to natural phenomena are of the greatest importance to physicists, and we are only slowly learning how to identify them. Excellent work is being done at the present time in attempting to link up European broadcasting stations to Great Britain by land telephone cables. In this way the local station can radiate the performances taking place abroad, the announcer telling what we are to hear and where it comes from. We look forward to hearing in this way in London an opera in Vienna or a German orchestra in Berlin. Direct listening to foreign and distant stations, whether identified or not, is rarely pleasurable. It is probable that, in the future, by utilising short wave transmissions, broadcasting programmes from any part of the world will be radiated with but little distortion from many local stations.

In the construction of the Scottish section of the British national 'grid' of electric overhead wires, steel cored aluminium conductors are being used. Some engineers have expressed doubts as to the permanence of the qualities of these composite conductors. It is satisfactory, therefore, to read a paper by E. T. Painton in the *Electrician* for Jan. 27 giving both experimental and practical results on these wires extending over a period of years. It is known that pure aluminium does not corrode even in the neighbourhood of cement works. On the other hand, aluminium is strongly electro-positive, and unless a junction can be kept perfectly dry, it should not be used in contact with other metals. We might expect that the natural tendency of steel to rust would be increased in the case of composite wires by electrolytic action. Practical experience, however, has proved that over long periods of operation no case of corrosion has occurred. In order to test whether a single layer of aluminium wires was sufficient to protect the

galvanised steel core, Mr. Painton erected steel cored aluminium wires along the sea wall of a harbour in Northern Ireland. On stormy days the wires are wet with sea water and subjected to the penetrating action of the wind. Every six months short lengths of the wires were cut off and their mechanical and electrical properties were measured and their appearance noted. After five years, there has been no diminution in the strength of the aluminium strands, and although the galvanising of the core is no longer bright, there is no sign of rust. The galvanising still withstood three full minute immersions in copper sulphate. These results are important, as steel cored aluminium is 80 per cent. stronger mechanically than the equivalent copper cable. The huge State network in France, which forms an important section for the rehabilitation of the devastated areas, consists almost entirely of steel cored aluminium wires.

THE use of electricity for baking ovens was discussed by E. Styles in a paper read to the Institution of Electrical Engineers on Jan. 19. In Great Britain very little progress has been made in the application of electric heating to bakers' ovens. This is generally attributed to the high cost of electrical energy. But the author showed that the cost of the energy is only about three per cent. of the price of the bread when energy can be obtained at $\frac{3}{4}d.$ per unit. The oven can be heated very quickly by electric current, and it can retain its heat for many hours after the current has been switched off. As baking is generally carried out during the night, most electric supply companies would allow special rates for these ovens. When an electric oven is used, there is a considerable saving of floor space and of labour, as dirt and ashes are eliminated and no cleaning of flues is necessary. Owing to the ease with which the temperature can be maintained constant, there is an appreciable saving in the quantity of ingredients used. On the Continent and in the United States, the number of bakeries which heat electrically is rapidly increasing. In several towns in Great Britain they could be installed economically at the present time.

A RECENT addition to the Department of Zoology of the British Museum (Natural History) is a mounted specimen of a young Sumatran rhinoceros, presented by His Highness the Sultan of Perak; the specimen is of exceptional interest as exhibiting the very hairy nature of the skin in the young of this species. The Department has also acquired the skin and skeleton of a gorilla collected for the Museum in the Belgian Congo, by special permission of the Belgian Minister for the Colonies. Through the generosity of Sir George H. Kenrick, the series of types contained in the Museum has received a valuable addition in the shape of 218 specimens, of which 197 are types, of New Guinea and Madagascar butterflies and moths. This donation comprises the types of 21 species of butterflies and 176 species of moths, many of which were described by Sir George Kenrick himself, and also the Malagasy Geometridæ described by Mr. L. B. Prout.

AMONG recent purchases for the Geological Department the most interesting is a curious fossil from the lithographic stone of Solnhofen in Bavaria. It looks like two pieces of a large curved feather, and is thought to be a colony of hydroid polyps related to the modern Sea Fir. This fragment was no doubt torn up by a storm from a neighbouring sea-floor and swept on to the flats of the Solnhofen lagoon at the time when Kimmeridge Clay of Britain was being laid down. A small lot of fossils recently obtained from the London Clay included the shell of a Pinna in which were several pearls. Recent donations include the pupa-case of a dragon-fly found by Mr. W. H. Wickes in the Rhætic plant bed near Bristol; 147 shells from the Cretaceous and Pliocene rocks of Angola, collected by Mr. Beeby Thompson; five bony fishes from the Eocene of Egypt, including a new sole and a new form of primitive eel, discovered by Mr. C. Crawley. The total number of visitors to the Museum during 1927 was 569,318, and constitutes a record. The highest attendance in any previous year was 535,116 in 1909. The number of visitors on August Bank Holiday, 13,431, while not quite the largest recorded on any one day, is in striking contrast with the number, 506, on Boxing Day. These figures illustrate the effect on museum attendances of two different types of bad bank-holiday weather.

DR. C. G. Abbot, who is well known for his work on the measurement of the solar constant, has been elected secretary of the Smithsonian Institution of Washington.

THE annual meeting of the Iron and Steel Institute will be held on May 3–4, at the house of the Institution of Civil Engineers, Great George Street, London, S.W.1, under the presidency of Mr. Benjamin Talbot. The autumn meeting of the Institute will be at Bilbao during the week commencing Sept. 24.

THE Geological Society of Stockholm has elected the following to corresponding membership: Dr. F. A. Bather, London; Prof. Reginald Daly, Cambridge, Mass.; Prof. P. Niggli, Zurich; Prof. Charles Schuchert, New Haven, Conn.; Dr. E. O. Ulrich, Washington.

THE Ministry of Health has issued "Amendment Regulations" dealing with the labelling of condensed and of dried milks. They are primarily designed to secure that in the labelling of condensed and dried skimmed milks, greater prominence shall be given to the words "Unfit for Babies." These Regulations are to come into force in May and in September 1928, respectively.

OWING to the occurrence of a number of cases of smallpox among casuals during recent weeks, the Minister of Health has directed that from now until Mar. 31 next, the medical officers of all Unions shall examine all casuals admitted, with the view of detecting cases of smallpox (Circular 859).

SEVERAL letters on sun images through window glass, referring to Prof. S. Russ's letter in our issue of Jan. 14, have been received, which record similar observations. It seems probable that the formation of these images is due to parts of the glass having an appreciable convexity, which cannot, however, be detected by the naked eye.

AT the anniversary meeting of the Royal Anthropological Institute, held on Jan. 24, Prof. J. L. Myres was elected president in succession to Mr. H. J. E. Peake, whose term of office has expired. The vacancy for a vice-president was filled by the election of Prof. H. J. E. Fleure, and Mr. G. D. Hornblower was elected to the office of honorary treasurer in succession to Dr. F. C. Shrubsall, who has resigned on account of pressure of other work.

THE twentieth annual general meeting of the Institute of Metals will be held in London on Mar. 7 and 8, under the presidency of Dr. W. Rosenhain, Superintendent of the Department of Metallurgy and Metallurgical Chemistry in the National Physical Laboratory. The papers to be read and discussed include contributions from metallurgists in Germany, Japan, and the United States, as well as Great Britain. The autumn meeting will be held at Liverpool on Sept. 4 to 7.

IT is announced in *Science* that the Edison medal, conferred annually by a committee of the American Institute of Electrical Engineers for "meritorious achievement in electrical science, electrical engineering, or the electrical arts," has been awarded for the year 1927 to Dr. William D. Coolidge, assistant director of the research laboratory of the General Electric Company, "for his contributions to the incandescent electric lighting and to the X-ray arts."

THE ninetieth meeting of the German Society of Naturalists and Physicians will be held at Hamburg on Sept. 16–28 next. Special emphasis will be given in the general meetings and in the sections to the relationship of German science and medicine to maritime studies and to overseas countries. Particulars of the meeting can be obtained from Prof. B. Rassow, Geschäftsstelle der Gesellschaft Deutscher Naturforscher und Ärzte, Leipzig C.1, Gustav-Adolf-Str. 12.

THE Registrar-General has issued the provisional figures for England and Wales of the birth-rate, death-rate, and infantile mortality during the year 1927. The birth-rate and the death-rate per 1000 of population are respectively 16·7 and 12·3. The birth-rate is 1·1 per 1000 below that of 1926, and is the lowest rate recorded since the establishment of civil registration. The death-rate is 0·7 per 1000 above that of 1926, the excess being due to the high mortality in the first and fourth quarters of the year. The infantile mortality rate (deaths under one year per 1000 births) is equal to that of 1923, the lowest on record.

As is generally known, an interest in the business of Messrs. Adam Hilger, Ltd., was acquired by Messrs. Vickers, Ltd., in 1916. On the conclusion of the War, this connexion in great part lost its utility for both parties, and an arrangement has now been made whereby the whole of the shares will be held by Mr. F. Twyman, F.R.S., and the widow and children of the late Mr. Otto Hilger. One of the latter, Mr. John Adam Hilger, now becomes a director of the firm.

LLOYD E. JACKSON and George H. Johnson, senior industrial fellows of the Mellon Institute of Industrial Research, University of Pittsburgh, have been elected to honorary membership in the U.S. National Association of Dyers and Cleaners. Mr. Jackson, who is in charge of the research of the Mundatechnical Society of America, has made a number of notable contributions to garment-cleaning practice and is the joint inventor of a successful process of moth-proofing wearing apparel and house furnishings. Mr. Johnson has enjoyed much success in the investigational work he is carrying on for the Laundryowners' National Association; he is also the author of standard treatises on textiles and laundering.

PROF. E. N. da C. Andrade's recent course of Christmas Lectures at the Royal Institution on "Engines" is to be published in book form this spring by Messrs. G. Bell and Sons, Ltd.

MESSRS. Bernard Quaritch, Ltd., 11 Grafton Street, W.1, have just issued another of their well-known Catalogues (No. 413). It gives the titles, and in many cases other particulars, of nearly 700 works relating to astronomy, chemistry, physics, engineering, electricity, mathematics, and navigation. The Catalogue should be seen by readers interested in these subjects.

THE returns furnished for 1926 have afforded the first opportunity for a comprehensive survey of the work done by local authorities in Great Britain under the national scheme for the treatment of tuberculosis since its initiation. The Ministry of Health has therefore considered it desirable to issue a memorandum containing an analysis of these returns (Memo. 131/T.). The items are arranged under forty-six headings, and are reduced to a percentage standard for all the authorities, county councils and joint committees, county borough councils, and metropolitan borough councils. By this arrangement the different local authorities and their officers will be able to compare their own figures and results with those of others. Thus, columns 4 to 6 of the Table give some idea of the efficiency of the notification of tuberculosis in each area, which varies from 100 per cent. in some areas to so low as 70 per cent. in others. Column 7 gives the percentage of tuberculosis cases on the Dispensary Register per 100 of notifications, and the figures vary from 98 in some areas to so low as 10 in one. For England as a whole, the death-rate from all forms of tuberculosis in 1926 was 957 per million population, but in different areas it varies from a maximum of 1776 (South Shields) to a minimum of 530 (Peterborough). Of the metropolitan boroughs, Shoreditch and Bermondsey have the highest tuberculosis death-rate, and Hampstead the lowest. We notice an error in the return for Wandsworth, given as 165: it should be 865. This statistical analysis should be very valuable, and ought to be a stimulus to some of the authorities to improve their tuberculosis administration.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in mathematics at the Bradford Technical College—The Principal, Technical College, Bradford (Feb. 11). A male senior secretary in the Academic Registrar's department, the University of London—The Principal Officer, University of London, South Kensington, S.W.7 (Applications for form, by

Feb. 6, return of form by Feb. 11). A professor of public health at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, South Kensington, S.W.7 (Feb. 16). A professor of pathology at the London (Royal Free Hospital) School of Medicine for Women—The Academic Registrar, University of London, South Kensington, S.W.7 (Mar. 1). An assistant in the botany department of the University of Aberdeen—The Secretary, University, Aberdeen (Mar. 1). A science master under the Agricultural Department, Nigeria—The Secretary, Board of Education, Whitehall, S.W.1 (marked C.A.(N.)), or The Secretary, Scottish Education Department, Whitehall, S.W.1 (marked N.) (Mar. 31). A whole-time research worker, for research work on infectious diseases of the bowels, with special reference to industrial areas, at the Calcutta School of Tropical Medicine—The Director, School of Tropical Medicine and Hygiene, Calcutta (April 15). An assistant pathologist at the Royal Infirmary, Leicester—The House Governor and Secretary, Royal Infirmary, Leicester. Civilian education officers in the Royal Air Force Educational Service—The Secretary, Air Ministry, Adastral House, Kingsway, W.C.2. A temporary post in the department of mycology of the Rothamsted Experimental Station, for research work on wart disease of potatoes—The Secretary, Rothamsted Experimental Station, Harpenden, Herts. A senior unqualified assistant in the biochemical department of the Wellcome Physiological Research Laboratories, Beckenham—The Director.

ERRATUM.—Through misunderstanding of a telegraphed correction to the first footnote to the table in Mr. E. J. Williams' letter in NATURE of Jan. 28, p. 135, the expression for $(\rho-1)/(\rho+1)$ was wrongly printed $(15/8)\sigma a \div (15/8)\sigma a/8$ instead of $(15/8)\sigma a$.

Our Astronomical Column.

PHOTOGRAPHY OF THE CORONA WITHOUT AN ECLIPSE.—G. Blunck describes in *Astr. Nachr.*, 5539, some interesting experiments on obtaining photographic images of the corona in full sunlight. He points out as the probable cause of the failure of previous attempts of this kind that they were made in too short a wave-length. He gives the percentage difference of illumination between the corona and the sky background as 0·2 per cent. at λ5000, 0·8 at λ7000, 1·7 at λ8500, 2·5 at λ9500; he states that Pinazyanol gives a maximum degree of sensitivity at λ6500, Dizyanin at λ7500, Neozyanin at λ8000. The last named makes corona photography just possible, but the author claims to have obtained a new sensitising dye called Prozyanol, which gives a maximum sensitivity at λ8500.

Full directions are given in the paper as regards the exposure, development, and subsequent treatment of the plates; there is a warning that the author himself suffered from the poisonous nature of some of the chemicals employed. Reproductions are given of three images obtained on Sept. 6 last, which strongly suggest that they are real photographs of the inner corona. An obvious test would be to take photographs by this method when the moon's disc is just outside that of the sun. If the coronal image is real, the dark outline of the moon should be traceable upon it.

M. ANTONIADI'S OBSERVATIONS OF MERCURY AND THE JOVIAN SATELLITES.—Allusion has already been made in this column to M. Antoniadi's examination of Mercury during the last three years with the great Meudon refractor, which confirmed the 88-day rotation. He gives further details of his observations in *L'Astronomie* for January, and notes that on several days observations were continued for several hours, during which no shift of the markings was discernible. He considers that there is evidence of some atmosphere on Mercury, producing thin veils of mist at times over the markings, since their darkness appeared to vary from time to time, though the conditions of our own atmosphere were appreciably the same. He gives a diagram illustrating the libration of the illuminated region arising from the eccentricity of the orbit. This was constructed by utilising the proposition that the angular motion of a planet about the empty focus is very nearly uniform.

During the same period, M. Antoniadi examined the satellites of Jupiter, of which he gave interesting drawings in *L'Astronomie* for last August. He notes the extremely high albedo of satellite II., which he states to be the highest of any body in the solar system. There had previously been no certain detection of any markings on this satellite, but a dusky marking was discerned on Sept. 14, 1926. The presence of a bright equatorial belt on satellite I., first announced by Barnard in 1893, was confirmed. Occasionally in transit across Jupiter this bright zone was alone visible, the rest of the disc being indistinguishable from the planetary background.

PARALLAXES OF BINARY STARS DEDUCED FROM ASSUMPTIONS OF THEIR MASS.—It has for a long time been the custom of the computers of the orbits of binary stars to append to their resulting elements the 'hypothetical parallax,' which is that resulting from an assumed mass of the system, generally taken either equal to that of the sun or double this. A further refinement was possible when Prof. Eddington showed that mass and absolute magnitude were correlated. Assuming the mass-luminosity relation we can make a closer approximation to the dynamical parallax than that based on the assignment of a uniform mass to all stars.

Mr. R. O. Redman applies this method to 803 stars in *Mon. Not. Roy. Ast. Soc.* for November. 120 of the stars have determined orbits; the method can be applied with greater confidence to those. The remaining stars have arcs observed which are too short for the deduction of individual orbits, but they can be used statistically, as suggested by Russell and Hertzsprung. The results for the dwarf stars are fairly consistent, and give absolute magnitudes agreeing with the Russell diagram. The mean absolute magnitudes for different spectral types are: *F*0, 2·7; *F*5, 3·4; *F*8, 3·8; *G*0, 4·1; *G*5, 4·9; *K*0, 4·7. The mean result for the solar velocity comes out 21·67 km./sec., and the mean kinetic energies for stars of the different types come out fairly uniformly, though the results for types *B*0 to *B*6, and for the giants from *F* to *K*, appear to be rather high.

On the whole, the paper adds fresh evidence in favour of the mass-luminosity relation. The individual parallaxes are printed for all the stars with determined orbits. They are especially useful for the smaller parallaxes; for the larger ones the trigonometrical values are more trustworthy.

Research Items.

KENT'S CAVERN.—In the *Proceedings of the Torquay Natural History Society* for 1926–27, Sir Arthur Keith describes the fragment of a human jaw which was found at a depth of 10½ feet in the cave earth in the vestibule of Kent's Cavern. It represents part of the right half of the upper jaw, and includes the alveolar process from the middle of the socket of the canine to almost the hinder or distal margin of the socket of the second molar. Three teeth are in place —the right canine, the second right premolar, and the first right molar. The sockets for the first premolar and the second molar are empty, their teeth having fallen from the sockets after death. A small area of the lower wall of the sinus maxillaris and the basal part of the zygomatic ridge of the upper jaw are preserved, as well as a small part of the palatal process on the inner margin of the alveolar process. There is no sign of disease, but the crowns are worn flat and smooth so that a border of enamel encloses the exposed dentine. The state of the canine indicates an edge-to-edge bite. The condition of the fractured surface of the bone suggests that it was broken away before the animal matter had entirely disappeared. The bone is coloured a pinkish red, the colour of all fossil specimens from the cave earth, and there can be no doubt that it is as old as the date of the deposition of the cave earth. The teeth and jaws may very well have belonged to the same people whose remains have previously been found in the cavern, that is, the palate found in the stalagmite by Mr. Pengelly and the fragment described in the last report. It belongs to the type of modern man which includes the late palæolithic peoples of Europe.

ARGENTINE ROCK-PAINTINGS.—Among the papers presented to the twenty-first International Congress of Americanists at the Göteborg session was a study of Argentine rock-paintings by Mr. G. A. Gardner, which has since been published with illustrations in the *Proceedings*. Although rock-paintings were known to exist in the Province of Cordoba, Mr. Gardner, in the course of investigations extending over three seasons, was able to visit and record a large number which had not previously been described. The paintings are found along the back walls of shelters eroded from the exposed edges of the horizontal strata of the triassic sandstone occurring among the mountains of Cordoba. The individual figures which compose the paintings number more than nine hundred and consist chiefly of natural objects and designs of a geometrical character. Many are incomprehensible. The commonest geometrical figures are circles, but there is a number of rectangular figures resembling gratings, while others are not unlike the European palæolithic 'tectiforms.' Combinations of dots and strokes, suggesting tallies, are found, and some figures may represent human footsteps and animal footprints. The natural objects consist largely of animals drawn in a realistic manner, of which some are the llama or the huanaco, and undoubted canines and felines. Birds are scarce but lifelike. Reptiles are represented by serpents, highly conventionalised, and a few tortoises. Recognisable vegetable forms are almost entirely absent. The absence of the human figure in most shelters was remarkable. They occurred in rudimentary and conventionalised form. A few were highly realistic, showing the dress and weapons of the Indians. Finally, representations of men on horseback appeared, clearly Spanish soldiers. Foot-soldiers are also shown. Few of the figures are in outline, most being silhouetted in colour laid on flat. Superposition is noticeable. They clearly extend over a very long time, and probably ceased with the loss of independence of the Comechingons, as these Indians were known to the Spaniards, soon after the Conquest.

SCOTTISH SEA TROUT.—As a result of the continuous work being carried out by the Scottish Fishery Board on salmon and sea trout, Mr. G. H. Nall has collected information about the sea trout from the tidal waters of the Don and Ythan (*Fisheries, Scotland, Salmon Fish.*, No. II., 1927. London: H.M. Stationery Office), both of which rivers flow out on the Aberdeenshire coast, the former with a tidal estuary one mile long, and the latter with one four miles in length. Recapture of marked fish has shown that in 1926 the sea trout present in the Don estuary were 95 per cent. finnock, and consisted for the most part of fish wandering from other rivers, only a few being natives of the Don. Interesting movements of the trout were disclosed, one having travelled in eight months a distance of 165 miles by the coast line from the Ythan to the River Teith at Callander, in which river perhaps it was originally born. In marked contrast to the mixed population in the Don waters were the fish in the Ythan estuary, nearly all of which were natives of the Ythan river. Collections in this estuary were spread over the whole of 1926, and a review of the changing composition of these trout according to age is given. The writer adds a word of warning against the danger of depleting the stock of the Don and other rivers by anglers who capture thousands of finnock from the Don estuary, many of which in the spring are ill-conditioned fish. Amongst other interesting observations is the effect of the difference in type of west coast and east coast rivers at their junction with the sea on the feeding of the sea trout, which is reflected in their scales. A new departure is made by writing this paper in non-technical language, for the advantage of anglers interested in sea-trout life.

AERATION OF AQUARIA.—The attention of those who desire to maintain aquaria and to provide for their aeration is directed to an account, by Prof. H. Graham Cannon and Dr. A. J. Grove, in the December issue of the *Journal of the Royal Microscopical Society*, of a simplified apparatus which has proved efficient in use. The clear description and two text-figures will enable anyone who has even a moderate amount of technical skill to make and put together the apparatus. The principle is that previously employed in the apparatus of Gemmill, namely, that water from a tap flows through a tube into the horizontal arm of a ⊣-tube and down the lower vertical arm sucking in air through the upper vertical arm. The suction tube in this apparatus, instead of being straight as in the previous types, has upon it near the top a complete twist, and "it is an advantage for this twist to be badly made" and to contain "one or two constricted bends such as the ordinary amateur glass-worker manages to produce." This apparatus should prove useful in many biological laboratories.

THE SPECIES OF ANCYLOSTOMA.—B. Schwartz (*Proc. U.S. Nat. Mus.*, vol. 72, Art. 1, 1927) has made an examination of specimens of *Ancylostoma pluridentatum* and confirms the validity of the species. Abnormalities in the teeth in the mouth capsule are recorded—the outermost teeth on the dorsal wall of the capsule being in some cases truncated and resembling those of *A. braziliense*, but the author considers the two species to be distinct. He gives

a brief review of the species of Ancylostoma and a key by the help of which they may be differentiated. He points out that the teeth in the ventral portion of the mouth capsule are three pairs in some species (e.g. *A. caninum*); in other species (e.g. *A. duodenale*) the innermost of the three teeth is small or rudimentary; in others (e.g. *A. malayanum*) only two pairs of ventral teeth are present; and in *A. pluridentatum* and *braziliense* the inner pair is reduced in size and in some examples of the latter species is entirely absent, there being only a single pair of ventral teeth.

A PARASITE OF THE EGG OF THE LIVER FLUKE.—Prof. J. Bayley Butler and J. J. C. Buckley describe (*Sci. Proc. R. Dublin Soc.*, vol. 18, No. 45, 1927) the occurrence of a Chytridiacean parasite, *Catenaria anguillulæ*, in the eggs of the liver fluke, *Fasciola hepatica*, kept in tap-water in laboratory cultures. The source of the Catenaria is believed to be the tap-water employed. The infection of the fluke egg takes place by a zoospore of Catenaria settling upon the egg-shell and piercing it obliquely, making an aperture about 0·5μ in diameter. The penetration takes place within twelve hours from the settling of the zoospore. The zoospore after entering enlarges to form a subspherical cyst from which a mycelial filament grows out into the contents of the egg and develops a series of enlargements which vary considerably in shape. The intervening unswollen parts of the mycelium become septate and form isthmuses. The enlarged parts—the sporangia—develop nutritive rhizoids which may branch. Within the sporangia, zoospores are formed and eventually escape through a dehiscence tube or beak which usually pierces the egg-shell or pushes open the operculum of the egg. No form of sexual reproduction and no resting spores have been observed. The eggs of the liver fluke will continue to live and to hatch out into miracidia if kept at laboratory temperature for a period of nine months. At any time during this period miracidia can be obtained by placing some of the eggs in test tubes in water in an incubator at 24° to 26° C. Eggs infected with Catenaria would not develop. The possibility of using Catenaria as a means of checking the infection of snails by miracidia is suggested.

ASCENT OF SAP IN TREES.—Before the recent meeting of the American Botanical Society, Dr. D. T. MacDougal, Prof. J. B. Overton, and Prof. G. M. Smith described some experiments on the passage of water up the trunks of trees (*Daily Science News Bulletin*, by Science Service, Washington). They conclude that the wood vessels in the sap-wood of trees, assumed to be wholly devoted to carrying water upwards to the leaves, are to some extent air reservoirs. These air-containing vessels are, moreover, not scattered at random, but have a definite zoned arrangement which differs in different species of trees. Investigations were carried out by injecting red dye into various kinds of trees and either letting the natural suction of the leaves pull it up or pulling it up by a vacuum pump. When the suction applied was small, the dye travelled up the trunk in a natural way, and of course did not enter the vessels blocked by air. The zone of transport was thus clearly marked in red. By this means it was found that in willow the sap stream passed exclusively through wood formed late in autumn, in alder in the early spring wood only, and in walnut through the inner and outer faces of an annual ring, but not through the median portion.

SERPENTINES OF THE SHETLANDS.—Dr. F. C. Phillips makes a noteworthy contribution to the local geology of a somewhat inaccessible region, and to the general problem of the transformations undergone by ultrabasic rocks, in a paper published in the *Quar. Jour. Geol. Soc.*, pp. 622-652, 1927. The Unst intrusion, which is the largest studied, ranges from dunite and peridotite through pyroxenite to gabbro, the latter being penetrated by pegmatoid gabbro. Disseminated, banded, and massive varieties of chromite occur in the more basic serpentines, and form workable deposits. The differentiation series is thus of a normal character, and is referred to primary crystallisation *in situ*. Autometamorphism brought about serpentinisation of the ultrabasic rocks, amphibolitisation of the pyroxenes, and saussuritisation of the felspars. Dynamic action is considered to have contributed to the metamorphism at two stages: contemporary stress to the genesis of antigorite; and subsequent stress to that of various schistose products. The formation of carbonates is referred in part to the action of atmospheric weathering.

CORAL REEFS AND A MIGRATING ANTICLINE IN FIJI.—The Fiji Islands include examples of fringing, barrier, and atoll reefs in all stages of growth, and elevated barriers and atolls in various stages of dissection. The region has therefore played a considerable part in the coral-reef controversy. In the *Amer. Jour. Science* for November last, Prof. W. M. Davis uses it to show that despite many weighty opinions to the contrary, its evidence may still be unequivocally in favour of Darwin's theory. He shows that four or five roughly north-south belts of unlike reefs can be recognised, and he describes the vertical movements which the islands of each belt have suffered. It is found that the phases of movement of the western belts occur later than the corresponding phases of belts to the east. This suggests the westward propagation of a broad and shallow wave-like deformation of the ocean floor. The observed changes of level thus appear to be equivalent to the slow westward migration of a broad anticline preceded and followed by shallow synclines. The wave-length is to be measured in scores of miles, but the height from trough to crest is only a few thousand feet. This remarkable hypothesis co-ordinates in a very simple fashion a large variety of observations which hitherto have given a hopelessly confused picture of the history of this unstable region. Prof. Davis finds that the adoption of his scheme of a migrating anticline at once removes all the difficulties which Darwin's coral-reef theory has had to encounter in Fiji. He concludes, ". . . in spite of the many obituaries written over it in the past forty years, it may be expected to regain in the coming half-century the worldwide acceptance that it enjoyed for a generation a hundred years earlier."

OPAQUE MEAL FOR X-RAY DIAGNOSIS.—We have tested a sample of a new barium meal preparation for X-ray diagnosis prepared by the British Drug Houses, Ltd., and supplied under the name 'Shadoform.' It is put up in boxes containing the equivalent of 4 oz. chemically pure barium sulphate specially prepared, so that it forms, when mixed with cold water, a fine suspension with no tendency to settle, as the cruder forms of barium sulphate are apt to do. A little care is necessary in mixing with the water to form a suspension free from lumps, but if the instructions are followed a very good mixture results, which is palatable and of a smooth texture. The definition on the screen is good, and the meal can be manipulated easily while in the stomach. No tendency of the opaque material to settle was noticed, and excretion appeared to be satisfactory. The material is stated to be chemically pure, and hence no possibility of absorption

of barium salts will arise. In this material we have a satisfactory meal which can be quickly made up.

SCATTERING OF ELECTRONS IN IONISED MEDIA.—The article by Dr. I. Langmuir in the *Zeitschrift für Physik* of Dec. 14 on electric discharges in gases at low pressures, is a valuable review of some of the advances of recent years for which he has been directly or indirectly responsible. His methods for measuring potentials, and ionic concentrations and energies, are by now well established, and have been applied to numerous problems, but there is the curious outstanding difficulty that groups of electrons acquire a thermal distribution of velocities far more readily than can be accounted for by collisions of any ordinary type. Dr. Langmuir gives reasons for supposing that the apparent scattering cannot be an effect of either regular or aperiodic fluctuations of the discharge, as has been suggested by other authors, but the exact mechanism by which it takes place is still obscure. A large number of numerical results has, however, been collected by now, and it appears probable that the process is reversible, and that the agent responsible, whatever its nature, is in a species of thermal equilibrium with the electrons affected.

SPACE CHARGES IN ELECTROLYTES.—Various aspects of the electrical convection of liquids, many of them known to Warburg and other earlier workers, are discussed by Prof. A. Coehn and Dr. Schnurmann in the *Zeitschrift für Physik* of Jan. 2, their object being to extend the analogy between conduction in gases and in liquids. The latter usually contain ions in such large numbers that many phenomena typical of the former are masked, but the correspondence is closer with electrolytes of one thousandth or less normality, and is especially prominent in the large fields near the surfaces of small sheathed electrodes. Here the differences in mobility of the positive and negative carriers are sufficient to set up a space charge, which can give rise to a motion of fluid *towards* the electrode. A particularly neat experiment that is described shows this effect, as well as the analogue of the electrical wind, by the reaction on a light enamelled wire, suspended in millinormal sulphuric acid with its lower end bent round, and only the extreme tip serving to give electrical connexion between the metal and fluid.

HUMIDITY TEST EQUIPMENT.—The amount of moisture in the atmosphere has a great effect on the mechanical and electrical properties of all fibrous materials. It is therefore to be expected that telephone apparatus connected to miles of insulated circuits and having closely adjusted moving parts should be specially susceptible to the effects of moisture. It is necessary for telephone laboratories to have humidity test departments where the effect of various percentage humidities in the atmosphere can be accurately studied. E. B. Wood, in the *Bell Laboratories Record* for December, describes the facilities this company has in its development laboratory for making humidity tests. The equipment consists of large cork insulated rooms, small air-tight chambers, and smaller portable units. The large rooms have a capacity of about 1500 cubic feet. The temperature and humidity of each room are controlled by a system of sprays, water-cooled radiators, and electric heaters, the air from a centrifugal blower circulating through them. This apparatus enables the humidity to be kept constant at any value from 30 to 95 per cent., and the temperature at any value between 70° and 110° F. This covers the range of conditions usually existing in telephone buildings. The operation is automatic, the humidity being maintained with one per cent. accuracy and the temperature to within half a degree Fahrenheit. It is thus easy to test both raw materials and large pieces of apparatus under various operating conditions. The smaller test chambers are thoroughly heat-insulated from the outside. The humidity is controlled by the use of a solution of sulphuric acid contained in a large shallow lead tray over which the air is circulated by a fan. For temperatures below room temperatures, air cooled by contact with ice is circulated by an electric blower. For very accurate tests or for tests like corrosion tests which require a long exposure, these chambers are used. The portable units have a capacity of about eight cubic feet and are used for the inspection testing of raw materials and small manufactured articles.

REICHERT MICROSCOPES AND ACCESSORIES.—In a recently issued catalogue (List E 7), Messrs. C. Reichert of Vienna give a description of various types of their microscopes and photomicrographic apparatus for biological and mineralogical purposes. Several models of the new mono-binocular stereo-microscope are illustrated. In this instrument, the pencil of light from the objective is equally distributed between the two oculars by internal reflection from a silvered prism. The silvering is thinner on one half of the reflecting surface than on the other. This gives rise to a difference between the intensity of the rays in the left half and that in the right half of the ocular receiving the reflected portion of the light. The conditions are exactly reversed in the other ocular, which receives the light transmitted through the partially silvered surface. The parallactic differences thus produced in the pictures presented to the two eyes give rise to the stereoscopic effect. This effect is obtained without the loss of light which is involved when part of the pencil of light has to be screened off. A series of F/4 anastigmat lenses suitable for macro-photography or projection is also listed in the catalogue. These give magnifications of from 4 to 24, with focal lengths of 100 mm. to 20 mm. respectively. Amongst the various types of vertical illuminators illustrated is a polarising illuminator which can be screwed on to the microscope tube when it is desired to examine metals or ores under polarised light. The illuminator embodies a rectangular illuminating prism, a rotating polariser, illuminating lenses, filter slot, and an electric bulb as the source of light. The catalogue also includes a wide range of objectives, eyepieces, condensers, and other microscope accessories made by Messrs. Reichert, whose London agents are Messrs. Chas. Hearson and Co., Ltd., 27 Mortimer Street, W.1.

BABYLONIAN ARTIFICIAL LAPIS LAZULI.—In the *Chemiker-Zeitung* of Dec. 31, Prof. Neumann gives an interesting account of some analyses which he has recently carried out of fragments of Babylonian *artificial* lapis lazuli, dating from about 1400 B.C., from the excavations at Nippur. The high percentage of lead previously found by Bertrand has been shown to be quite erroneous, but it has been conclusively established that both cobalt and copper are present as colouring matters. It is claimed that this is the only antique glass which is definitely known to be coloured by cobalt, for in spite of frequent references in technical literature to the existence of this metal in antique glasses, they appear to have no justification. Their origin has now been traced to a faulty observation published by Davy in 1815. Although many specimens of antique glasses from the period between 1500 and 850 B.C. have been analysed by Neumann and his collaborators, cobalt has hitherto never been detected in them.

The Genetics of Cereals.

THE volume of published investigations on the genetics and cytology of cereals continues to increase, and some important problems of variation and relationships in these forms are being solved. One of the most recent of these discoveries relates to oats.

The sporadic origin of fatuoid or false wild oats from cultivated varieties has been an agricultural problem for forty years. They resemble the wild oat, *Avena fatua*, but differ in not having delayed seed-germination. An extended study of the genetics and cytology of fatuoids by Dr. C. L. Huskins (*Jour. of Genetics*, vol. 18, No. 3) has resulted in the important discovery that these are mutations resulting from chromosome irregularities in normal oats. While ordinary oats (*Avena sativa*) has forty-two chromosomes, Dr. Huskins has found that in different fatuoid strains the chromosome numbers range from forty to forty-four.

The commonest type of heterozygous fatuoid has forty-two chromosomes and segregates into normals, heterozygous and homozygous fatuoids in a 1 : 2 : 1 ratio. The segregated fatuoids frequently have a single trivalent and a univalent chromosome or, in homozygous forms, a quadrivalent. Probably such fatuoids arise through the formation of a quadrivalent chromosome in which the elements are not segregated in their proper pairs in the reduction division. Another fatuoid type has forty-one chromosomes and produces a few sterile dwarfs with forty chromosomes. The type with forty-three chromosomes produces a few sterile dwarfs with forty-four.

This work constitutes a new and striking case of correlation between chromosome content and genetic behaviour. Numerous similarities are pointed out between fatuoid oats and speltoid wheats, which also arise as variations. Both conditions apparently arise through aberrant chromosome distributions. The practical possibility is suggested that a strain of oats may be produced which does not give rise to fatuoids.

Novel results are obtained by Mr. A. E. Watkins (*Jour. of Genetics*, vol. 18, No. 3) in the study of crosses between Rivet wheat (*Triticum turgidum* with 14 pairs of chromosomes) and *T. vulgare* (vars. Yeoman and Iron) with 21 pairs. The F_1 is partially sterile, but was back-crossed with both parents reciprocally. Chromosome counts in these hybrids show that while the F_1 fertile egg-cells usually have a chromosome content intermediate between 14 and 21, the F_1 pollen grains with intermediate numbers are largely sterile. Thus while the eggs tend to be genetically intermediate, the 14-chromosome pollen grains are found to be carrying chiefly the *turgidum* characters, while the pollen with 17-21 chromosomes carries mainly *vulgare* characters. The keel on the glume, which distinguishes *turgidum*, can be transferred to *vulgare* by crossing. The view is expressed that there are not many factor differences between the *turgidum* chromosomes and the 14 *vulgare* chromosomes with which they pair, the *vulgare* characters being associated with the extra chromosomes. The view is therefore upheld that there is a simple polyploid relationship between the two species.

The interesting discovery is made that in some of these back-crosses the germination of the grain is largely determined by the chromosome content of the endosperm. Grains from the cross 42-chromosome ♀ × 28-chromosome ♂ are plump and germinate well, while from the reciprocal cross they are wrinkled and germinate badly. Successful germination depends on the relations between embryo and endosperm. The conclusion is reached that germination is good if all chromosomes are present in the endosperm in the diploid or triploid condition, but bad when some of them are only represented once.

In a continuation of this work (*Jour. of Genetics*, vol. 19, No. 1), Mr. Watkins has studied the inheritance of such features as waxy leaves, keeled glume, and susceptibility to *Puccinia glumarum* in F_1 *T. vulgare* × *T. turgidum* back-crossed with *turgidum* or *vulgare*. The results lead to the conclusion that the two species carry homologous factors in homologous paired chromosomes, while the extra *vulgare* chromosomes carry another set of very similar if not identical factors.

In crosses between the tetraploid *T. durum* and *T. vulgare*, Prof. W. P. Thompson (*Genetics*, vol. 10, p. 285) found in F_2 and F_3 some plants resembling *T. durum*, some like *T. vulgare*, and some intermediate. They have chromosome numbers corresponding to their external appearance, and the forms with intermediate numbers and appearance tend to be eliminated in F_3. The correlation between the *T. durum* characters and rust-resistence was broken, but since resistance evidently depends on more than one factor, it will be very difficult to get full rust-resistance in *T. vulgare* types.

Various crosses between wheat (21 chromosomes) and rye (7 chromosomes) have been made in recent years. Prof. Thompson (*Genetics*, vol. 11, p. 317) describes the cytology of a cross, using an unspecified variety of wheat as mother. This particular cross, he finds, is easily made. In the hybrid, no chromosomes pair at reduction, but the 28 separate into two groups and split lengthwise either before or after this separation. Very few F_2 plants were obtained, as the pollen sterility is almost complete.

Prof. G. K. Meister and his collaborators at the Saratov Experiment Station on the Volga have published a series of papers on wheat-rye hybrids, beginning in 1918, which should be more widely known. Their most recent contributions in Russian, with English or German résumés, are contained in *Jour. Exp. Agric. S.E. Eur. Russia*, vol. 4, Part I. They find that the reciprocal crosses between *vulgare* wheat (var. *erythrospermum*) and rye can be made, and they give identical results. The rye × wheat cross was made by using the local winter rye and the pollen of a winter wheat. The F_2 from these crosses was grown in large numbers in 1926, and many of the plants showed greatly increased fertility.

The cytology of the hybrid between *T. monococcum* ($n=7$) and *T. turgidum* ($n=14$) has been investigated by Prof. W. P. Thompson (*Jour. Genetics*, vol. 17, No. 1). In the pollen formation of this triploid hybrid, three to seven bivalent chromosomes appear, the remainder being unpaired. Sax, using another variety of *turgidum*, has previously reported the regular occurrence of seven bivalents. The later history of the chromosomes is also different, Thompson finding that after the bivalents separate the univalent chromosomes arrange themselves medianly and split. In the homotypic division these univalents lag, fail to divide, and wander irregularly to the poles. Sax, however, found the univalents dividing in the second division and not in the first. Thus a small difference in one of the parents appears to make a great change in the chromosome behaviour. These two varieties of *turgidum* ought to be crossed together and the hybrids studied.

Reference may be made to one more paper on wheat hybrids, by Miss Melburn and Prof. Thompson (*Amer. Jour. Bot.*, vol. 14, p. 327). In *T. spelta* ($n=21$) × *T. monococcum* ($n=7$) the hybrid is completely sterile, and the heterotypic division shows from five to no bivalent chromosomes. The remainder mostly split, but in the second division they lag and form extra nuclei. The hybrids between different types of wheat can thus be arranged in a series according to the amount of pairing of chromosomes and the irregularities in the behaviour of the univalents. R. RUGGLES GATES.

The Introduction of Civilisation into Britain.

AT the anniversary meeting of the Royal Anthropological Institute, held on Tuesday, Jan. 24, the outgoing president, Mr. H. J. E. Peake, delivered an address on "The Introduction of Civilisation into Britain." He said that it seems certain that the art of agriculture, the first step in civilisation, was first practised in the Near East, more probably in Asia than in Africa, and that the first grain-growers were also potters. At an early date both these arts were introduced into the Ægean area and into the Plain of Hungary, and Prof. Childe has shown how they spread from the latter area to Switzerland, to the Rhine, and to the country around Liège.

Dr. Frankfort has recently pointed out the existence of a trade-route in Early Minoan times; this started from the head of the Gulf of Corinth and reached southern Italy and Sicily. Along this route passed commodities from the second city of Hissarlik. Frankfort suggests that this trade was carried farther west, and Childe has noted the presence of Early Cycladic beads in Portugal. This indicates that the elements of civilisation had reached the Atlantic coast before 2200 B.C.

Prof. Bosch-Gimpera has shown that early in the Copper Age there were two small centres of civilisation in the Iberian peninsula, one at Almeria in the south-east and the other in the south of Portugal, and that between them the Capsian natives used a rough pottery, based on leather models. These people had evidently learned the first elements of civilisation from the eastern traders, and had developed a rude civilisation that Bosch-Gimpera calls "la civilisation des grottes." He has also shown that this type of rude pottery spread so far as the Maritime Alps.

It is believed that agriculture and the potter's art reached Britain at the dawn of the Neolithic Age, and this view, as we shall see, is justified. In 1910, Mr. Reginald Smith described some round-bottomed bowls, one of which came from Mortlake, and some similar fragments from Peterborough, and pointed out that pottery of that type has been found in Finland and East Sweden. In 1925, Mr. T. D. Kendrick described two neolithic wares, one of which was found at Rodmarton and other sites in Gloucestershire and Wiltshire, the other at Mortlake and Peterborough, and in the same year Prof. O. Menghin also described these wares under the names of *Grimston-keramik* and *Peterborough-keramik*, suggesting that the former is earlier than the latter. Quite lately Mr. E. Thurlow Leeds has discussed the problem, criticising Menghin's terminology, and claiming that the first ware arrived from the south and the second from the north-east about the same time.

The best evidence comes from Windmill Hill, Avebury, now being excavated by Mr. Alexander Keiller, who has kindly allowed this information to be published. Here have been found three concentric rings of intermittent ditches, resembling those at Michelsberg, but without the distinctive tulip-shaped vase of the latter site. Pottery was found abundantly in the ditches, but in two layers separated by an almost sterile interval.

In the top layer, along with fragments of beakers, were found a number of pieces of the *Peterborough-keramik* and many sherds resembling the *Grimston-keramik*. In the lower layer, however, the prevailing ware is different, but the paste somewhat resembles that of the *Grimston-keramik*. Mrs. Keiller has restored several pots, which resemble closely some found in the lake-dwellings of Switzerland, and are called by Reinerth the *Westische-keramik*; these seem to have been introduced into Switzerland from the basins of the Rhone or Saône.

It appears likely that the elements of civilisation passed up the Rhone valley into Burgundy, where this *Westische-keramik* developed among a people who lived in fortified villages of the Michelsberg type. Thence the potter's art, and the elements of agriculture, spread into Switzerland, through the Belfort Gap into the Upper Rhine basin, where it developed into the characteristic Michelsberg type, and into the north of France and Belgium, where it spread over a large area, in which was a culture called by Bosch-Gimpera "la civilisation du silex." From this last region it reached the south of England some little time before the arrival of the *Peterborough-keramik* on the north-east coast.

Marine Oil-Engines.

IN the first Thomas Lowe Gray lecture, delivered before the Institution of Mechanical Engineers on Jan. 6, Prof. C. J. Hawkes makes an interesting survey of the past development, present status, and probable future development of the marine oil-engine. Past development is but briefly outlined. In regard to the present position, attention is directed to the fact that recent improvements in fuel consumption of marine steam turbine installations have reduced the advantage in this respect held by the oil-engine. In the tests conducted by the Marine Oil-Engine Trials Committee, the Still airless-injection two-stroke engine, consuming 6880 B.T.U., and the Doxford airless-injection opposed piston two-stroke engine, consuming 7570 B.T.U. per brake horse-power per hour, were the best performances, and it is shown that while the former has a less efficient fuel combustion, this is more than balanced by the energy recovered from the jackets and exhaust gases. It is estimated that the minimum consumptions possible at the present time are 6240 and 6820 B.T.U. per brake horse-power hour for the Still and Doxford engines respectively.

In a discussion of possible improvements it is regarded as doubtful whether the installation of waste heat boilers for the purpose of increasing the overall efficiency is justifiable. The employment of high speed engines transmitting power through hydraulic clutches and mechanical gears, which effects a saving in weight, etc., is considered to be limited to four-stroke trunk-piston engines of moderate power. The four-stroke single-acting engine has much to recommend it for moderate powers, and for larger powers the two-stroke single acting is preferred to the four-

stroke double-acting engine, the former being less complicated than, and at least as efficient as, the latter. For still larger powers the two-stroke double-acting engine is considered to be the logical line of development. Experimental engines of this latter type are being tested, and it is to be expected that a reliable two-stroke double-acting engine will be produced. There are difficulties involved in applying the oil-engine to high-powered war vessels, and a warning is expressed against applying it indiscriminately or without full consideration of its suitability for the service.

The most important stresses to which the liners, pistons, and covers are subjected are those resulting from temperature, and the real safe continuous power rating of an internal combustion engine is therefore largely dependent upon the heat flow through the liners, etc. The maximum power which can safely be developed thus depends upon the working fluid temperatures, and in order to limit the latter without reducing the mean pressure, attention must be given to the efficiency of combustion and volumetric efficiency. The efficiency of combustion is mainly dependent upon the shape of the combustion space and the movement of the air within that space. A compact combustion space is desirable, as this enables a lower compression ratio to be adopted, and the hemispherical-cavity form is considered to be the best. Whether airless or blast injection is adopted, any movement of the air in the combustion space which causes the globules of fuel to collide with each other or with the walls of the combustion space is to be avoided.

If two engines develop the same mean pressure, that with the lower volumetric efficiency must necessarily be hotter. The crank case engine is a very simple type, but it has a low volumetric efficiency and is consequently a hot and low duty engine. The four-stroke engine has a higher volumetric efficiency than the two-stroke engine because of its more effective scavenging. The introduction of port scavenging simplified the two-stroke engine at the expense of volumetric efficiency, but recent improvements have largely counteracted this. In four-stroke engines the opposed piston type is considered to have nearly as high a volumetric efficiency as the single-piston engine. Heating the induction air has an adverse effect upon volumetric efficiency. Supercharging is receiving considerable attention, but its adoption will only be justifiable if it enables higher mean pressures to be attained without increasing cycle temperatures.

Direction Finding in Navigation.

It is of great importance to aircraft to know exactly the direction in which they are travelling, and hence direction-finding equipment has been elaborated. This not only takes up much of the limited space available but is often also difficult to operate. The Air Ministry has recently developed a new method of direction finding in its design establishment at Biggin Hill. This was described on Jan. 4 to the Institution of Electrical Engineers by Messrs. T. H. Gill and N. F. S. Hecht.

The chief object of the method is to replace the direction-finding equipment on the aircraft by something very much smaller and easier to operate. A loop aerial is employed at the station, the energy radiated from the loop being a maximum in one direction and a minimum in another. The loop rotates about a vertical axis at a speed of one revolution per minute and sends out a continuous signal. This signal is interrupted when the line of minimum radiation is in the true north direction and a special Morse signal is transmitted at that moment. This enables the observer to start a chronograph. He can then find the interval between the north signal and the instant at which he is receiving minimum radiation. He thus obtains his bearing.

From the results obtained it was found that bearings could be determined with an accuracy at least equal to that obtained by any other radio method of direction finding. For the accuracy necessary for aerial navigation, this method gives a range of 200 miles.

The Air Ministry having found the 'rotating beacon' method of great use for aircraft, the Radio Research Board has made a series of experiments to find out if it would be equally useful for navigation. The results of these experiments were communicated to the Institution of Electrical Engineers by Messrs. R. L. Smith-Rose and S. R. Chapman at the same meeting.

The rotating-loop beacon was installed near Gosport and a calibration was carried out at fixed points in various directions up to a distance of 60 miles. It was found that the observed bearings were subject to a permanent deviation due to land effects. This permanent deviation was not greater than one or two degrees. At distances exceeding 60 miles, radio bearings got by this method were found to be subject to night effects similar to those obtained in radio direction finding. The errors were not serious, however, until the range exceeded 90 miles oversea. Even at great distances a fair accuracy can be obtained by taking the average value of a series of readings made in about ten or fifteen minutes. It was concluded that, up to 50 miles, the rotating beacon method gives accurate readings.

Compared with the ordinary direction-finder as used on board ship, this method has several advantages. It is independent of the steadiness of the ship, and also of the accuracy with which the ship's head is given by the compass reading at the instant of observation. No correction or compensation corresponding to the quadrantal error associated with the ship's direction-finder is necessary. It was proved, however, both theoretically and experimentally, that the limitation of the accuracy by night effects applies equally to both methods.

School Natural History.

THE annual report of the Marlborough College Natural History Society, the 75th in series, shows evidence of considerable vigour under the presidency of Mr. L. G. Peirson, who is clearly a naturalist of wide attainment. The area of work is defined as ten miles from the College as centre. All the various sections (Astronomy, Archæology, Ornithology, Botany, and Entomology) seem to have vigorous boy-members with to each a master having the same hobby. This year the most notable record is that of 558 species and varieties of flowering plants—evidence of close raking, though the surrounding country is singularly varied with its forest and great downs, its chalk hills and lands of high cultivation, its water meadows and valleys of rocks. It is the only place where the Icterine Warbler has been

known to breed in England, and perhaps this is true of the Sand Grouse, which once seemed to bid fair to become a permanent resident of Martinsell, drinking from its dewponds.

The Society as its serious task records the meteorology of its area, the dates of flowering of plants, of appearances of all kinds of insects, and of the laying of eggs by birds, with other similar information. The splendid old records of Preston and of Smith, of Everard im Thurn, and above all of Edward Meyrick, allow comparisons of the organisms of forty to fifty years ago with those found to-day; but they are to some degree deceptive, as the area for intensive study was practically ten miles in diameter then, while it is now twenty. For purely scientific purposes there should be subdivisions into ecological regions, and this is being attempted by similar societies elsewhere. We believe, however, that boys are gregarious creatures and prefer mass rather than individual studies, and that such changes, if forced, may drive the work entirely into the hands of masters —an action which would kill the object of the Society to suggest natural history to the greatest number of boys as likely to be a delightful hobby in after life.

Clearly, with the boys as first object in view, the Society no longer publishes the research work of one of the masters—A. G. Lowndes—but this is a gain to science, not a loss, as it is readily accepted in specialist journals. He and his pupils keep and breed many animals and plants from ponds, playing with the pH of the water and attempting to correlate form with its variation. The technique is excellent, and Lowndes's work, in proving the negation of Labbé's results on many species of Cyclops, is important. To the boy a live animal is the thing, and we should like to see more records of the keeping and breeding of insects, worms, snails, and all invertebrates in the records of the different sections; indeed, we hold that the museum of every natural history society requires a separate gallery for such work on living animals, and we believe it would prove the popular section of its exhibits.

University and Educational Intelligence.

CAMBRIDGE.—Mr. W. B. R. King, Fellow of Magdalene College, has been awarded the Sedgwick Prize for an essay on " Contributions to the Geology of some District in which Sedgwick worked." The subject announced for the next award is "A Petrological or Stratigraphical Study of a Rock Group."

EDINBURGH.—At a meeting on Jan. 23, the University Court received, with very great regret, intimation from Sir James Walker of his intention to retire from the chair of chemistry at the end of the current academical year. It was resolved to record the high appreciation of the Court of his long and distinguished service to the University.

The status of University lecturer was conferred upon Dr. Alexander Lauder, head of the Chemistry Department in the Edinburgh and East of Scotland College of Agriculture, in recognition of the responsible part which he has long taken in the teaching of chemistry in the curricula for degrees in agriculture and forestry.

The Court received with gratification intimation of a bequest by the late James Sanderson, Galashiels, of five shares of the residue of his estate, to be applied for the advancement or promotion in the University of technical and scientific study and research in the chemistry and engineering branches of the Faculty of Science. The amount of the bequest is estimated at about £35,000.

The offer was accepted of an endowment contributed by former students and others associated with the work of emeritus Prof. Robert Wallace, for the foundation of a University prize, to be known as the " Wallace Prize," to be awarded to the best degree student of the third year in agriculture not holding a Vans Dunlop or Steven Scholarship.

NOTTINGHAM.—In view of the fact that the new buildings, which are being erected by Sir Jesse Boot, Bart., in the University Park, will be opened by H.M. the King in July next, the authorities of University College are contemplating in the near future an appeal to increase the endowment fund of the College. Two members of the Council of the College, Mr. H. F. Lancashire, J.P., and Mr. G. Spencer, J.P., have announced their intention of endowing a chair by a joint gift of £20,000. Mr. Lancashire, who has been on the Council of the College since 1917, and was in 1926 elected a vice-president of the Court of Governors, is managing director of Messrs. J. B. Lewis and Sons, Ltd., hosiery manufacturers of Nottingham and Ilkeston. He took an active part in the reorganisation of the Textiles Department of the College in 1920, and has been for some years chairman of the Textiles Advisory Committee. It is no doubt due to his untiring energy that University College, Nottingham, now possesses possibly the finest hosiery laboratory in Great Britain. Mr. George Spencer, who was elected a member of the College Council in 1923, is head of the firm of Messrs. George Spencer and Co., hosiery manufacturers, of Nottingham, Hucknall, and Lutterworth. Mr. Spencer has for many years taken a great interest in the work of the College, and is one of the two trustees of the Revis Bequest, whereby the College acquired a sum of approximately £49,000, the interest on which is to be devoted to the provision of scholarships and studentships.

The new buildings occupy a commanding position in the new University Park, and will provide accommodation for the Faculties of Arts, Pure Science, and Economics and Commerce. The Applied Science Faculty will remain at the old building in Shakespeare Street, with the exception of the Heat Engines Laboratory connected with the Engineering Department, for which provision is being made in a special block of the new buildings. A hall of residence, accommodating eighty women students, is being erected in the University Park, and it is hoped that this will be ready for occupation during the ensuing session. The playing fields of sixteen acres are situated in the Park, within a few minutes' walk of the University and the Hostel. Sir Jesse Boot bore the cost of the laying out of these, and also of the erection of the sports pavilion and the women's hostel.

OXFORD.—It is understood that during the next two terms the problems presented by the congested state of the Bodleian Library will be seriously considered by the Hebdomadal Council. The principle of separate faculty libraries has already been accepted in the case of Law and Natural Science. Novels are shelved in cellars far removed from the main library, so there are precedents for the separation of that vast mass of 'deposited' literature, much of it of doubtful value, that at present dilutes, and renders difficult of access, the more valuable portions of the library.

A lecture delivered on Jan. 26 on "Isocrates in England" in ancient Greek by the Public Orator is in the nature of a revival of a lecture founded in 1583, the year in which Galileo watched the pendulum in the Duomo at Florence. It was noticeable that the lecturer does not include natural science among the subjects to be taught to boys between 16 and 18 years of age; evidently pendulums are still swinging.

Dr. F. A. Dixey, late Sub-Warden, Wills Medical Fellow and Bursar of Wadham College, has been elected to an emeritus fellowship.

Calendar of Customs and Festivals.

February 5.

ST. AGATHA, martyred at Catania under Decius by the governor Quintianus. She was miraculously healed of the wounds inflicted on her by torture, by the apostle Peter, who appeared to her carrying a vase and accompanied by an angel. After her death, an unknown young man accompanied by a hundred children placed an inscribed marble tablet on her tomb and then disappeared and was never seen again.

February 10.

ST. SCHOLASTICA, a festival formerly observed at Oxford, when the burgesses attended at St. Mary's. The origin of the custom is said to have been a quarrel between the citizens and students of the University which took place on this date in the year 1354. The outbreak lasted for some days, several students being killed; and all the religious crosses of the city were destroyed. For this offence the King, who was then at Woodstock, deprived the city of many privileges, bestowing them on the University, and the Bishop of London forbade the administration of the sacraments to the citizens, a sentence which was not removed until 1357, when a total abrogation was granted on the condition that St. Scholastica's day should be celebrated by a number of masses for the souls of the students, the mayor and bailiffs, with 60 burgesses, being bound under penalty of 100 marks to swear at St. Mary's Church observance of the customary rights of the University. Further, each of the burgesses was to offer individually on the altar one penny to be divided between the poor and the Curate of St. Mary.

SEASONAL FESTIVALS.—In popular tradition and custom there is a tendency to confuse the celebration of St. Bridget's Day with Candlemas. Candlemas observances, such as the kindling of the Yule Log and the dismantling of the decorative foliage, characteristic of winter or the Christmas season, mark the change from one season to another and the passing of winter. St. Bridget celebrates the opening of spring. Both traditions rest on a division of the year by seasons rather than months, and therefore belong to an earlier phase of calendrical arrangement.

It must be remembered that Feb. 1, the date of the feast of St. Bridget, falls twelve days later in the Old Style year than in the revised calendar and is by that much a more appropriate date for the celebration of the coming of spring. The effect of intercalation is seen in popular custom in the belief that, during the early part of the year, especially between Christmas and Twelfth Night, each day of a certain period foretells the weather in the coming year. The Celtic calendar, to reconcile the lunar and solar years, intercalated a thirty days' month in two and a half years, and other members of the Indo-European group followed the same system. In Brittany the last six days of the old year and the first six of the new were known as 'supplementary days.' Each was called by the name of a month, and each prognosticated the weather of the month in the coming year with which it corresponded. It is also a Brahmanic belief that the twelve intercalated days are an 'image' of the coming year.

In the Highlands of Scotland, the survival of the older method of reckoning is seen in the popular system of fixing periods of time by reference to seasons and often in such a way as to cut across the monthly divisions. The Celtic calendar divided the year into four seasons, but there is evidence of an older division into two seasons; one beginning on May 1 at Beltane and the other on Nov. 1 at Samhain, the latter marking the beginning of the Celtic year. Earrach, spring, began on Feb. 1; Foghainhan, the festival of Lughnasadh, the harvest feast, took place on Aug. 1. This festival would appear to be the last to be added to make the fourfold division of the year. That festivals were observed on May 1, Aug. 1, and Nov. 1—the two latter preserved in Lammas and All Souls respectively—is well known, but for the occurrence of a spring festival the evidence rests principally upon what may be deduced from the surviving tradition in the observance of St. Bridget's Day.

The form and divisions of a calendar, together with the ritual observances attached to it, are governed by the occupations of the people or group with whom it originated. The fourfold division of the year derives from the natural divisions into which the changing seasons group the activities of an agricultural community. On the other hand, the year of a pastoral community naturally falls into two divisions, one beginning when the flocks and herds are sent out to graze at the coming of the warm season, and the other when they are brought home at the setting in of cold weather. If, therefore, the Celtic year is correctly interpreted as showing a change from the twofold to the fourfold division, it would point to a corresponding change in occupation from pastoral to agricultural, the ceremonial fires of Beltane on May 1 still being lit for the purification of the flocks and herds before they were sent out to graze.

The twofold division of the year was apparently characteristic of the Aryan-speaking peoples. It appears in the Slavic calendar and also in the Norwegian. The latter is of a very primitive type. It was divided into summer and winter only; the former opened on April 14, and the latter on Nov. 14. There were two great festivals, one in early summer and the second at the beginning of winter, when there is reason to believe the year began.

The association of Candlemas in ecclesiastical tradition with a Roman festival points to a connexion between Christian observance and Roman custom, of which it is not an isolated instance. The impulse towards purification on entering upon a new phase of existence which can be observed in the practices of the New Year, and is of wide distribution, appears in both the Christian and the Roman calendar. Until the reform of Julius Cæsar, the Roman year began in March. The feasts of the Roman calendar in its early form can be traced back to the observances and customs of a primitive agricultural community. As might be expected from a people at that stage of culture, the last month of the old year was a time of solemn purification and of renewal of the spiritual influences which protected the individual and society as a whole. The name of the month of February is said to be derived from Februus, an instrument of purification. The chief feasts of the month were directed to this end. The Terminalia, Feb. 23, renewed the solemn ritual of the placing of the boundary stones. The Parentalia, which lasted over nine days, renewed the bonds between the family and their dead, culminating in a celebration by the whole State on Feb. 21: while the Lupercalia, in a ceremony of which much is obscure, by a solemn procession around the Palatine on Feb. 15, the participants in which were girt with skins, apparently purified the sacred area from evil influences of the past and reinforced its sacred character for the coming year. It is scarcely necessary to dwell upon the resemblance between this period of solemn observance and the Christian Lent.

Societies and Academies.

LONDON.

Royal Society, Jan. 26.—**G. I. Taylor**: The deformation of crystals of β-brass. β-brass, which has a crystal structure similar to that of α-iron, behaves in a similar, though not identical, manner when distorted. The peculiar feature of the distortion of iron crystals, namely, the fact that slip does not occur on a definite crystallographic plane, is repeated in β-brass within a certain range of orientations of the crystal axes in the specimen. On the other hand, in another range of orientations, slip occurs on a definite crystal plane of type {110}. The variation in resistance to shear which occurs as the plane of slip rotates about the direction of slip determines which type occurs. This variation is calculated from the experimental results within the range to which they apply, and it is shown that resistance to shear is least when the plane of slip coincides with a crystal plane of type {110}. On either side of this position shear stress increases linearly.

F. Horton, A. C. Davies, and U. Andrewes: Critical potentials for soft X-ray excitation. An account of an extension of work on the critical potentials for the excitation of soft X-rays from the elements chromium, manganese, iron, cobalt, nickel, copper, and zinc, using steady deflexion methods instead of the ordinary timing method of measuring with the electrometer the photoelectric currents produced by the rays. This greatly facilitated the taking of series of observations, and in consequence additional critical points have been detected. It is suggested that some critical potentials may be characteristic of the arrangement of atoms at the surface of the target, as distinct from others which would be characteristic of encounters between electrons and isolated atoms. At low voltages, the efficiency of soft X-ray excitation is nearly the same for all the elements investigated.

H. Gough: The behaviour of a single crystal of α-iron subjected to alternating torsional stresses. Subjected to alternating torsional stresses, the direction of slip coincides with that of the most highly stressed principal line of atoms, and four such possible directions of slip exist within the crystal, each being parallel to the normal to one of the four set of octahedral planes, and at any point on the circumference of the crystal there exists a plane on which the value of the shear stress on the plane resolved in one of the octahedral directions is a maximum. Slip only occurs on one of the following two combinations of planes: (*a*) 110 and 123, or (*b*) 112 and 123; it cannot occur on a 112 plane combined with a 110 plane.

R. W. James, I. Waller, and D. R. Hartree: An investigation into the existence of zero-point energy in the rock-salt lattice by an X-ray diffraction method. Within certain limits of frequency the F curve, or atomic scattering curve, of an atom for X-radiation can be calculated by applying the classical law of scattering to the distribution of charge represented by the Schrödinger density-distribution for the atom. The F curves calculated from the Schrödinger distributions for the ions Na^+ and Cl^-, obtained theoretically by an approximate method, and those obtained experimentally from observations on the rock-salt crystal at different temperatures, agree very closely, assuming that the crystal possesses zero-point energy of amount half a quantum per degree of freedom, as proposed by Planck.

H. T. Flint and J. W. Fisher: The fundamental equation of wave mechanics and the metrics of space. The wave equation introduced into quantum mechanics by Schrödinger is deduced from a law of metrics in space-time. This law is expressed by a simple divergence equation, which, by making use of Eddington's extension of Weyl's theory, may be converted exactly into the real part of the wave equation. It appears that quantum phenomena are directly related to the gauge factor, λ, of space-time which occupies the place of ψ in Schrödinger's theory.

B. Swirles: The internal conversion of γ-rays. The internal conversion of γ-rays is discussed on the lines of the quantum mechanics. The problem is that of the perturbation of a hydrogen atom of nuclear charge Z by a Hertzian doublet at its centre. An expression is obtained for the coefficient of absorption in the K-levels, which gives values about one-eighth smaller than the experimental ones; the discrepancy is probably due to a neglect of the screening by the other electrons.

A. Muller: On the input limit of an X-ray tube with a circular focus. The well-known heating in the focus of an X-ray tube puts certain limits to the input. An attempt is here made to calculate the limiting input, assuming that the focus spot is a circle.

L. F. Bates: The specific heats of ferromagnetic substances. The thermal and magnetic behaviour of a simple ferromagnetic compound of manganese and arsenic has been studied. This compound has a critical point at 45° C. Heat is very rapidly absorbed when the substance changes from the ferromagnetic to the paramagnetic state. The thermal and magnetic phenomena are intimately connected, and with magnetic change there is associated a heat of transformation. Magnetic phenomena in the region of the critical point are evidence of transformation, which in this case appears to be complete at that temperature, but, in general, may reach only a particular stage at the critical point.

W. Jevons: The ultra-violet band-system of carbon monosulphide and its relation to those of carbon monoxide (the '4th positive' bands) and silicon monoxide. Martin (1913) discovered a band-system in the region $\lambda 2837$—$\lambda 2436$ in the carbon disulphide tube discharge and in the sulphur-fed carbon arc. On experimental evidence he ascribed it to CS. More extensive measurements have been made of the heads in Martin's spectrograms and vibrational quantum numbers n', n'' assigned. The two heads of each double-headed band belong to the R and Q branches respectively. The bands are probably of the simplest type, with single R, Q, and P branches. The CS, and also the SiO, systems are attributed to the electronic transition $1^1P \rightarrow 1^1S$, where 1^1S is the normal state and 1^1P the second excited state of the molecule. The CO and SiO systems are more nearly alike than the CO and CS systems as regards (*a*) the ratio of system-origin to comparable atomic line, (*b*) the proportional increase in vibrational frequency, and (*c*) the intensity distribution, and, therefore, the proportional decrease in moment of inertia.

P. E. Shaw and C. S. Jex: Tribo-electricity and friction. (Part 2.) Prepared glass rods are rubbed by various solid elements in an apparatus designed to give constant conditions of pressure and surface. Some elements never, with any type of glass surface tried, show negative charge. These are carbon, cadmium, iron, lead, bismuth, silver, copper, gold, platinum, magnesium, tungsten. Other elements show ultimate negative charge. These are zinc, tin, aluminium, antimony, nickel, cobalt, selenium, telurium, arsenic, chromium, tantalum, and sulphur. Residual acid, alkali, or water films on the glass have a predominating influence on the charging. Rubbing *in vacuo* yields results similar to those found in the open air, at least in the typical cases tried. (Part 3.)

Commercial textile material is unsuitable for precise tribo-electric experiments, on account of natural and artificial impurities. Well-cleansed material acts consistently on the various solid elements. The arrangement of the various elements according to their charges on textiles and glass corresponds closely to their chemical qualities. Anomalies are found in the case of some strongly electro-positive elements, which appear in two places in the tribo-electric series.

G. P. Thomson: Experiments on the diffraction of cathode rays. The patterns formed by cathode rays scattered by thin films of aluminium, gold, celluloid, and an unknown substance are closely similar to those obtained with X-rays in the 'power method.' The sizes of the patterns agree to 5 per cent. with those predicted on the de Broglie theory of wave mechanics, regarding the phenomenon as one of diffraction of the phase waves associated with the electrons.

B. F. J. Schonland: (1) The polarity of thunderstorms. A discussion is given of the tests available for determining the polarity of thunderclouds and further observations at Somerset East are described, which appear to support the conclusions of Craib and the writer that the polarity of these storms was positive. (2) The interchange of electricity between thunderclouds and the earth. Observations were made to examine the part played by (*a*) point-discharge currents, (*b*) lightning discharges between cloud and ground, and (*c*) charged rain, in the electrical interchange between an active thundercloud and the earth. From these observations, (*a*) and (*b*) are estimated to produce continuous currents of the order of 2·1 and 0·1 (equivalent) amperes respectively, in an upward direction, and (*c*) to produce a reverse downward current of the order of 0·02 amp. The resultant current is thus estimated at 2·2 amp. in such a direction as to convey a negative charge to earth.

H. Gregory and **S. Marshall**: The thermal conductivities of oxygen and nitrogen. The apparatus used was the vertical compensated hot-wire type employed in the determination of the thermal conductivity of carbon dioxide. The results are 589×10^{-7} cal. cm.$^{-1}$ sec.$^{-1}$ deg.$^{-1}$ for oxygen, and 580×10^{-7} cal. cm.$^{-1}$ sec.$^{-1}$ deg.$^{-1}$ for nitrogen, at 0° C. and are consistent with those of Gregory and Archer for the thermal conductivity of air at 0° C.

E. V. Appleton and **J. A. Ratcliffe**: On a method of determining the state of polarity of downcoming wireless waves. For downcoming waves of 400 metres wave-length in England, the polarisation is approximately circular with a right-handed sense of rotation. According to the magneto-ionic theory of atmospheric deflexion of wireless waves, in which the influence of the earth's magnetic field is taken into account, such right-handed elliptical polarisation might be expected if the effective electrical carriers are of electronic mass.

H. Glauert: The effect of compressibility on the lift of an aerofoil. The effect of compressibility of air on the characteristics of an aerofoil moving with velocity approaching that of sound is of fundamental importance for design of high-speed airscrews. A solution has been obtained of the general equations for the motion of a non-viscous compressible fluid at a large distance from a point-vortex, in a stream of uniform velocity, and an approximate expression has been derived for the effect of compressibility on lift of aerofoil. The analysis appears valid up to a velocity of order 0·6 velocity of sound. In this range, slope of curve of lift coefficient against angle of incidence increases without any change in angle of no-lift.

W. A. Bone, D. M. Newitt, and **C. M. Smith**: Gaseous combustion at high pressures (Part 9). The effects have been studied of increasing pressure between 1 and 125 atmos. upon the 'explosion limits' of hydrogen–air, methane–air, and carbonic oxide–air mixtures respectively. In the first two, the 'lower' limit remains practically unchanged, but the range of explosibility widens with increasing pressure, particularly for methane-air mixtures. On the other hand, the 'limits of explosibility' of carbon monoxide–air mixtures materially diminish with increasing pressure. The same holds true when nitrogen from air is replaced by argon or helium, but more so when argon is the diluent.

A. T. Doodson: The analysis of tidal observations. The advantages claimed for the new method described are (1) systematic condensation of the observational material; tidal constituents not treated independently of one another until the last stage of analysis; (2) results readily show whether analysis is complete or not; (3) perturbations of one constituent upon another are adequately eliminated; (4) correlation with astronomical arguments is very much simplified.

H. R. Lang: On the measurement of the specific heat of aniline with temperature, using the continuous-flow electric method. Two types of flow calorimeter were used. It was extremely difficult to get the liquid perfectly dry, as it was hygroscopic. The very small water-content was determined in each case from the freezing-point. A separate investigation gave the relation between water-content and freezing-point, a small correction being applied to give the value for perfectly dry aniline. Between 5° and 75° C., rate of change of specific heat with temperature increases with rising temperature.

T. H. Havelock: Wave resistance. Direct proofs are given of certain expressions used in previous calculations. The method can readily be extended to more general cases. The results obtained can be applied to give the wave resistance for any distribution of doublets in any positions and directions in a uniform stream.

K. Yardley: An X-ray study of some simple derivatives of ethane (Part 1). The substances C_2Cl_6, C_2Br_6, $C_2Cl_4Br_2$ (two forms), C_2Br_5F, $C_2Cl_3Br_3$, $C_2Br_4(CH_3)_2$ (two forms), form an isomorphous series, crystallising in the space-group Q_h^{16}. The unit-cell contains four plano-symmetrical molecules. Two halogen atoms and the two carbon atoms lie in the symmetry plane (010). The formula of both forms of $C_2Cl_4Br_2$ appears to be $CCl_3 . CClBr_2$. The two CH_3 groups in $C_2Br_4(CH_3)_2$ lie in the symmetry plane. (Part 2.) Attempts to obtain X-ray data for $C_2(CH_3)_6$ and $C_2(CH_3)_5Br$ failed because of the extreme speed with which these substances volatilised. $C_2Br_4(CH_3)_2$ possesses a third (tetragonal) form, which bears no apparent resemblance to the two forms described in Part 1. $C_2(CH_3)_4Br_2$ forms needle-like tetragonal crystals, the molecules themselves simulating tetragonal symmetry. They occupy approximately face-centred positions in a unit-cell of dimensions $10{\cdot}45^2 \times 8{\cdot}14 A^3$. The orthorhombic cell of $C_2(CH_3)_5OH$ may be divided into two pseudo-tetragonal parts; in each the arrangement of molecules resembles that in the unit-cell of $C_2(CH_3)_4Br_2$. The space-group is C_{2v}^{21}.

Physical Society, Dec. 9.—**H. P. Walmsley**: The scattering of light by individual particles in smokes. Applying the expression given by Maxwell for the number of collisions that occur between two sets of spherical uncharged molecules in a gas to the case of a smoke the particles of which cover a wide range of sizes, it appears that particles of a given set collide less frequently with themselves than with those in sets of much larger or much smaller size. If the particles unite on contact, one would expect therefore that the units of the resulting aggregates would differ greatly in size. This result is at variance with the deductions

of Patterson and Whytlaw Gray from experimental data.—**J. J. Manley**: On the construction and standardisation of an interferometer pressure gauge. A Michelson interferometer is applied to the determination of gas pressures ranging from 0·0001 to 20 mm. of mercury. The gauge can be set instantaneously and the pressure which obtained at the moment of setting measured at leisure.—**Anne I. Anderson**: The dielectric constant of liquid bromine. An account is given of a re-determination of the dielectric constant of liquid bromine, the value found being 3·119 at 15° C., and at a frequency of 187,000 per sec., with a temperature coefficient of $-0·00191$ referred to 0° C. Applying the dipole theory of Debye and Gans to the results, a value of $0·40 \times 10^{-18}$ is deduced for the electric moment of the bromine molecule Br_2.

PARIS.

Academy of Sciences, Dec. 27.—**Charles Moureu** and **Charles Dufraisse**: Autoxidation and antioxygen action. The theory of antioxygen action. The theory of antioxygen action, proposed by the authors in previous communications, appears to be opposed to certain consequences of the general theories of catalysis, since, in fact, a certain displacement of equilibrium under the action of a catalyst is implied. The difficulty comes down to the definition of a catalyst, which is critically discussed.—**Pierre Termier**: The Vanoise-Mont Pourri tectonic, in the Savoy Alps, is not separable from the Briançonnais stratum.—**V. Grignard** and **G. Mingasson**: The mechanism of the catalytic hydrogenation of the phenols. Use is made of the catalytic addition of hydrogen under reduced pressure (with nickel catalyst) to bring out the intermediate phases of the hydrogenation of phenols. The experimental results prove that the addition of hydrogen to phenols follows the course that could be predicted from the Kékulé formula: the two double bonds not adjacent to the hydroxyl group taking up hydrogen giving the enol form of the corresponding cyclohexanone.—**C. Camichel, P. Dupin,** and **M. Teissié-Solier**: The application of the law of similitude to the periods of formation of the alternate vortices of Bénard-Karman.—**B. Berloty**: Observations of the passage of Mercury across the sun, November 10, 1927, made at the Observatory of Ksara.—**R. Maire** and **L. Emberger**: General sketch of our phytogeographical knowledge of Morocco: the climatic stages of vegetation.—**Maurice Gevrey**: Conditions at the limits relating to tangential differentials.—**Jules Drach**: Determination of the linear elements of Liouville for which the equation of the geodesic lines admits at least two rational integrals of the first differential.—**Léon Pomey**: Non-linear differential and integral equations.—**Floran Vasilesco**: The problem of Dirichlet.—**W. Gontcharoff**: The determination of functions by the zeros of their differentials.—**Četajev**: The equations of Poincaré.—**Émile Merlin**: The distribution of velocities and densities in a heterogeneous fluid in rotation.—**W. Margoulis**: The application of nomography to the study of turbo-machines with screws.—**Maurice Girault**: The geometrical construction of the profiles of wings by conformal representation of a circle.—**Th. Vautier**: The increase of the intensity and of the duration of extinction of sound.—**Thadée Peczalski**: The dispersion of metals in solid salts under the action of the electric current.—**F. Bedeau** and **J. de Mare**: Continuous hissing produced by a piezoelectric quartz, emitting simultaneously two high frequency oscillations.—**Ernest Esclangon**: The optical dissymetry of space and the laws of reflection.—**Auguste Le Thomas**: The 'heredity' of castings. The quality of castings from a particular foundry appears to be connected with the foundry and to be independent of the chemical composition. The explanation of this 'structural heredity' is not known.—**Leon Guillet**: Remarks on the preceding communication.—**A. Mailhe** and **Renaudie**: The transformation of alcohols into petrol. The vapours of normal butyl alcohol passed over uranous oxide heated to 420° C. - 440° C. gave a gas containing a high proportion of ethylenic hydrocarbons and a liquid containing butyric aldehyde and a mixture of hydrocarbons boiling between 80° C. and 125° C.—**Paul Combes**: The stratigraphic chronometer of Saint-Nazaire-Penhoët and the age of Glozel. The section exposed by Kerviler in the Penhoët basin in 1877 would place the Neolithic nearer the Christian age than has hitherto been supposed, about seven centuries B.C.—**Joseph Devaux**: The formation of glaciers by the daily fusion and nocturnal regelation of névés. J. Vallot has shown that at the top of Mt. Blanc the snow is transformed progressively into ice, although the temperature remains always below $-15°$ C. The older view of fusion and regelation, however, is not incorrect, and can be shown to be taking place in certain cases.—**H. Colin** and **Ch. Neyron de Méons**: The inulin of the asphodel.—**Pierre Lesage**: The influence of heat on the potential energy of plants.—**George F. Jaubert**: The destruction of *Galleria mellonella* by means of chloropicrin. The efficacy of chloropicrin in destroying this pest in beehives is proved.—**Gabriel Bertrand**: Remarks on the preceding communication.—**H. Lassalle**: The evaluation of the neuro-muscular excitability. Theoretical discussion.—**Charles Kayser** and **Albert Ginglinger**: The systematic variations and signification of the respiratory quotient as a function of the temperature in animals.—**H. Simonnet** and **G. Tanret**: The hypoglycæmic properties of galegine sulphate.—**Jean Saidman**: The biological properties of X-rays of 8 Angström units. X-rays of wave-length 8 A. are absorbed by the superficial layers of the epidermis and do not reach the vascular zone, alterations in which produce dermatitis. The roots of the hair are also unattacked. These rays have been successfully applied to the treatment of chronic eczema of the hands.—**Marcel Duval**: The molecular concentration of the blood of the snail. The influence of the state of activity of the animal. Starting with the known fact that the activity of the snail is markedly affected by the presence or absence of moisture in the air, experiments were devised to see how far the humidity factor regulated the activity by a physico-chemical process. The molecular concentration of the blood was measured during the hibernating state and in summer when moving and when inert within the shell. The expected relation between the activity of *Helix pomata* and the molecular concentration of its blood was proved experimentally.—**Y. Manouélian** and **J. Viala**: Nerve cells and the virulence of the salivary glands.—**Georges Blanc** and **J. Caminopetros**: Experimental researches on the antidysentery vaccination in man.—**Burnet**: The impossibility of vaccinating the goat against *M. melitensis* with large doses of vaccine.

Official Publications Received.

BRITISH.

Seventh Congress of the Far Eastern Association of Tropical Medicine: Souvenir. The Indian Empire: being a Brief Description of the Chief Features of India and its Medical and Sanitary Problems. Pp. vii+546+20 plates+4 maps. (Calcutta.)

Canada. Department of Mines: Geological Survey. Summary Report, 1926, Part A. (No. 2185.) Pp. 60A. Summary Report, 1926, Part C. (No. 2186.) Pp. 143C. Economic Geology Series, No. 4: Arsenic-bearing Deposits in Canada. By M. E. Hurst. (No. 2181.) Pp. iv+191. 25 cents. (Ottawa: F. A. Acland.)

The Gas Light and Coke Company. Printed for the Visit of the Science Masters' Association to Horseferry Road, Fulham and Watson House, Friday, 6th January 1928. Pp. 17+3 plates. (London.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 46: Some Experiments on Feeding Rats with Soya Beans and other Materials. By D. T. Barry and J. Freud. Pp. 513-519. 6d. Vol. 18 (N.S.), No. 47: The Formation of Vortices behind a Cylinder moving through a Liquid. By E. T. S. Walton. Pp. 521-534+1 plate. 1s. 6d. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

Africa: Journal of the International Institute of African Languages and Cultures. Edited by Diedrich Westermann. Vol. 1, No. 1, January. Pp. 144. (London: Oxford University Press.) 6s.

Union of South Africa: Department of Agriculture. Division of Chemistry Series, No. 85: The Key to the Secrets of Nature—The Indispensable Work of the Chemist. (Being the Annual Report of the Chief, Division of Chemistry, for the Year ended 30th June 1927.) Pp. 10. (Pretoria: Government Printing and Stationery Office.)

Transactions and Proceedings of the New Zealand Institute. Vol. 58, Part 3, September. Pp. iv+189-358+p'ates 21-37. (Wellington, N.Z.)

Tide Tables for the Eastern Coasts of Canada for the Year 1927: including the River and Gulf of St. Lawrence, the Atlantic Coast, the Bay of Fundy, Northumberland and Cabot Straits; and Information on Currents. Pp. 76. Tide Tables for the Eastern Coasts of Canada for the Year 1928. Pp. 76. (Ottawa: F. A. Acland.)

Tide Tables for the Pacific Coast of Canada for the Year 1927: including Fuca Strait, the Strait of Georgia, and the Northern Coast; with Data for Slack Water in the Navigable Passes and Narrows and Information on Currents. Pp. 72. Tide Tables for the Pacific Coast of Canada for the Year 1928. Pp. 72. (Ottawa: F. A. Acland.)

Annals of the Cape Observatory, Vol. 13. Part 2: Results of Meridian Observations made at the Royal Observatory, Cape of Good Hope, in the Years 1918-1925, under the Direction of Dr. H. Spencer Jones. Pp. xvii+114. (London: H.M. Stationery Office.) 17s. 6d. net.

Cape Astrographic Zones, Vol. 11. Catalogue of Rectangular Co-ordinates and Diameters of Star-Images derived from Photographs taken at the Royal Observatory, Cape of Good Hope. Commenced under the Direction of Sir David Gill; Completed and prepared for press under the Supervision of S. S. Hough. Zone -51°. Pp. xxxvi+466. (*London: H.M. Stationery Office.*) 55s. net.

Memoirs of the Geological Survey of India. Palæontologia Indica. New Series, Vol. 8, Memoir No. 4: The Fossil Suidæ of India. By Dr. Guy E. Pilgrim. Pp. vi+104+20 plates. (Calcutta: Government of India Central Publication Branch.) 11.12 rupees; 19s.

Indian Central Cotton Committee: Technological Laboratory. Bulletin No. 7, Technological Series No. 3: Technological Reports on Standard Indian Cottons, 1923-26. By A. James Turner. Pp. iii+95. Bulletin No. 9, Technological Series No. 4: The Effect of Temperature and Humidity on Cotton Spinning, with particular reference to Conditions in Bombay. By A. James Turner. Pp. ii+46. 2 rupees. Bulletin No. 10, Technological Series No. 5: The Effect of subjecting Cotton to repeated Blow-Room Treatment. By A. James Turner. Pp. ii+23. 1 rupee. Bulletin No. 11, Technological Series No. 6: Technological Reports on Standard Indian Cottons, 1927. By A. James Turner. Pp. vi+117. 2 rupees. (Bombay.)

FOREIGN.

United States Department of Agriculture. Technical Bulletin No. 19: Parasites of the Pink Bollworm in Hawaii. By H. F. Willard. Pp. 16. (Washington, D.C.: Government Printing Office.) 5 cents.

University of Washington Publications in Anthropology. Vol. 2, No. 1: Adze, Canoe and House Types of the Northwest Coast. By Ronald L. Olson. Pp. 38. Vol. 2, No. 2: The Ghost Dance of 1870 among the Klamath of Oregon. By Leslie Spier. Pp. 39-55. (Seattle, Wash.: University of Washington Press.)

Lauksaimniecibas pārvaldes rakstu krājums. VI burtnica. Latvijas jūras zvejniecība 1926 gadā. Sakopojis V. Miezis. (Bulletin statistique des Pêches maritimes de Lettonie, année 1926. Rédigé par V. Miezis.) Pp. 49. (Riga.)

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 79. Notes on the Philippine Fishes in the Collection of the Academy. By Henry W. Fowler. Pp. 255-297. (Philadelphia.)

Smithsonian Miscellaneous Collections. Vol. 80, No. 5: Drawings by A. DeBatz in Louisiana, 1732-1735. By David I. Bushnell, Jr. (Publication 2925.) Pp. 14+6 plates. (Washington, D.C.: Smithsonian Institution.)

Journal de la Société des Américanistes de Paris. Nouvelle Série, Tome 19. Pp. xxix+559. (Paris.)

U.S. Department of Agriculture: Weather Bureau. Monthly Western Review, Supplement No. 29: The Floods of 1927 in the Mississippi Basin. By H. C. Frankenfield. (W.B. No. 986.) Pp. 49+7 plates. (Washington, D.C.: Government Printing Office.)

Scientific Papers of the Institute of Physical and Chemical Research. Nos. 92-94: *Syntheses of some Fatty-Aromatic Amines containing* Phenolic Hydroxyl Groups in Benzene Nucleus, by Shôzô Kobayashi; Relation between Chemical Constitution and Pungency in Acid Amines, by Shôzô Kobayashi; Double Compounds of α-Unsaturated Acid Amines with Acid and with Ammonia, by Shôzô Kobayashi. Pp. 149-196. 53 sen. No. 111: The Radiograph of a Crystal having the Face-centered Cubic Lattice. By Masaichi Majima and Sakuichi Togino. Pp. 75-78+plates 5-19. 40 sen. No. 116: On the Reproductive Failure of White Rats on Synthetic Diets. By U. Suzuki, W. Nakagara and N. Hashimoto. Pp. 143-152+4 charts+plates 20-22. 55 sen. Nos. 117-118: Über die Löslichkeit der Celluloseester, 1 Mitteilung, von I. Sakurada and T. Nakashima; Über die Löslichkeit der Celluloseester, 2 Mitteilung, von I. Sakurada and T. Nakashima. Pp. 153-172. 30 sen. Nos. 120-121: The Effect of Caustic Alkali on the Oxidation of Stannous Chloride by Air, by Susumu Miyamoto; On the Oxidation of the Mixture of Stannous Chloride and Sodium Sulphite in Alkaline Solution by Air, by Susumu Miyamoto. Pp. 189-200. 25 sen. No. 122: Residual Thermoelectric Phenomena of apparently Homogeneous Wire. By Torahiko Terada, Toshimasa Tsutsui and Mituo Tamano. Pp. 201-236. 60 sen. (Tokyo: Iwanami Shoten.)

Annales de l'Observatoire d'Astronomie physique de Paris. Tome 7: Recherches sur la constitution des comètes et sur les spectres du carbone. Par F. Baldet. Pp. iv+109+5 planches. (Paris.)

Koninklijk Nederlandsch Meteorologisch Instituut, No. 102. Mededeelingen en Verhandelingen, 1a: Het Koninklijk Nederlandsch Meteorologisch Instituut. A: Organisatie en Inrichting. (Institut Météorologique Royal des Pays-Bas. A: Organisation et Disposition.) Pp. 72+9 planches. ('s-Gravenhage: Algemeene Landsdrukkerij.) 1.00 f.

Annotationes Zoologicæ Japonenses. Vol. 11, No. 2, July 25. Pp. 97-194+6 plates. Vol. 11, No. 3, November 8. Pp. 195-287+10+9 plates. (Tokyo: Zoological Society of Japan.)

Instituto Geográfico y Catastral. Anuario del Observatorio Astronómico de Madrid para 1928. Pp. 541+lvi. (Madrid.)

Conseil Permanent International pour l'Exploration de la Mer. Bulletin statistique des Pêches maritimes des Pays du Nord et de l'Ouest de l'Europe. Rédigé par D'Arcy Wentworth Thompson. Vol. 15, pour l'année 1925. Pp. 49. Journal du Conseil. Rédigé par E. S. Russell. Vol. 2, No. 3. Pp. 267-400. (Copenhague: Andr. Fred. Høst et fils.)

Reprint and Circular Series of the National Research Council. No. 80: Doctorates conferred in the Sciences by American Universities, 1926-1927. Compiled by Callie Hull and Clarence J. West. Pp. 30. (Washington, D.C.: National Academy of Sciences.) 50 cents.

Bulletin of the American Museum of Natural History. Vol. 57, Art. 4: The Chilopoda and Diplopoda collected by the American Museum of Natural History Congo Expedition (1909-1915), with Notes on some other African Species. By Ralph V. Chamberlin. Pp. 177-249. (New York City.)

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 27: Measurement of Variable Velocity relative to Air with Pitotstatic Tube. By Koroku Wada and Syôdirô Nisikawa. Pp. 327-396. (Tôkyô: Kôseikai Publishing Office.) 1.05 yen.

U.S. Department of the Interior. Report of the Commissioner of Education for the Year ended June 30, 1927. Pp. iii+32. (Washington, D.C.: Government Printing Office.) 10 cents.

CATALOGUES.

A Catalogue of General Literature, including History and Biography. (No. 440.) Pp. 20. (Cambridge: Bowes and Bowes.)

B.I.M. Microscopes. Pp. 12. (London: Charles Baker.)

Diary of Societies.

SATURDAY, FEBRUARY 4.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—H. C. Colles: Musical London from the Restoration to Handel (1660-1759) (I.).

ASSOCIATION OF WOMEN SCIENCE TEACHERS (Annual General Meeting) (at St. Paul's Girls' School), at 4.30.—Sir John Russell: The Growth of Crops: Applications of Botany and Chemistry to Country Life (Lecture).

RURAL CONSTRUCTION ASSOCIATION (at London School of Economics), at 5.50.—R. Borlase Matthews: Electricity in Rural Life.

WESTERN JUNIOR GAS ASSOCIATION.—Thomas Hardie: Address.—Dr. E. W. Smith: Modern Tendencies in Carbonising Practice.

MONDAY, FEBRUARY 6.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Prof. F. O. Bower: Obituary Notice of A. Anstruther Lawson.—Prof. W. H. Lang: The Flora of the Old Red Sandstone of Scotland: a General Survey.—E. B. Bailey: Schist Geology: Braemar, Glen Cluny, and Glen Shee.—Dr. H. H. Read: Highland Schists of Middle Deeside.—*To be read by title only: —Prof. D. M. Y. Sommerville: An Analysis of Preferential Voting.*—Sir Thomas Muir: The Theory of Jacobians from 1885 to 1919.

VICTORIA INSTITUTE (at Central Hall, Westminster), at 4.30.—Rev. A. H. Finn: The Miraculous in Holy Scripture.

BIOCHEMICAL SOCIETY (at Lister Institute), at 5.—H. Jephcott and A. L. Bacharach: The Quantitative Estimation of Vitamin D.—A. L. Bacharach and E. Allchorne: The Vitamin B Content of Malt Extract.—M. G. White and J. J. Willaman: The Alcoholic Fermentation of Pentoses by Fusarium Lini.—Prof. A. V. Hill: Increased Anaerobic Metabolism in Muscle following Stimulation.—D. Jordan Lloyd and W. B. Pleass: The Effect of Nitrates on the Absorption of Water by Gelatin.—H. W. Kinnersley, R. A. Peters, and V. Reader: Metabolic Constancy in the Pigeon.—R. T. Brain and H. D. Kay: Phosphate Excretion.—R. P. Cook and B. Woolf: The Deamination and Synthesis of l-aspartic Acid by Bacteria.—R. Robison and K. M. Soames: *Calcification in Vitro.*

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Percy Sargent: The Surgery of the Posterior Cranial Fossa.

SOCIETY OF ENGINEERS (at Geological Society), at 6.—C. H. J. Clayton: The National Rivers and their Functions (Presidential Address).—D. C. Fidler: Presentation of Premiums awarded in 1927.

INSTITUTION OF AUTOMOBILE ENGINEERS (Western Centre) (at Merchant Venturers' Technical College, Bristol), at 6.45.—W. West: Foundry Work.—C. T. Skipper: Machining Operations on a Six-Cylinder Block.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—*F. Selley and others: Discussion on Domestic Water Heating.*

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—F. H. Carr: Some Problems Encountered in Making Fine Chemicals.

SURVEYORS' INSTITUTION (at Institution of Civil Engineers), at 8.—L. Crouch: The Landlord and Tenant Act, 1927.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—T. A. Barns: In Portuguese West Africa.

TUESDAY, FEBRUARY 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. A. P. Newton: The Settlement of the Dominions, 1783-1870.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the months of October, November, December 1927, and January 1928.—D. Seth Smith: Exhibition of a Blue Variety of the Masked Love-bird (*Agapornis personata*).—Dr. P. R. Lowe: Studies and Observations bearing on the Phylogeny of the Ostrich and its Allies.—S. Zuckerman: The Age-changes in the Chimpanzee, with Special Reference to Growth of Brain, Eruption of Teeth, and Estimate of Age, with a Note on the Taungs Ape.—F. F. Laidlaw and the late H. Campion: Notes on Oriental Dragonflies (Odonata) with Descriptions of New Species.

INSTITUTION OF CIVIL ENGINEERS, at 6.

LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.), at 6.30.—Annual Spring Exhibition.—Miss C. E. Longfield: By Rail, Road, and River, through the Heart of South America.—Rev. H. J. Gamble: My Week-end in the Home of Tutankhamen (Lectures).

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at Loughborough College), at 6.45.—C. D. Gibb: Modern Reaction Turbines.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—F. H. Clough; Stability of Large Power Systems.

INSTITUTE OF METALS (Birmingham Local Section) (jointly with Birmingham Metallurgical Society and Staffordshire Iron and Steel Institute) (at Engineers' Club, Birmingham), at 7.—Prof. F. C. Lea: Testing of Metals.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—A. Keighley: North Palestine and Syria.

INSTITUTE OF METALS (North-East Coast Local Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—Dr. J. A. Smythe and C. E. Pearson: Demonstration of Mechanical Testing of Metals.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.

ROYAL AERONAUTICAL SOCIETY (jointly with Institution of Automobile Engineers) (at Royal Society of Arts), at 7.45.—Wing Cmdr. J. G. V. Fowler: The Repair and Maintenance of Aero Engines.

WEDNESDAY, FEBRUARY 8.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. G. Grey Turner: The Treatment of Congenital Defects of the Bladder and Urethra by Implantation of the Ureters into the Bowel, with a Record of 14 Personal Cases.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. W. J. Pugh: The Geology of the District around Dinas Mawddwy (Merioneth).

ROYAL SOCIETY OF MEDICINE (Sub-Section of Proctology), at 5.30.—F. J. McCann: An Operation for Prolapse of the Rectum in the Female.—Z. Cope: The Treatment of Irreducible Sigmoido-rectal Intussusception in Old People.—W. B. Gabriel: Four Cases of Small Gut Obstruction Round Colostomies.—Demonstration by Dr. P. H. Manson-Bahr: Sigmoidoscopic Appearances in Colitis.

BRITISH PSYCHOLOGICAL SOCIETY (Industrial Section) (at Royal Anthropological Institute), at 6.—Dr. M. Culpin and others: Discussion on Occupational Neuroses.

INSTITUTE OF METALS (Swansea Local Section) (at Thomas' Café, Swansea), at 7.—N. Alan: Gases in Metals, with Special Reference to Copper.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section) (Middlesbrough), at 7.30.—E. Graham: Some Notes on Ship Construction.

ROYAL SOCIETY OF ARTS, at 8.—H. D. Wilkinson: Theatre Lighting.

THURSDAY, FEBRUARY 9.

ROYAL SOCIETY, at 4.30.—Prof. O. W. Richardson: On the Extraction of Electrons from Cold Conductors in Intense Electric Fields.—R. H. Fowler: (*a*) The Restored Electron Theory of Metals and Thermionic Formulæ; (*b*) The Photo-electric Threshold Frequency and the Thermionic Work Function.—P. A. M. Dirac: The Quantum Theory of the Electron.—Dr. H. T. Flint and Prof. O. W. Richardson: On a Minimum Proper Time and its Application to (1) the Number of the Chemical Elements, (2) Some Uncertain Relations.—*To be read in title only*:—Dr. H. Jeffreys: Some Cases of Instability of Fluids.—Dr. H. T. Flint: Relativity and the Quantum Theory.—C. A. Clemmow: A Theory of Internal Ballistics based on a Pressure Index Law of Burning for Propellants.—Prof. H. A. Wilson: The Emission of Light by Flames containing Sodium and the Absorption of Light by Mercury Vapour.—C. N. Hinshelwood and H. W. Thompson: The Kinetics of the Combination of Hydrogen and Oxygen.—E. T. Copson: On Electrostatics in a Gravitational Field.—K. Darwin: Examples of the Zeeman Effect at Intermediate Strengths of Magnetic Field.—W. R. Brode: The Analysis of the Absorption Spectrum of Cobalt Chloride in concentrated Hydrochloric Acid.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: From Faraday's Note Books (2). "Crispations": The Forms of Fluids on Vibrating Surfaces.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Informal Meeting of Colour Group), at 7.—T. J. Offer: Instantaneous Colour Photography in the Theatre.

SOCIETY OF DYERS AND COLOURISTS (Midlands Section) (at Nottingham University College), at 7.30.—A. J. Hall: Action of Alkalines on Cotton and Art Silk.

INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—J. Conway: Development of the Rotary Converter.

INSTITUTE OF METALS (London Local Section) (at 83 Pall Mall), at 7.30.—R. G. Batson: Properties of Metals and Alloys at High Temperatures.

OPTICAL SOCIETY (at Imperial College of Science and Technology) (Annual General Meeting), at 7.30.

ROYAL SOCIETY OF MEDICINE (Ophthalmology and Neurology Sections), at 8.30.—Dr. J. Collier (Neurology), F. A. Williamson-Noble (Ophthalmology), Dr. A. Feiling, Dr. J. R. Perdrau, M. L. Hine, R. Foster Moore, and Dr. W. J. Adie: Special Discussion on Ocular Complications of Encephalitis Lethargica.

OIL AND COLOUR CHEMISTS' ASSOCIATION.

FRIDAY, FEBRUARY 10.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—Sir Edward A. Gait: Bihar and Orissa (Sir George Birdwood Memorial Lecture).

ROYAL ASTRONOMICAL SOCIETY (Anniversary Meeting), at 5.—Presidential Address; Presentation of the Gold Medal to Prof. R. A. Sampson, and of the Jackson-Gwilt Medal to Dr. Steavenson.

MEDICAL OFFICERS OF SCHOOLS ASSOCIATION (Annual General Meeting) (at 11 Chandos Street, W.), at 5.—Dr. A. A. Mumford: The School Medical Officer of the Future.

PHYSICAL SOCIETY (at Imperial College of Science and Technology), at 5.—Dr. A. Ferguson and E. J. Irons: A Simple Graphical Method for the Determination of Galvanometer and Fluxmeter Constants, with a Note on the Measurement of Intense Magnetic Fields.—Dr. C. J. Smith: On a Method of Constructing the Caustic Curve formed by Refraction at Plane Surfaces.—J. C. Hudson: The Application of Electrical Resistance Measurements to the Study of Atmospheric Corrosion of Metals.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. J. H. Sheldon: An Undescribed Disease of Bone.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Newcastle-upon-Tyne), at 6.—J. E. Southcombe: Some Contributions to the Theory and Practice of Lubrication.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (jointly with Manchester Association of Engineers) (at Engineers' Club, Manchester), at 7.15.—E. J. Parish: Inspection Methods.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Prof. H. P. Philpot: Some Principles of Investigation in Engineering Work.

INSTITUTE OF METALS (Sheffield Local Section) (in Applied Science Department, Sheffield University), at 7.30.—J. B. Forster: Casting.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (jointly with Society of Dyers and Colourists) (at Chemical Society), at 8.—E. A. Alliott: Dry Cleaning and Finishing Machinery.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. B. Melvill Jones: Research on the Control of Aeroplanes.

SOCIETY OF DYERS AND COLOURISTS (Scottish Section) (at Glasgow).—Dr. H. H. Hodgson: The Relation between Laboratory and Bulk Production.

SATURDAY, FEBRUARY 11.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—H. C. Colles: Musical London from the Restoration to Handel (1660–1750) (2).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 4.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Mrs. R. Aitken: Village Life in High Castile.

MONDAY, FEBRUARY 6.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Dr. H. P. Biggar: The Discovery of Canada from Cabot to Champlain.

GRESHAM COLLEGE, at 6.—G. P. Bailey: Modern Science and Daily Life: Rare Gases of the Atmosphere.

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—W. R. Day: The Cultivation of the Cricket Bat Willow.

TUESDAY, FEBRUARY 7.

KING'S COLLEGE, at 5.30.—Prof. S. Alexander: Emergence, or Primary, Secondary and Tertiary Qualities of Things. (Succeeding Lectures on Feb. 14 and 21.)

UNIVERSITY COLLEGE, at 8.15.—Miss E. Jeffries Davis: More London Place-Names. (Succeeding Lectures on Feb. 14, 21, 28, and Mar. 6.)

WEDNESDAY, FEBRUARY 8.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.30.—Dr. W. Norwood East: Some Problems of Forensic Psychiatry.

UNIVERSITY COLLEGE, at 5.30.—I. C. Gröndahl: Norwegian Country Life, Customs and Sayings. (Succeeding Lectures on Feb. 15 and 22.)

THURSDAY, FEBRUARY 9.

UNIVERSITY COLLEGE, at 5.30.—Prof. P. Fleming: Relics of Monastic London.

FRIDAY, FEBRUARY 10.

GUY'S HOSPITAL MEDICAL SCHOOL, at 5.30.—G. Simpson: The Surgery of the Kidney and Ureter. (Succeeding Lectures on Feb. 17 and 24.)

UNIVERSITY COLLEGE, at 5.30—E. J. Holmyard: Chemistry in Mediæval Islam.

SATURDAY, FEBRUARY 11.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—M. A. Phillips: In the Haunts of the Sea-birds.

CONFERENCE.

TUESDAY, FEBRUARY 7.

CONFERENCE ON POWER FOR CULTIVATION AND HAULAGE ON THE FARM (at Rothamsted Experimental Station), at 11.30 A.M.—Chairman: Sir Merrik Burrell.

H. C. Burford: The Design of a General Purpose Tractor.
G. W. Watson: The Care of the Tractor on the Farm.
E. Porter: Practical Experience of Power on the Farm.
R. D. Moser: Rotary Cultivation.
Dr. B. A. Keen: Horse and Mechanical Power in Farm Operations.

SATURDAY, FEBRUARY 11, 1928.

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The Great Barrier Reef.

ELSEWHERE in this issue an account is given of the expedition shortly to visit the Great Barrier Reef, one of the chief natural wonders of the world, a breakwater built by still-living organisms along a continental coast for 1300 miles. Starting from Harvey Bay, 120 miles north of Brisbane, the reef extends from lat. 25° S. to join up to New Guinea in 9° S. Much broken in its southern two degrees, where is the great Capricorn Passage, by which ships enter, the barrier soon becomes more marked, until in places it forms an almost continuous breakwater, the edge becoming again less defined as the influence of the water of the Fly River is felt. Its distance from the mainland varies from more than 100 miles in the north and south to an average of not more than 30 miles over a long stretch in the middle, though in places outstanding capes reduce the enclosed channel (lagoon) to less than ten miles in breadth. Cairns, the chief town near the proposed headquarters of the expedition, is situated at the south end of this area about lat. 16° 30′ S. Near it are broad channels through the great seaward reef, and a fairly clear lagoon, though with reefs exposed at low tide. About half-way to the outer barrier lies a small reef with an islet, upon which the members of the expedition will camp, absolutely in the centre of their work.

The Barrier Reef was first explored by Capt. Cook, and it was a little north of Cairns where he ran on to a reef, afterwards careening his ship for repair in Endeavour River, now the site of Cooktown. His course thence was inside the reef for about 70 miles, but navigation for sail was difficult within the narrowing lagoon, and he passed out to seaward, afterwards re-entering through Providential Channel, 150 miles north, and exploring Torres Straits. The coast bristles with his names, among which may be cited Capes Upstart, Flattery, Capricorn, and Tribulation, Repulse and Trinity Bays, Possession Island and Thirsty Sound. Other explorers were King, Flinders, and Bligh, but the first systematic survey was by H.M.S. *Fly* and *Bramble* in 1842–6 under Capt. Blackwood, with J. Beete Jukes as naturalist to the survey. This was merely carrying on the generous hospitality of the Admiralty to scientific men, so profitable in the association of Banks with Cook, and continuous from then for 160 years to the present day. This survey followed on that of the Maldive Islands by Capt. Moresby in the previous decade, and laid the foundation of the accurate knowledge of the topography of great reef areas.

Both surveys were remarkable achievements

with the instruments and means at that time at the disposal of the surveyors, and that of the *Fly* materially assisted in the opening up of Queensland. Some of the barrier was shown to consist of linearly extending reefs, while in other places it was represented by a series of ring- or atoll-shaped structures. The passages through this reef have clearly no close correlation with the drainage of the land, for the north of Queensland drains rather to the west than to the east. The enclosed lagoon has nowhere a greater depth than 50 fm., and in few places more than 30 fm. It was found to be studded with many shoals, most of which reach the surface and there spread out, submerged ridges and patches being comparatively scarce. Outside, in the Coral Sea, were discovered a whole series of reefs, some with cays, all within the 1000 fm. line and extending towards New Caledonia. To the north is a deep of about 2500 fm., lying south of the eastern horn of New Guinea, just north of which is the tiny Planet Deep (4998 fm.), surrounded on three sides by land. Lastly, it was shown that an elevation of less than 10 fm. would join Australia to New Guinea, and that shallow water extended far west, the north of Australia having indeed one of the largest areas of shallow sea in the world.

The views of Darwin on the formation of coral reefs were published in 1837, and his wonderful book on the subject in 1842. The suggestion of subsidence as the predisposing cause in the formation of reefs met with almost universal acceptance, and for the Barrier Reef was endorsed by Savile Kent, who presented a book of delightful photographs rather than of scientific consideration. Indeed, he only sought spots for his hobby, and we have to fall back upon Jukes for accurate and studied observations. Murray doubted whether Darwin's views had the general applicability demanded, and Alexander Agassiz differed *in toto* after visiting the Barrier Reef in 1896 in very bad weather. The first boring at Funafuti was then being undertaken, and a subsequent boring showed a vertical thickness of 200 fm. of limestone material. Other workers proved that this could not have been directly formed by upgrowth at a greater depth than 50 fm., for 'reef-building' corals were shown to depend for their nutrition on commensal algæ, and all plant growth stops below this same depth owing to an absence of sufficient light. At the same time, heavy, stony algæ (Lithothamnioneæ) were seen to be the main reef builders in shallow water under heavy seas, with other herbaceous calcareous forms to provide small material to fill up any hollows. It was stated that the lagoon topography was not consistent with subsidence and that lagoons are being added to by solution of limestone. To this was added the removal of fine material in suspension to form vast areas of coral mud covering some millions of square miles of the ocean floor in coral regions.

Research was mainly directed on the subsidence side to the study of the embayments of islands, and Prof. Davis has pointed out the extraordinary resemblance between the coasts within the Great Barrier Reef with its numerous capes and outlying islets to those of Fiji, Tahiti, and other groups, which he claims proves his contentions. On the whole, the geological study of elevated reefs in Fiji, West Indies, and other lands is said to help on the same side; but anomalies exist, and there is often difficulty in settling the geological periods of the limestones. Meantime the history of Falcon Island, Tonga, has given striking proof of the possibility of the views of Wharton that many of the isolated atolls and submerged atoll banks of the world have foundations produced by submarine eruptions, the products of which are loose material, easily cut down to 40 or 50 fm. by the waves.

A discovery of volcanic ash off Providence Reef, between Madagascar and Seychelles, gives confirmation of this view, and indeed is the first definite indication of the foundations of any existing reef. Next came the gradual appreciation of the fact that most coral islands largely owe their existence to a change of level of at least 10 feet in the sea, a change usually explained by polar glaciation. Finally, Daly suggested that by the same means an alteration of as much as 250 ft. was possible, and that land, cut down to sea-level by oceanic agencies, might, by the melting of the polar ice caps, be submerged to this depth and so provide foundations for extensive post-Pleistocene reefs. This view would seem peculiarly attractive as applying to the Great Barrier Reef area, but Prof. Davis points out that the broadness of the continental slope off Queensland as compared with its narrowness in the southern half of the same coast is not consistent with the view, and that there are also material differences in the two coast lines.

Thus the controversy went on until the Governor of Queensland (the Right Hon. Sir Matthew Nathan), Prof. Richards, and others, formed the Great Barrier Reef Committee of Australia, recognising that the problem could only be solved by repeated observations on a coral reef area, preferably connected with a great land mass, the geological conditions of which could be studied for hundreds of miles inland. The Great Barrier Reef lies near the centre of the disturbance of earth movements,

which, according to one theory, produced arcs of reefs and islands on the crests of earth waves flowing over the Pacific. It also fringes part of a continent where the newer problems of weight pressures (isostasy) are being considered. The committee studied the geology of coastal areas, examined reefs and islands, and finally put down a boring on a reef near Cairns in the lagoon channel. It met with very great difficulties, owing to the loosely coherent nature of the material in the bore, but reached 100 fm. The bottom part contained many foraminifera and other organisms, which occur under quite shallow water conditions and on reef flats, so that, if the living forms are confined to such depths and are in their place of growth in the bore, there has been a subsidence of 600 ft.

In 1913 the late Dr. A. G. Mayor had made an ecological survey of Murray Island at the north end of the Great Barrier, mapping out the zones of life and correlating the distribution of species of corals with physical conditions. These he continued from 1915 until 1920 in Samoa, testing his conclusions experimentally by transplantation and other experiments. The biological work of the Australian committee had cognisance of this, but all the plans for further development were held up by the death of Mr. Charles Hedley, the biological director, and also, no doubt, by the universal scarcity of competent marine biologists. In these circumstances the committee invited the formation of a British committee to send out a biological expedition for the study of the many problems that arose as to the feeding, the rate of growth, the seasonal reproduction, the distribution, etc., of corals, foraminifera, sponges, and marine algæ, and as to the interrelations of these forms to one another in the building of reefs.

A study of the organisms together should lead to conclusions as to whether surface reefs are growing out, either seawards or lagoonwards. Linear surface changes can be perhaps better ascertained by aerial photography with three fixed permanent marks on some small reefs, these being repeated each decade; but unfortunately the changes are often subsurface, and sounding and dredging have to be undertaken as well. These should also give an account of upgrowth and loss on the lagoon floor, and for the former the association of the organic complex with temperature, with salinity, with acidity of the sea (pH) and with currents acting as food carriers, is all-important. Half-a-dozen genera of foraminifera, forming part of the cementing sand, live in the floating plankton of the outer ocean and pass within the reefs to destruction. Many of the building animals feed on small animal and plant organisms of the same habitat, and the plant builders depend on nitrates, largely produced there, as well as upon sunlight. The nutrition of the organic life is ultimately a matter of the chemical constituents and of the physical conditions of the water, and the governance of the varied seasons of reproduction is almost certainly the same, phenomena never up to the present studied in tropical seas. The expedition is to camp in its little area and to make weekly observations on such matters for twelve consecutive months. In its plan is revealed the advance of science, research directing its aims to the basal conditions governing all organic life, the period of general explorations being largely passed.

Finally, the Great Barrier Reef, with its 100,000 square miles of area capable of being developed for economic ends, may well be a matter of importance to the Empire in the future, and the close study of coral growth should at once yield results of value to navigators in all coral seas. Fish become of value in proportion to their quality, to their quantity, and especially to the distance of the fishing grounds from dense areas of consumption. As yet they may be of little importance, but the advance of freezing processes has brought to the fore the catching and distribution of fish from all seas. There is also the sea slug (trepang), an elongated starfish, dried and exported to China for soup. Good eating oysters are to be found in places, as well as many other edible molluscs. Next comes the pearl shell, used for buttons, for inlay, and for all sorts of beautiful ends, its value increased almost half by its contained pearls. There is a world shortage now in this, and the supply can no longer be left to Nature, since its possibilities of cultivation are proved; and Torres Straits is the home of its most valuable species. The uncontested sovereignty of the British Empire over the Great Barrier Reef from shore to ocean, however broad, suggests peculiar potentialities for such farming. Depths, too, are suitable for sponges, which likewise have to be grown by man, and there are other shells and products that can be sold. For all these—and indeed for fisheries of all classes—the first knowledge required is that of the water and its contained food, for these are fundamental to the knowledge of the optimum conditions of growth, of reproduction, and of distribution, on which commercial success depends.

We need say no more except to commend most highly this new development in research, the cooperation in equal partnership towards the highest scientific aims of committees thoroughly representative of Great Britain and Australia. We

feel that this is as things should be, and we trust that no questions of finance or of personnel will hinder the successful prosecution of this expedition. The sunshine of the tropics brings into prominence biological processes, such as the metabolism of lime, which in our northern climate are weakly developed and intermittent. The great Pacific Ocean forms a vast reservoir of water which ensures a constancy never to be found in the North Sea and the fluctuating English Channel. The co-ordinated work of zoologist, botanist, physiologist, chemist, and geographer for twelve consecutive months on the Barrier Reef should furnish results giving a new point of departure for our knowledge of the conditions of all life.

Science and Theology.

(1) *The Way of Modernism: and other Essays.* By the Rev. J. F. Bethune-Baker. Pp. vi + 150. (Cambridge: At the University Press, 1927.) 6*s*. net.

(2) *The Creator Spirit: a Survey of Christian Doctrine in the Light of Biology, Psychology, and Mysticism.* The Hulsean Lectures, Cambridge, 1926–27: The Noble Lectures, Harvard, 1926. By the Rev. Canon Charles E. Raven. With an Appendix on Biochemistry and Mental Phenomena, by Dr. Joseph Needham. Pp. xv + 310. (London: Martin Hopkinson and Co., Ltd., 1927.) 8*s*. 6*d*. net.

(3) *Life in the Stars: an Exposition of the View that on some Planets of some Stars exist Beings higher than ourselves, and on one a World-Leader, the Supreme Embodiment of the Eternal Spirit which animates the Whole.* By Sir Francis Younghusband. Pp. xiv + 222 + 4 plates. (London: John Murray, 1927.) 10*s*. 6*d*. net.

(4) *Contributions of Science to Religion.* By the Rev. Shailer Mathews, with the co-operation of William E. Ritter, Robert A. Millikan, Edwin B. Frost, Edward B. Mathews, C. Judson Herrick, John M. Coulter, Ellsworth Faris, Charles H. Judd, John M. Dodson, Charles B. Davenport, E. Davenport, C.-E. A. Winslow, Horatio Hackett Newman. Pp. xi + 427 + 5 plates. (New York and London: D. Appleton and Co., 1927.) 12*s*. 6*d*. net.

(1) THE theological readjustments which seem called for in consequence of an acceptance of evolution have recently been prominently discussed. Thus the time is opportune for the appearance of Prof. Bethune-Baker's essays. The writer's qualification is that he is an expert in the history of the development of Christian theology, who thus knows exactly what meaning orthodox dogmas originally had for those who formulated them. The importance of the theory of evolution for Christian theology cannot be exaggerated, since it supplies entirely new views both about man and about creation.

"I need not remind you that in our doctrine of Christ we are stating a doctrine both of God and of Man. We interpret Christ according to the ideas we have of God and Man, and our ideas to-day of God and Man are very different from those of Christians of the fifth century" (p. 13).

Man is no longer to be regarded as the victim of a 'fall,' but as the result of a long and painful struggle upwards. Thus, if the traditional anthropology is wrong, the traditional scheme of redemption requires revision. With regard to the traditional doctrine of creation, it depended on a view of God which regarded Him as apart from the world, whereas we tend to conceive of Him as immanent both in the world and in man. The traditional doctrine of the incarnation was framed to fit in both with the idea of fallen man who was apart from and distinct from God, and of a God who was, so to speak, outside His creation. It had to explain how two such incompatible natures could ever come to be combined.

"We do not get much help from our tradional statements of doctrine. Our technical definitions are frankly dualistic. They treat God and Man as two distinct real existences ('substances'), each with its own special characteristics, which are incapable of being blended or fused into one" (p. 100).

Prof. Bethune-Baker holds that the new evolutionary theology must present Christ as the consummator, that is, as one in whom the divine design for man finds expression. This design, which in Christ emerged in fullness, "is at the heart of the universe, the secret of its process, and its goal." This idea is found in the Fourth Gospel, with its doctrine of the divine 'logos,' or purpose, which was visibly embodied, so that "the ideal was seen, full of grace and truth, in all its attractiveness and power of revealing their true selves to men." It is found also, in language of astonishing modernity, in the famous eighth chapter of *Romans*, and elsewhere in the writings of St. Paul. This means that, although in Christ we have "an emergence of a new consciousness and a new quality, a new type, as it were, of manhood," yet the divine purpose which emerged in Him is one with the purpose that has emerged in Nature and in man. That is to say, there is no gulf between man and God; they are not incompatible substances. This is the sort of Christian theology, essentially orthodox as it is, which students of

science can understand; and Prof. Bethune-Baker deserves their gratitude.

(2) Canon Raven's book contains his Hulsean and Noble Lectures. As a distinguished naturalist as well as theologian, he speaks with authority for students of natural science. As Prof. Bethune-Baker's book is a protest against the antithesis between God and man, so Canon Raven's is a protest against a dualism of God and Nature. The manifestation of God in His creation has been neglected.

"There has been a general tendency in Christian thought to regard nature and the natural order, if not as inherently evil, at least as spiritually meaningless, a mere stage on which the divine drama of regeneration was to be played, or even a hostile environment from which men were to be set free" (p. 6).

Yet the modern outlook does not appear to make things easier:

"To earlier generations it was easier to assume that as God had made the world, it must all be very good, save where His plan had been upset by the wiles of Satan. . . . Of the awful indifference and machine-like fixity and terrifying scale of things, as of the evidences of struggle and cruelty and waste and suffering in the animal world, there was little consciousness. The outlook was frankly anthropocentric" (p. 9).

Canon Raven cannot reconcile modern cosmic pessimism with Christian theology. The God who is revealed in Nature must also be the God revealed in Christ (that is, in theological terms, "the Father" and "the Son" must be "of one substance"). This can only be grasped by thinking in terms of creative process. Its lower products may seem incongruous with its higher, but the process is one, and its purpose one. In other words, the unity of the world lies in the law of its development, and what that law is may be seen in the highest product of the process. Here Canon Raven brings us to the same point as Prof. Bethune-Baker, *i.e.* to the Johannine christology. The Word, or Purpose, was in Christ; in Him "the Word became flesh." Canon Raven interprets the evolutionary process, following Profs. Lloyd Morgan and Alexander, in terms of 'emergence,' and quotes the former as saying that "Emergent evolution is from first to last a revelation and manifestation of divine purpose" (p. 85).

What will specially appeal in this book to working biologists is the well-documented criticism of Weismannism in Chap. ii.; but the whole work may be said to be the ablest attempt made in recent years systematically to interpret the results of biological science in terms congruous to Christian belief.

(3) Sir Francis Younghusband's speculations about the possibility of life on the stars and of its nature, will interest many. Very few astronomers, perhaps, will have spent night after night, as has Sir Francis, in the waste and silent places of the earth under the vast vault of heaven, beholding "the terrors and splendours of the night." After all, if one star in a million were attended by such another planet as our own, "there would be at least five thousand suitable abodes." The poetic imagination of Dante led him to believe in the existence of such beings as Sir Francis suggests to us: beings far higher than ourselves, who may somehow shed abroad influences to reach as far as ourselves. This book, though speculative, is one of very great charm; it provides a pleasant antidote to the austere mathematical abstractions to which modern astronomy must confine itself.

(4) Dr. Shailer Mathews has edited a valuable collection of essays by experts in the different branches of natural science. The first part of the book gives us the facts, and the second part tells how this knowledge can be used for the benefit of humanity. The third and final section, written by Dr. Shailer Mathews himself, shows how science justifies the religious life and gives content to religious thought. Altogether a most valuable book, which ought not to be without its effect on the Fundamentalist controversy in America.

J. C. HARDWICK.

Coal Carbonisation.

(1) *Coal Carbonization, High and Low Temperature: a Treatise on the Principles and Processes of Manufacturing Coke and Semi-Coke.* By John Roberts. (The Specialists' Series.) Pp. xvi + 406. (London: Sir Isaac Pitman and Sons, Ltd., 1927.) 25*s*. net.

(2) *Oil and Retortable Materials: a Handbook on the Utilisation of Coal, Torbanite, Cannel and Oil Shale.* By George W. Halse. Pp. vii + 146. (London: C. Griffin and Co., Ltd., 1927.) 7*s*. 6*d*. net.

THESE two books exemplify the activity which is now being displayed in following up the possibilities of the carbonisation process in various directions, and the results of operating by methods removed in varying degrees from the standards of normal coke-oven and gas-works practice, including the treatment of raw materials other than ordinary coal.

In the first and longer work, the stress is laid upon carbonisation as a means of producing different varieties of solid fuel which can be grouped under the name of coke, while Mr. Halse's smaller book is inspired by the purpose of discussing what may be done to increase the production of liquid fuel in Great Britain by the utilisation of such materials as torbanite, cannel, and oil shale.

(1) Mr. Roberts's book sets out to deal with coal carbonisation at high and low temperatures, and there are several features in it which are noticeable and give it a character of its own. In the first place, more than in any other book with which the reviewer is acquainted, special attention is directed to the nature of the changes which coal undergoes in its transformation into coke, and the different factors which operate in determining the character of the final solid product of carbonisation. It is only during the last decade that our want of knowledge under this head has been properly appreciated, so that much of the experimental work which Mr. Roberts calls upon in his account of the coking process is quite recent, and has not come into book form before. He has marshalled his facts and arguments well, and reproduces a number of useful illustrations of coke formation under various conditions.

It would, however, be a mistake to suggest that this study of coke formation is the only outstanding characteristic of the author's treatment of his subject. Equally remarkable is the amount of ground which has been covered in gathering material of another kind bearing upon the numerous plants and processes which have been described in technical literature, and in patent specifications, for the carbonisation of coal at low and high temperatures. The book is packed with information of this kind, and it is given, so far as the reviewer has been able to see, with accuracy and clearness, collecting a mass of descriptive detail into a comparatively small volume of 400 pages.

This mode of treatment, to which we have become accustomed in books on technical subjects, although not always followed out with the same care and knowledge as is forthcoming from the author, has, however, its accompanying disadvantage. So many processes are described that the author plainly cannot claim first-hand knowledge of all, and is compelled to retail the claims made with little comment. The critical examination of processes necessary for their real evaluation is out of the question, from space considerations alone. The quantitative thermal and chemical aspects are necessarily given very little attention, partly from this want of space, and partly because the requisite data have never been acquired or never published.

Such a work as this should be read, however, by the serious student with the limitation above outlined clearly in mind, and that being taken for granted, he will find both interest and profit in following up the many ramifications of technical practice brought to his notice.

The newer developments are naturally in the main those associated with processes of low temperature carbonisation, and that for a very good reason. The success of such processes, if and when attained, depends largely upon their power of speeding up the transformation of carbonisation (as compared with the standard high temperature processes), so lowering installation and working costs per unit of coal carbonised. The fact that lower temperatures of working are employed permits the use of steel instead of fire-clay as the principal material of construction in the plant, and consequently permits also the use of new mechanical devices. This principle is employed in many of the plants of which descriptions are given by the author.

One feature of the book which is interesting, although it does not seem to find a natural place under the title, is a complete account of the author's views on the origin of anthracite, according to which the assumption has to be made that bituminous coal has been converted into anthracite by attaining a temperature of from 500° to 550° in the earth's crust while subject to great pressure. It should not be understood by the reader that the actual development of so high a temperature has been so far demonstrated as to be generally accepted.

Summarising, one may say that Mr. Roberts's book may be welcomed as treating the process of carbonisation comprehensively and well from a viewpoint which is not that of the gas engineer or the coke-oven manager, but has its advantages in making for originality and breadth. It is well printed, and the illustrations are numerous and well chosen for the author's purpose.

(2) Mr. Halse's book is much smaller and, as stated above, its range is much more limited. No attempt is made to describe processes in detail or to discuss the chemistry of them in any critical spirit. Its chief point of usefulness is in bringing together information, which until now has been scattered, on torbanites, cannels, and oil shales, in explaining what are the characteristics of these materials, and what processes have so far been

employed in utilising them for the supply of liquid fuel. The work of a number of authorities has been drawn upon in order to bring out the distinctions between coals, lignites, torbanites, etc., and this information has been usefully tabulated.

At the end of the book is a two-page glossary, but some of the information contained therein, such as that gels are "stable colloidal aggregations," does not in itself carry the average reader very far, while surely the definition of a British Thermal Unit and of a calorie might be taken for granted. The author claims quite rightly in justifying his book that "the importance of liquid fuel to national life cannot be over-estimated, and a right understanding of what has been accomplished towards making additional supplies available is of great moment." J. W. C.

Magnetism and the Electromagnetic Field.

Handbuch der Physik. Herausgegeben von H. Geiger und Karl Scheel. Band 15: *Magnetismus; Elektromagnetisches Feld.* Redigiert von W. Westphal. Pp. vii + 532. (Berlin: Julius Springer, 1927.) 43·50 gold marks.

IN a comprehensive treatise in many volumes there is a great danger of lack of co-ordination between the parts. Few individuals, and unfortunately not all scientific libraries, however, are likely to purchase all the twenty-four volumes of the "Handbuch der Physik," and in practice the utility of the work will depend largely on the independent value of single volumes. These suffer considerably from the general tendency to avoid any overlapping in the 'Handbuch' as a whole. Co-ordination is partly obtained by the systematic subdivision of the subject matter—in this respect the 'Handbuch' has been carefully planned—but the value both of the work as a whole and of the single volumes would have been greatly enhanced by a much more lavish use of cross-references. The lack of an author index is a considerable drawback. There are numerous footnote references, but short selected bibliographies to the separate sections, which would have been a useful feature, are only given in a few cases.

The 'Handbuch' may perhaps best be regarded as an ordered series of short monographs. Those in the present volume fall into two groups, dealing with magnetism and the electromagnetic field. In the first chapter, on magnetostatics, P. Hertz, using the conception of magnetic charge, develops in great detail the mathematical theory which may be built up on a few simple fundamental laws. The action at a distance and medium viewpoints are adopted successively and shown to lead to equivalent results. The treatment proceeds in stages of increasing generality—from the case where the permeability is unity to that where there is hysteresis—in a way which conduces to clearness but not to brevity. The second chapter, also by Hertz, is on the magnetic fields due to currents.

W. Steinhaus gives an account of the magnetic properties of materials in Chap. iii. The section on dia- and para-magnetism, which occupies 15 pages out of the total of 270 on magnetism in this volume, is very inadequate as an account of the present state of knowledge. The description of ferromagnetic phenomena, however, in particular of hysteresis and of temperature and magneto-mechanical effects, is excellent. It is unfortunate that the important investigations of the last few years on single crystals of iron could not receive notice. The specific heat of ferromagnetics, and the magneto-caloric effect, might have been briefly discussed in connexion with the molecular field hypothesis.

A most interesting chapter on ferromagnetic substances is contributed by E. Gumlich. The extensive material is admirably summarised. The effect of thermal and mechanical treatment, and of impurities, on the magnetic properties of iron and steel is fully described. A short section follows on cobalt and nickel, and 'cryptoferromagnetic' manganese. Finally, alloys of ferromagnetic metals and Heusler alloys are dealt with.

G. Angenheister gives an account of the observations on terrestrial magnetism and their interpretation in Chap. v. (The measuring instruments and methods, as for magnetism generally, are described in another volume.) The observational results are presented with the aid of a number of recent world and regional magnetic charts. The formal analysis of the results is given, and the various theories of the earth's permanent magnetism—none of them satisfactory—are considered. The character of the periodic changes is described, and then that of the aperiodic, and the two theories which connect these with the emission of electrically-charged particles, and of radiation from the sun, are discussed.

The second part of the volume opens with a chapter by S. Valentiner on the fundamental phenomena of electromagnetic induction, essentially those described by Faraday, presented clearly in the light of later developments. Coefficients of induction are worked out for a number of

special cases, and a most useful list of references is given.

R. Schmidt deals clearly and very completely with the analytical and graphical methods for the treatment of alternating currents in Chap. ii. In the third chapter, on electric oscillations, E. Alberti considers the behaviour of single and coupled closed circuits, the effect of iron cores, and also oscillations in open circuits.

The last chapter, on the dispersion and absorption of electric waves, is by W. Romanoff. An outline of the theories and of the experimental methods is first given. It is only in the last few years that convenient valve methods for the production of short undamped waves have become available, which will enable satisfactory experiments to be carried out in this difficult region of investigation. Much of the older work is of doubtful value, but the coherent account of some of the more satisfactory results, and their comparison with theory, will form a valuable basis for further research.

Although the volume suffers from the drawbacks which have been mentioned, it is a mine of information on those particular aspects of physics with which it deals. As an example of book production the standard is high. The printing of both the text and diagrams is admirable.

E. C. S.

Our Bookshelf.

The Druids: a Study in Keltic Prehistory. By T. D. Kendrick. Pp. xiv + 227. (London: Methuen and Co., Ltd., 1927.) 12*s.* 6*d.* net.

In this book Mr. Kendrick is decidedly an iconoclast. Ideas relating to the Druids which have taken a firm hold on the popular imagination are carefully weighed and found wanting. First among them is the tradition which connects the Druids with Stonehenge and other megalithic monuments. Mr. Kendrick shows that this connexion cannot be traced back to a period earlier than the seventeenth century, when Aubrey claimed Stonehenge for the Druids and interest in these functionaries was beginning to revive after their eclipse dating from the Saxon invasion. It is to be noted that Geoffrey of Monmouth in his well-known description of Stonehenge makes no allusion to the Druids.

Mr. Kendrick's aim is to clear away the cloud of misunderstanding and vain imagining which has gathered round the Druids by bringing together in a critical synthesis all that is known positively from historical records of their organisation, ritual, and beliefs, together with such inferences as may legitimately be drawn from the archæological data relating to the period. A recital and examination of the multitudinous theories which have been formulated on the subject is therefore beyond his purpose, and his own speculations on the subject have been reduced to a minimum. It is to be noted that although he rejects the responsibility of the Druids for Stonehenge and megalithic monuments, necessarily as the monuments must for the most part belong to an earlier period, he suggests that they may possibly have used them at some later period for their ritual observances. Gratitude is due to Mr. Kendrick for his admirably judicious and judicial sifting of the material, even if he has dispelled some cherished illusions in the cold light of reason.

Gmelins Handbuch der anorganischen Chemie. Achte völlig neu bearbeitete Auflage. Herausgegeben von der Deutschen Chemischen Gesellschaft. Bearbeitet von R. J. Meyer. *System-Nummer* 2: *Wasserstoff.* Pp. xvi + v + 273. (Berlin und Leipzig: Verlag Chemie G.m.b.H., 1927.) n.p.

More than half this volume is devoted to a detailed description of the physical properties of hydrogen, which is perhaps not astonishing when one considers the exceptional interest which belongs to the simplest of the elements. In the discussion of atomic structure the term hydrogen-nucleus (*H-Kern*) is generally used, but Rutherford's convenient term 'proton' is mentioned as being preferable to other suggested names. Atomic weight estimations are given in detail from the time of Berzelius to the year 1926.

Mechanical, thermal, optical, magnetic, and electrical properties of hydrogen and also hydrogen-electrodes are discussed fully. Considerable space is also devoted to the technical preparation of hydrogen on a large scale. The chemical section deals with the behaviour of the gas towards metallic compounds and aqueous solutions of salts, with catalytic hydrogenation and with analytical methods. There is also a special account of the hydrides, which are classified as (*a*) *metallic* hydrides, in which varying amounts of the gas can be absorbed into a homogeneous phase, the character of the metal itself and its lattice structure remaining intact; (*b*) *salt-like* hydrides, which are definitely polar, in which the hydrogen possesses the character of a negative ion (*e.g.* hydrides of the alkali and alkaline earth metals); and (*c*) *gaseous* hydrides, which are either gases or volatile liquids at ordinary temperatures. This class includes hydrides of bismuth and lead. The volume closes with an account of triatomic hydrogen, H_3 produced with the aid of positive rays.

Theoretical Mechanics: Statics and the Dynamics of a Particle. By Prof. William Duncan MacMillan. Pp. xviii + 430. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1927.) 25*s.* net.

As the author of this book remarks, mechanics is a difficult subject not merely for the student but also for the race, as is evident by the fact that it came into existence two thousand years later than its allied subject geometry. In our time, however, it has also become a difficult subject for the textbook writer. Torn as he is between the practical

necessity of retaining the framework and development of the Newtonian viewpoint and a desire to disavow the older conceptions of mass, energy, and force, this attempt to keep a foot in each camp is often more amusing than successful.

Admitting the difficulty, however, as more or less inevitable at the moment, this text-book is undoubtedly one to be recommended. Its style and its manner of presentation convey the impression that it is written by a good teacher. Wherever possible vectorial methods are utilised, and the fundamental principles are clearly and deliberately stated.

Part 1 deals with vectors and kinematical and geometrical concepts; Part 2 with statics of particles, rigid bodies, and deformable bodies, very clearly and easily developed; Part 3 with the dynamics of a particle, including a treatment of least action, Hamilton's principle, and Gauss's principle of least constraint. There are in all sixteen chapters, most of which are supplied with copious examples.

The British Journal Photographic Almanac and Photographer's Daily Companion: with which is incorporated The Year Book of Photography and Amateurs' Guide and The Photographic Annual, 1928. Edited by George E. Brown. Pp. 788 + 63 plates. (London: Henry Greenwood and Co., Ltd., 1928.) 2*s*. net.

THIS *Annual* continues to move in the direction of the character of other photographic annuals, though it remains unique as it preserves all its old features, except, indeed, that it is no longer an almanac. It contains twice as many pictorial photographs as last year's volume, and these are excellently reproduced in photogravure by the Vandyck Printers, Ltd. The special editorial article refers to the world-wide applications of photography, and other articles are on snapshots, amateur kinematography, and printing borders on development papers. The epitome of the year's progress, classified formulæ, tables, directories, legal details, and other useful information follow. It is worthy of note that the tables—optical, weights and measures, concerning exposure, and many other matters—are so numerous that for very many years it has been the custom to give a selection only of what would be possible and useful, but a classified and dated list is given of those published in past annuals that are not included in the present. The volume is practically indispensable for those who are in earnest in their photography, whatever the character of their work may be.

The Industrial Chemistry of the Fats and Waxes. By Prof. T. P. Hilditch. (Industrial Chemistry Series.) Pp. xv + 461. (London: Baillière, Tindall and Cox, 1927.) 18*s*. net.

THIS work is divided into ten sections, to each of which is appended a useful and up-to-date bibliography. An account of the chemical nature, analytical examination, and composition of fats and waxes is followed by a description of methods used in the extraction, refining, hydrogenation, and hydrolysis of fats. More specialised sections deal with the edible fat and soap industries; the use of fats in the manufacture of candles, illuminants, paints, linoleums, etc.; the production of glycerine; and the nature of fatty lubricants. The text contains a large number of useful tables and summaries, but illustrations and diagrams have been dispensed with. The book, written by an author possessing first-hand knowledge, provides a sound, workmanlike, and remarkably compact survey of an important field of applied organic chemistry, and it may be recommended to the student and research worker as well as to the industrial chemist.

Fogs and Clouds. By W. J. Humphreys. Pp. xvii + 104 + 96 plates. (London: Baillière, Tindall and Cox; Baltimore, Md.: Williams and Wilkins Co., 1926.) 18*s*. net.

CLOUDS have special importance to all who are interested in weather, now that forecasts are no longer based almost entirely on the movements of cyclones and anticyclones; we realise that the conditions are dominated by warm and cold parts —the boundary surfaces between air-masses at different temperatures; and so ability to recognise the clouds which mark these surfaces may give invaluable information. The different types of clouds are here systematically arranged, with a promising suggestion for an abbreviated nomenclature, and there are useful discussions of the physical processes involved, such as that of the mode by which 'the moon eats the clouds.' The author has also included a number of less familiar types, such as 'helm bars,' 'crest clouds,' 'cumulus boas,' and 'scarf clouds.'

Nature lovers will congratulate the author on the extent to which the photographs render the glory of a cloud-flecked sky; and there are excellent reproductions of lightning, of a rainbow, and of a halo with a parhelic circle.

Chambers's Encyclopædia: a Dictionary of Universal Knowledge. New edition. Edited by Dr. David Patrick and William Geddie. Vol. 10: Teinds to Zyrians. Pp. iv + 819. (London and Edinburgh: W. and R. Chambers, Ltd.; Philadelphia: J. B. Lippincott Co., 1927.) 20*s*. net.

THE concluding volume of the new edition of this encyclopædia has been revised up to the date of issue. As in the earlier volumes, there is a number of new maps, among which the orographical layer-coloured maps illustrating the article on the world-war may be mentioned for their special excellence. The completed encyclopædia forms an almost indispensable addition to modern works of reference. It is the custom in this encyclopædia to preface each volume with a list of the authors of only some of the articles: the others are anonymous. By way of criticism it is suggested that the authorship of the longer articles should be given, as is not always the case, while that of many short ones that afford no scope for original treatment could well be omitted if space is the chief consideration.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Distribution of Ionised Oxygen in the Gaseous Nebulæ.

THE suggestions made by Bowen in NATURE of Oct. 1 as to the probable origin of the well-known 'nebulium' doublet λλ5007, 4959, and of the strong radiations sometimes occurring at λλ3727, 9, have been confirmed by Prof. A. Fowler (NATURE, Oct. 29), and so generally accepted that it may not be premature to discuss the actual distribution of these radiations in the gaseous nebulæ on the assumption that the first doublet represents O III (twice ionised oxygen) and the second O II (once ionised oxygen). It is first of all important to note that there is no recorded evidence of the existence of the neutral atom of oxygen in the gaseous nebulæ, although some of the strongest lines, being in the extreme red, are beyond the reach of the apparatus usually employed. Neither can I find any references which support Bowen's statement that "the [gaseous] nebulæ are known to emit the well-known spectra of highly ionised nitrogen and oxygen." The most exhaustive study yet published of the nebular lines is that by W. H. Wright in *Lick. Obs. Pub.*, vol. 13, but although one line each is ascribed to neutral carbon and nitrogen, there is no identification with oxygen. On the other hand, the doublet λλ5007, 4959 is present in all cases considered, a total of 47 planetaries and the Orion nebula.

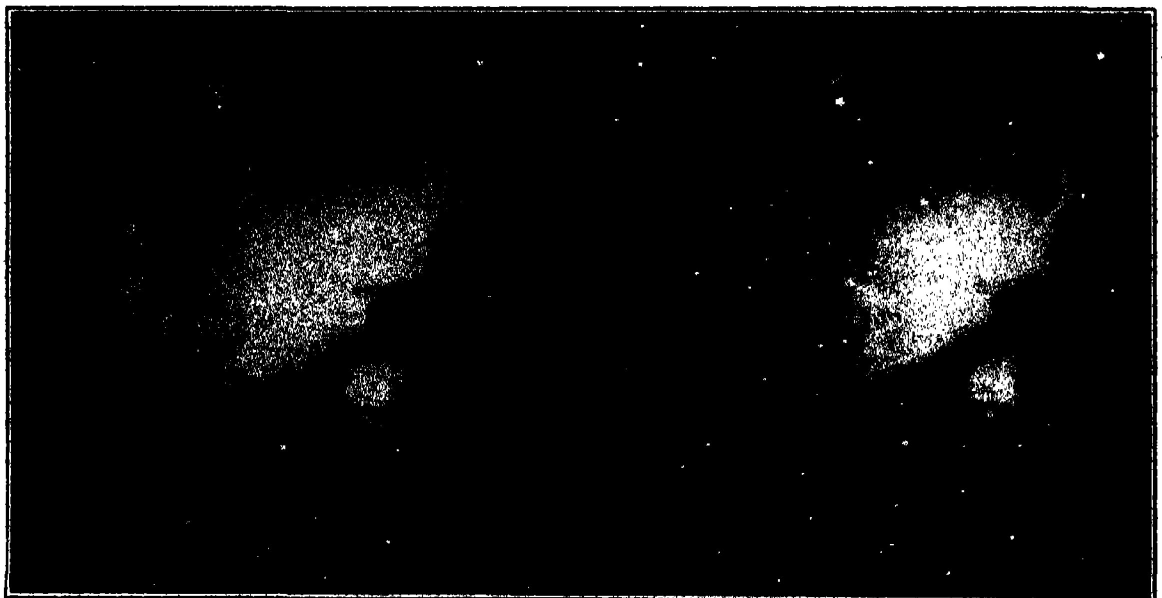
It was noted in the case of the Orion nebula visually by Campbell at the Lick Observatory in 1893 that these lines, although invariable with respect to each other, varied considerably in intensity in comparison with the neighbouring line H_β. In the regions round θ Orionis, λ5007 was four times as bright as H_β, but as the slit was moved away from the trapezium region the comparative intensity changed until H_β was much brighter of the two. The same concentration of λλ5007, 4959 within the inner regions is also marked in the planetaries photographed with a slitless spectrograph appearing in the Lick volume already mentioned.

In 1905, Hartman attempted to isolate the doublet by means of a green screen and an isochromatic plate, but it is doubtful whether the hydrogen radiations H_β and H_γ were satisfactorily eliminated in the direct photograph of the Orion nebula he obtained, as my own results with greater precautions to get rid of these radiations did not give such an extended image, although the Huyghenian region came out very strongly, in this respect agreeing with Campbell's visual observations.

It is, of course, only to be expected that the doubly ionised state of the oxygen atom should be found principally in the regions of the nebula most influenced by the B type stars of the central region.

The distribution of O II in the Orion nebula is, on the other hand, remarkable both for its great extent and for its intensity. The image ordinarily obtained when an exposure is made with an undyed rapid plate is to a large extent produced by this radiation in the ultra-violet, as such a plate is practically insensitive to the radiations λλ5007, 4959. The only other important radiations in the sensitive range are the hydrogen radiations from H_γ to the head of the Balmer series, and as these decrease in intensity rapidly towards the ultra-violet, the main radiations are H_γ, H_δ, and H_ϵ. If, therefore, an exposure is made with an æsculine screen cutting off the ultra-violet beyond λ4000, an image is obtained which consists almost entirely of hydrogen radiations.

On the other hand, an exposure with a screen of thin nickel oxide glass, transmitting 70 per cent. at λ3800, but cutting off the visual spectrum except at the extreme red, gives an image consisting almost entirely of λλ3727, 9. This piece of work was undertaken some years ago by me at Harborne, and at Helwân Observatory with the 30-in. reflector, and the results obtained are here reproduced. There can be no doubt that the differentiation of the hydrogen



(a) (b)

FIG. 1.—Screened photographs of the Orion nebula. (a) λ3727; 47 min. exposure. (b) Hydrogen; 40 min. exposure.

and O II images has been actually attained, as there are marked differences of detail as well as of distribution in the two images. Take, for example, the long scimitar-like projection on the right-hand side of each photograph with its companion, or the star, indicated by a cross in Fig. 1, on the outskirts of the nebula, which is surrounded with hydrogen nebulosity, but is clear of O II.

It has already been remarked that the stars involved in the central regions of the Orion nebula are B type stars, and the radiations λλ3727, 9 exceptionally strong. As a matter of fact, these radiations are either very faint or absent altogether in many of the planetary nebulæ, where the stars are almost invariably O type of much higher temperatures, although a radiation of shorter wave-length at λ3426 is often present. A conspicuous radiation at λ3869, as yet unidentified, sometimes appears in place of λ3727, although both are present in a few cases.

A comparison of the intensities of λ5007 (O III) with λ3727 (O II) in the list of planetaries given by Wright (*loc. cit.*) brings out certain features of interest.

The spectrum of N.G.C. 40 is unique, for although the slitless quartz spectrograph shows a conspicuous image at λ3727 there is no image at λ5007, but there is a trace of this radiation in the slit spectrograph exposure.

In three other cases (I.C. 418, N.G.C. 6720, and B.D. 30° 3639) λ3727 is brighter than λ5007. In ten instances λ3727 is absent altogether, with a trace only in two cases, altogether about 25 per cent. of the whole. In nine objects also λ5007 is ten times the intensity of λ3727, so it appears that the conditions favourable for the continuous existence of O II in any comparative quantity are absent in many planetaries. In all the planetary nebulæ the governing factor is undoubtedly the surface temperature and physical condition of the nuclear stars. Thirty of these stars are bright enough to yield a spectrum, and all these show the characteristic extension into the extreme ultra-violet denoting O type stars. Half of them contain bright bands, the other half are absorption spectra. There seems, however, to be no correlation between these divisions and the presence or absence of λ3727.

J. H. REYNOLDS.

Low Wood, Harborne.

The Affinity of Different Types of Enzyme for their Substrates.

IT is well known that as the concentration of substrate molecules is increased, other conditions being kept constant, the rate of catalysis of a reaction by an enzyme reaches a maximum value. On the view that the enzyme-substrate complex is a chemical compound, this is due to the combination of every enzyme molecule with the substrate or its products; on the theory that the union is adsorptive, it is due to saturation of the enzyme surface. On either hypothesis the substrate concentration at which half the maximum velocity is reached furnishes a measure of the affinity between enzyme and substrate. If, as is often the case, the law of mass action is followed, it is, of course, the dissociation constant of the enzyme-substrate compound, and the reciprocal of the affinity constant.

I have collected from the literature such apparent dissociation constants for 44 enzymic reactions. When these are expressed in molar concentrations, the enzymes fall fairly sharply into three groups. Group 1, of low affinity, includes the hydrolytic enzymes acting on crystalloidal substrates, and also yeast carboxylase and liver catalase. Ten of these enzymes, catalysing 21 different reactions, give dissociation constants ranging from 0·003 M up to at least 0·7 M. Their affinities for substances related to their substrates which inhibit the reactions are of the same order of magnitude, but on the whole less. Two hydrolytic enzymes, bone phosphatase and liver lipase, yield values at present undetermined, but less than 0·003 M and 0·005 M respectively.

Group 2, of medium affinity, consists of the enzymes which hydrolyse colloidal substrates, namely, the proteins and higher polysaccharides. The rather dubious dissociation constants for these substances mostly, if not all, lie between 5 per cent. and 0·1 per cent., or, taking probable molecular weights, in the neighbourhood of 10^{-4} M.

Group 3, of high affinity, consists of the only oxidising-reducing enzymes other than catalase so far studied from this point of view. The values are:

Plant peroxidase .	. 5×10^{-6}M	[Willstätter & Weber[1]].
Milk xanthine-oxidase	$<3 \times 10^{-6}$M	[Dixon and Thurlow[2]].
Yeast oxygenase .	$<6 \times 10^{-7}$M	[Warburg[3]].

The substrates were hydrogen peroxide, xanthine or hypoxanthine, and oxygen, respectively. It should be added that xanthine oxidase also slowly catalyses the oxidation of acetaldehyde, but in this case the apparent dissociation constant is of the order of 1 M. In the case of laccase, the concentrations of guaiacol giving half the maximum velocity vary with *p*H between about 0·1 M and 0·003 M [Fleury[4]]. But laccase is probably a mixture of enzymes including peroxidase, in which case Willstätter and Weber's results make it unlikely that such observations furnish a measure of enzyme-substrate affinity. Biological surfaces which act as catalysts of oxidation, but cannot be brought into colloidal solution, and are, therefore, probably best not included under the designation of enzymes, yield apparent dissociation constants covering a wide range.

While the moderately high affinities of the amylases and proteases may be regarded as an adaptation to the colloidal nature of their substrates, it seems likely that the very high affinity of the oxidases is due to a real difference in the mode of their union with their substrates and that of other enzymes.

J. B. S. HALDANE.

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Pleochroic Haloes and the Age of the Earth.

DR. LOTZE offers the suggestion, in NATURE of Jan. 21, that the effect of the alpha ray in promoting, according to Mügge, "isotropy in minerals, loosening of the crystal lattice, and alterations in cohesion," would account for the unexpectedly large radius of the inner ring of palæozoic uranium haloes.

The stopping power, as all know, is dependent upon the atomic weight of the atoms encountered (Bragg and Kleeman). The density of the medium is therefore involved; and I assume it is to changes in this, brought about by the rays themselves, that Dr. Lotze refers his suggested explanation.

Now the observed discordance of the radius of the inner halo ring with the ionisation curve for uranium and its derivatives is more than 10 per cent. of the estimated radius (*Phil. Trans.*, **217**, pp. 51-79). Can the changes which Dr. Lotze postulates be responsible for so great a reduction of density? It seems very improbable. If this considerable loss of density existed, we would expect some optical indications of its existence. But nothing abnormal, compared with the other halo rings, is visible.

[1] Willstätter and Weber, *Ann. Chem.*, **449**, p. 156; 1926.
[2] Dixon and Thurlow, *Biochem. Jour.*, **18**, p. 976; 1924.
[3] Warburg, *Biochem. Zeit.*, **189**, p. 354; 1927.
[4] Fleury, *Jour. de Pharm. et Chim.*, **2**, p. 105; 1925.

Dr. Lotze does not specially refer to the emanation halo. In this case there is a single steep curve of ionisation rising to more than half the height of the crest responsible for the inner uranium ring. That is to say, rather more than half the ionisation intensity is operative in the formation of the emanation ring. Moreover, these emanation haloes are often of exceptional delicacy of definition and in the mica of Ballyellen are abundant. But no outward displacement of these rings is observable: but rather there is a tendency in the opposite direction—very slight, it is true.

Again, in the case of the thorium halo, the intensity of the ionisation upon which the effect should depend is about half that of the first uranium ring, but no irregularity is detectable (*loc. cit.*).

Papers in the January and February numbers of the *Philosophical Magazine* of the current year, by Dr. J. H. J. Poole, deal with a theory of the mode of formation of haloes in biotite, which should be considered in connexion with Dr. Lotze's suggestion. According to this theory, the formation of the halo in biotite is due to the decomposition, by the alpha ray, of the water which enters into the composition of the mica. It is assumed that the liberated and ionised oxygen combines with the ferrous iron present, thereby deepening the colour of the mica. That this theory, or some modification of it, adequately accounts for the genesis of the halo is, I think, very probable.

Now, variations in the density may attend these chemical changes, for it is possible that a part of the hydrogen might gradually escape by diffusion. At first sight this might seem to support Dr. Lotze's theory. But it is easy to show that the loss of the whole of the hydrogen would not suffice to reduce the specific density by as much as one per cent. This very probable theory of the inner mechanism of halo-formation therefore gives no support to Dr. Lotze's suggestion.

J. Joly.

Iveagh Geological Laboratory,
Trinity College, Dublin.

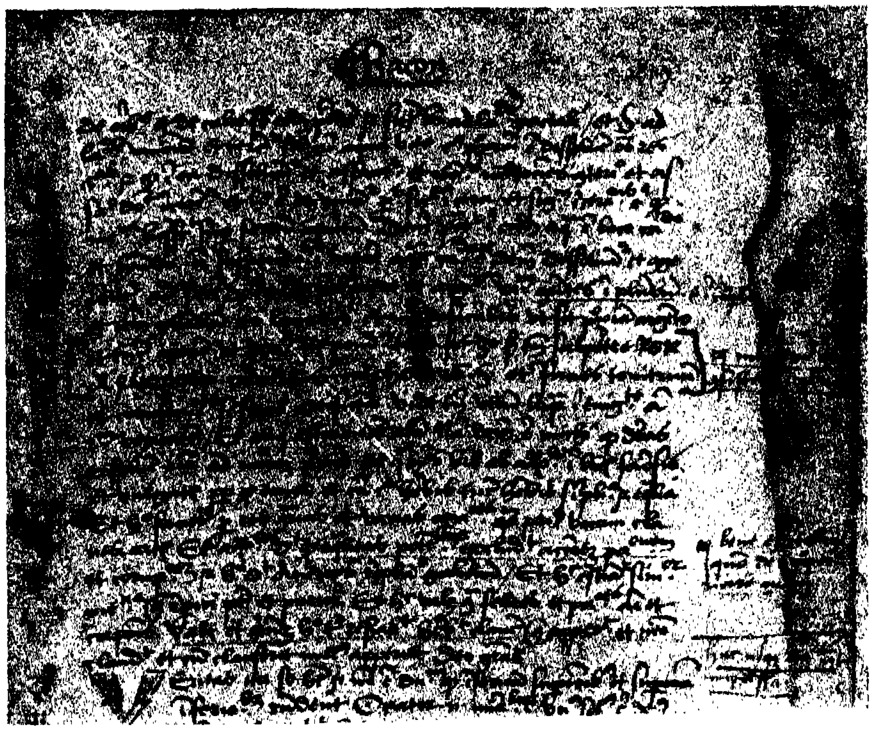

Fig. 1.—Harleian Manuscript. The passage containing the cipher is marked 1.

Luru Vopo Vir Can Utriet.

Every now and then a fresh attempt is made to solve this cipher attributed to Roger Bacon in the "Epistola de secretis operibus artis et naturæ et de nullitate magiæ" (see for example, Nature, Sept. 4, 1926, p. 352). These words have no manuscript authority whatever; they appear for the first time in an edition of the "Epistola" printed in Paris in 1542 from a poor MS., and seem to be due to an attempt to reproduce the text before him by the editor, Orontius Finé. The passage reads thus:

"Sed tamen salis petræ LVRV Vo Po Vir Can Vtriet sulphuris et sic facies tonitruum . . ." (f. 52). All later printed versions are corrected from this.

Only two manuscripts of this part of the "Epistola" are known—both in the British Museum, Harleian 3528 (1) and Sloane 2156 (2). A third at Quaracchi, of which I have obtained photographs, leaves a blank where the cipher should be. As will be seen from the reproductions (Figs. 1 and 2), the cipher was originally written in Greek characters, which in the course of two centuries of copying have become entirely transformed. It is probable that if any cipher was used at all, certain of the letters were altered to those immediately preceding or following them, for example, blchkmkb—alchimia.

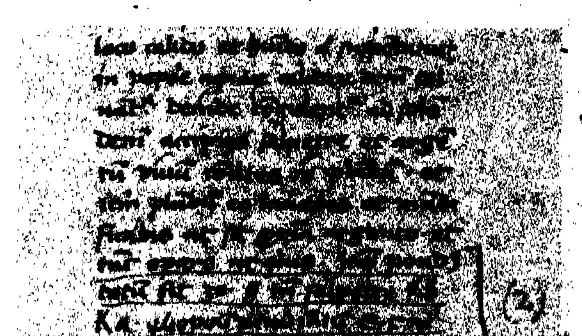

Fig. 2.—Sloane Manuscript. The passage containing the cipher is marked (2).

The relevant words in these reproductions are:

"Item pondus totum sit 30; set tamen salpetre . . ." The next signs read K 6, K 7—the K may

be R. Prof. Minns, who has kindly studied these photographs, writes that the following group of six signs may suggest *ανθρακ*; the sixth sign is, however, the number 6, which with another 6 and the final 5 make up the 30 of the text. The *þ* following the group does not suggest any meaning. The following group of seven letters is read as salikis, followed by 6. The last group is read sulphouris, 5. It is obvious that this first attempt at reading the cipher is unsatisfactory, and as the "Epistola" must be reprinted with Bacon's alchemical works, I should be grateful for any help that can be given. Brewer in 1859 read No. 2 as KB/KA/φhoþos þcaδικιs ε.Γ. vel PHOSRIS. S.,

Another interesting question is the equation of LVRV Vo Po, etc., to the letters of the Greek as a help to the reconstruction of the original passage.

Robert Steele.

Savage Club,
London, W.C.

The Pharmacological Action of Chloralose.

Chloralose was introduced some years ago by Richet for experiments on animals. The chloralose used in our experiments was obtained from Messrs. Baird and Tatlock, Ltd., but its origin is unknown. We have been informed that it is prepared by heating an anhydrous mixture of chloral and glucose at 100° C. for about one hour. The residue is treated with a little water and then boiling ether, and the toxic isomer, parachloralose, is eliminated by crystallisation. The formula is $C_8H_{11}O_6Cl_3$.

When a solution of chloralose saturated at 40° C. is injected intravenously into the decerebrate cat, we have observed an extraordinary action on the nerves. On stimulation of the splanchnic nerve, the normal rise of blood-pressure is increased to an almost incredible degree. Repeated injection of 10 c.c. of the solution at intervals results in still further increasing the rise.

Its action on the somatic nerves is apparently of an opposite nature; for example, stimulation of the sciatic and anterior crural nerves gave no reflex results, thus demonstrating an inhibitory effect.

The full effect of chloralose in the respects mentioned is not manifested immediately. There is a gradual exaggeration of the rise with the lapse of time, the maximum result being obtained approximately thirty minutes after the injection.

This remarkable effect of the increase of the rise of blood-pressure due to stimulation of the splanchnic nerve is not seen if clips are placed on the adrenal veins. It is thus evident that the action of the drug is through the medium of the adrenal bodies, and it seems likely that it is that part of the rise of blood-pressure normally due to liberation of adrenin which is increased by the action of chloralose.

When the semi-lunar ganglia on both sides are removed and the fibres to the adrenal bodies are stimulated, the rise of blood-pressure is very markedly increased by the injection of chloralose into the adrenal bodies. Thus it appears we have in chloralose a marked stimulant to the adrenal bodies, and the action appears to be on a local mechanism consisting of the gland itself, and the nerve fibres reaching it from the semi-lunar ganglia.

Intravenous injection of a mixture of chloralose solution (saturated at 40° C.) and adrenin (1 in 100,000) causes the ordinary transitory rise of blood-pressure obtained by injection of adrenin alone to be converted into a large and long-sustained rise of blood-pressure. A similar curve is obtained when adrenin is administered to a decerebrate animal under chloralose.

It has been suggested to us that this 'stabilising' of adrenin action by means of chloralose may be of therapeutic value.

Swale Vincent.
J. H. Thompson.

Dept. of Physiology,
Middlesex Hospital
Medical School, W.1.

Dug-out Canoe in Algoa Bay.

With regard to the recent correspondence in Nature on the derelict canoe washed ashore in Algoa Bay, I have now received information from Lieut.-Col. M. L. Ferrar, Chief Commissioner, Andaman and Nicobar Islands, that it was reported in October 1925 that the sailing ship *Sree Shanasckthi* picked up three Nicobarese who were found clinging to a submerged canoe, which would have been of the ordinary size, holding six to eight people. These men belonged to Lapati, Car Nicobars. In the Albany Museum, Grahamstown, there are pieces of pumice from the Krakatoa eruption, that were washed ashore in South Africa; they have been preserved with all the barnacles and seaweed adhering, just as they arrived. I saw the Port Elizabeth canoe shortly after it had been pulled out of the water, and the encrusting material was identical in kind, showing both had been submerged for the same time, under similar conditions. Some part must have been above the sea for them to have caught the monsoon wind that drove them across. If the boat is from Car Nicobars, then it took sixteen months to come to South Africa, and somehow I think that four months is more likely correct. I am still inclined to place the origin in the Mergui Archipelago, because of the spoon-shaped fore-foot, and general shape.

E. H. L. Schwarz.

6 Boundary Road,
Swiss Cottage, N.W., Jan. 16.

The Two Calories.

The suggestion made by Dr. Russell in his letter in Nature of Feb. 4, that the kilowatt hour with its multiples and submultiples is the best unit of heat, is not new. Some years ago Ostwald proposed the unit of a kilojoule, and recalculated all the thermal data to the new unit. The figures will be found in his "Grundriss der allgemeinen Chemie," 1909. The reason why such a unit is not adopted in thermochemistry is that all the data would then depend on each redetermination of the mechanical equivalent of heat. The accuracy with which the latter is known probably does not, as yet, exceed one in a thousand, and thermochemists prefer not to have an error of this magnitude involved in determinations which are claimed to have an accuracy of one in ten thousand.

J. R. Partington.

Kingsbury Close,
London, N.W.9.

Eyeglasses and the Microscope.

With reference to T. H. T.'s suggestion (Nature, Jan. 28, p. 137) for dealing with eyeglasses while using the microscope, I find it quite sufficient to remove the cap from the eyepiece of the microscope; this allows the eye to approach to the right distance and at the same time keep the vision corrected for astigmatism. Of course with modern students' microscopes, which usually are not fitted with eye caps, this cannot be done, and astigmatism has to be put up with.

T. J. Briant.

The Bicentenary of John Hunter.

By Sir Arthur Keith, F.R.S.

Consider for a moment the unenviable position of John Hunter's two executors in the year 1793—his nephew Dr. Matthew Baillie and his young brother-in-law, Mr. (later Sir) Everard Home. Hunter's sudden death on Oct. 16, 1793, in his sixty-sixth year, left on their hands a huge establishment running from Leicester Square to Charing Cross Road—just to the south of the site now occupied by the Alhambra Music Hall. The income of the establishment had suddenly ceased; a sum of more than £10,000 a year was needed to keep it going. A brief search showed them that the place was in debt; bills had to be met. Hunter's carriage 'blood-horses' and coach had to go; Mrs. Hunter, brilliant and fashionable, had also to part with her coachman, her carriage, her horses, and sedan chair. Pictures, books, furniture had to be sold to provide Mrs. Hunter and her daughter with a modest shelter in Brighton. The weekly wage bill had to be reduced; the staff, numbering more than a score, was reduced at a stroke to one—Mr. Hunter's young museum assistant, William Clift.

Fig. 1.—The statue of John Hunter, executed by Weekes and erected in the Royal College of Surgeons, London, by public subscription in 1858.

What was to be done with the Museum which Hunter had erected in the yard or garden of his premises? On this treasury he had lavished every sovereign he could earn or borrow, and every hour he could steal from practice, hospital, and sleep. It was the harvest of an intense lifetime. After seven years of 'lobbying,' the two executors succeeded in persuading a government in search of money to wage successful war with France, to buy Hunter's museum for £15,000. The collection was handed over to the Corporation of Surgeons in 1800; that body obtained at the same time a new charter, became the College of Surgeons, and established itself and its museum on the south side of Lincoln's Inn Fields—where both still flourish.

The two executors continued to believe in Hunter's greatness, as may be seen from the following quotation taken from the issue of the College calendar for the present year:

"In the year 1813, Dr. Matthew Baillie and Sir Everard Home, Bart., executors of John Hunter, 'being desirous of showing a lasting mark of respect' to the memory of the late Mr. John Hunter, gave to the College the sum of £1684 : 4 : 4, three per cent. Consolidated Bank Annuities for the endowment of an annual oration, to be called the Hunterian oration, and to be delivered in the theatre of the College on the 14th of February, the Birthday of John Hunter, by the Master, or one of the Governors for the time being, or such other member of the Court of Assistants as should be appointed—such oration to be expressive of the merits in Comparative Anatomy, Physiology, and Surgery, not only of John Hunter, but also of all such persons as should be from time to time deceased, whose labours may have contributed to their improvement or extension."

The first oration was given in 1814 by Sir Everard Home; last year it was delivered by the president of the College, Sir Berkeley Moynihan; this year Sir Holburt Waring is Orator, and will take the opportunity of measuring the debt which modern surgery owes to discoveries made by chemists and by physicists. Hunter's two executors were interested

parties; were they justified in launching on succeeding generations this act of Hunter worship? Is Hunter's memory being kept alive by a species of 'artificial respiration'? Many younger surgeons would return a frank affirmative; what Hunter thought and did, they hold, has no bearing on the surgical problem of the twentieth century. With whom lies the truth? With the executors, or with these modern critics?

Before seeking to measure our indebtedness to Hunter, let us first inquire how a youth—the youngest of a family of ten, bred on a bleak upland farm some eight miles southward of Glasgow, succeeded in establishing himself in London as the leading surgeon of his day. John Hunter's career was determined in 1736; "Jockie," then a spoiled boy of eight, was running wild at home, while his brother William, ten years his senior, had finished with the University of Glasgow and was thinking of the Church as a career. It was in this year that a young practitioner — William Cullen by name — settled in the neighbourhood. In due time he was to become the great Dr. Cullen and hold in medicine much the same position as his contemporary Samuel Johnson held in literature, but in the meantime we are concerned with him merely as medical attendant on the Hunter family. He recognised William's ability; took him into his house as pupil-apprentice; put him in touch with the medical problems of the time, and showed him how the leading minds of Europe were seeking to solve them. We are indebted to Cullen for the medical Hunters.

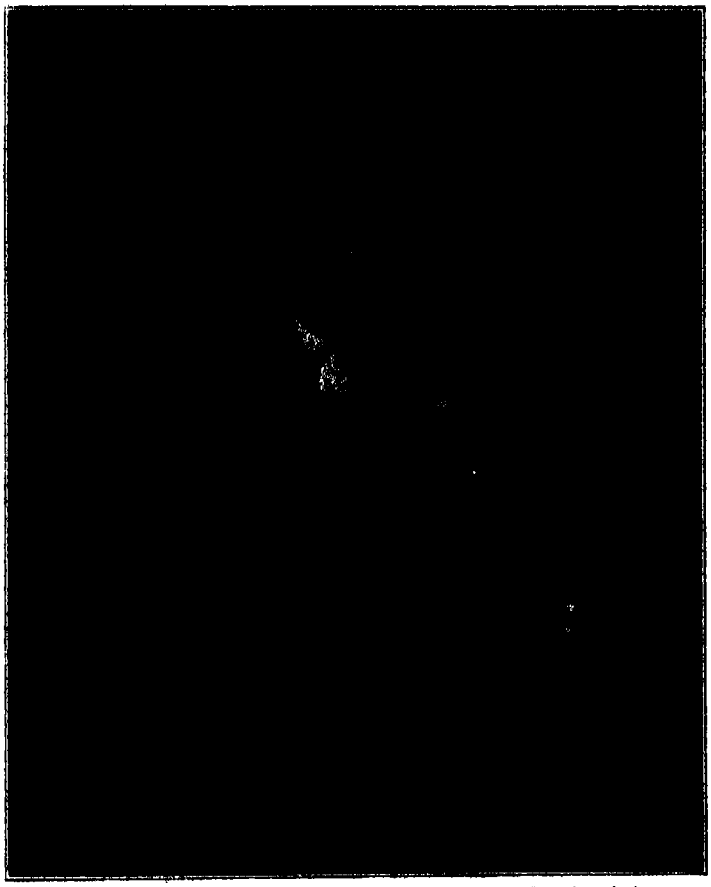

FIG. 2.—Portrait of John Hunter, from Sharp's engraving of the original picture painted by Sir Joshua Reynolds in 1788, when Hunter was sixty years of age.

William Hunter's ambition was thus fired; in October 1740 he visited London and found a pretext for not returning to Scotland. There were great hospitals in London then, but no medical schools were attached to them as is the case now. Such schools as existed were in private hands. William established one in Covent Garden, laying himself out for practice at the same time. He was careful in dress, suave in speech, and cultured in manner; he had an eye on Court and on the main chance; he was a scholar, a brilliant teacher, kept himself closely in touch with the best that was being thought and done in medical Europe, and made observations for himself at first hand.

In October 1748, William found his school in a prosperous state; his dissecting room was crowded; the preparations which he had made and preserved to illustrate his lectures began to form an imposing museum. His youngest brother, John, although twenty years of age, was still idling at home; he had grown into a short, thick-set fellow, with sandy hair and freckled face. William brought him to London and set him to work in the dissecting room. John took to the life as a duck takes to water; he had hands and could use them; he never really cared for books; he preferred to decipher the hieroglyphics of life at first-hand; he chose to register his discoveries in museum jars rather than in printed pages. It was only when he turned lecturer that he was compelled to reduce his observations, thoughts, and experiments to words. He was careless of dress, unconventional in manner, and uncompromising in speech. An unceasing search into the nature of life became his religion. He was resolved to win on merit; and in the long run, sheer merit was victorious. Cullen launched William on the sea of medicine, and in due course William launched his brother John—now the subject of seventy-four Hunterian Orations.

So I come back to my main question: What did Hunter do for medicine that we should continue to be mindful of him? Great men, as a rule, are so easily labelled—Jenner, Hunter's pupil, discovered the efficacy of vaccination; Charles Bell demonstrated the action of spinal nerves; Marshall Hall discovered reflex action; Lister, antiseptic surgery. In not one of these cases is the label adequate, but the public demands that its great men must be ticketed. There is no tag for John Hunter; to do him justice we must give him a hundred.

It has been said that Hunter was the founder of scientific surgery. If by this is meant that surgery will become a science only when all the secrets of life have been revealed and mastered, then Hunter has a just right to such a title. For the obsession of his life was the discovery of the mechanism of living matter; he perceived that life was the same in all its forms; an organised blood clot in a patient in St. George's Hospital was for him the same thing as the hydra which he grew in his vivarium at Earl's Court. He applied the same method of study to both. He knew nothing of oxygen, oxidation, or of the chemical nature of combustion, but he measured the 'amount of life' by the 'vital' heat generated, using the most delicate thermometer obtainable, to give him a standard for comparison. He knew nothing of those living units we now call cells or corpuscles; he measured the processes of 'simple life' in the mass. He subjected it to all degrees of temperature and noted its reactions.

In this way Hunter tried to get at the secrets of that reaction of living matter which is called inflammation. He used his thermometer to tell him what was happening in the hibernating hedgehog, his beehives in winter, and the trees of his garden when frost was deep in the ground. He realised to the full that if we are to understand life we must first study growth, and that of all the tissues of the animal body, bone was the one which best lent itself to an exact inquiry. He carried out an experimental study of the growth of bones, extending over many years, in fowls, pigs, asses, and deer; he used the modern methods of vital staining and of experimental operation. He regarded antlers as bony tumours; he sought to understand how Nature produced them and particularly he desired to discover the secrets of the bloodless operation by which she removed them annually—without fee. Living matter, by itself, had mastered the art of healing; if men were ever to become surgeons they must learn their art by studying the surgical ways of living matter. That was Hunter's message to his day and generation; for this reason he turned experimental embryologist, experimental botanist, experimental zoologist, experimental physiologist, experimental pathologist, and experimental surgeon. What he did and what he thought can never cease to be a source of inspiration to those who inquire at first hand, for the problems he sought to solve are still those which envisage us—the basal problems of life.

Why, then, do the younger surgeons of to-day neglect Hunter or brush him aside as out-of-date? It is because of the unbounded success of Lister's discovery; the Listerian revolution has led them to concentrate their whole attention on the cleanliness of their wounds and the technique of their operations. Their attention is occupied with the organisms which may invade wounds and they forget a fact ever present in Hunter's mind—that the powers of healing are resident in the living flesh. No one who notes what is happening now in the most progressive lines of biological inquiry—experimental embryology and experimental biology, as represented by tissue culture, tumour grafting, transplanting of living organs and parts—can fail to see that after a century and a half we are again returning to the Hunterian outlook and the Hunterian methods of approach.

Hunter's published works are contained in six volumes—the four volumes which are included in Palmer's edition (1837) and the two precious volumes of "Essays and Observations" published by Sir Richard Owen in 1861. A study of these volumes shows how dangerous it is to say wherein Hunter was wrong or mistaken; he made many grave errors of inference—none of observation. But in the majority of instances time has proved that it was not Hunter who was in the wrong, but his editors.

There is one aspect of Hunter's life which his annotators have refused to mention, or if they have alluded to it, explained it as an aberration of a great mind. The truth is that Hunter's inquiries had made him a pagan; he could not harmonise what he found in the realms of Nature with what his inquiries revealed to his own eyes. He silently and resolutely thought and wrote as if the book of Genesis had never been in existence. The last paper he ever penned was "Observations on the Fossil Bones presented to the Royal Society by His Most Serene Highness the Margrave of Anspach." In this paper the council of the Royal Society was alarmed to find that Hunter, in order to explain certain changes, postulated "thousands of *centuries*," and ultimately succeeded in getting the estimate reduced to thousands of *years*, thus bringing the estimate within the limits of Biblical chronology. In the meantime Hunter died, and his brother-in-law, Sir Everard Home, readily sanctioned the desired change. Even Sir Richard Owen in 1861 is an apologist for Hunter's heretical beliefs. In the 'advertisement' to "Essays and Observations" he wrote:

> "Some may wish that the world had never known that Hunter thought so differently on some subjects from what they believed, and would have desired him to think. But he has chosen to leave a record of his thoughts and, under the circumstances in which that record has come into my hands, I have felt myself bound to add it to the common intellectual property of mankind."

There would have been no record left if Sir Everard Home had had his way. That any record was preserved at all of Hunter's real thoughts is due to Owen's father-in-law, William Clift. Home burned Hunter's original manuscripts, the usual explanation being that he had pilfered from them. A close study of the conventional character of Sir Everard Home and of the circumstances which surround this infamous act of vandalism have convinced me that the accepted explanation is not the true one. Home shared implicitly in the religious beliefs of his time and never doubted that by destroying all evidence of Hunter's heretical convictions he was performing an act of piety on behalf of the world in general and for the memory of his brother-in-law in particular. The world has still much to learn from John Hunter.

British Association Expedition to the Great Barrier Reef.

By Dr. C. M. YONGE.

MARINE biology has advanced greatly of recent years. It is becoming quantitative in its methods, beginning to demonstrate cause as well as effect, while, as the result of co-ordinated research by plankton workers and chemists, the full story of the annual cycle of life in the sea is gradually being elucidated. Practically all this work has, however, been done in temperate seas, and the extent to which similar conditions prevail in tropic waters is entirely unknown. Here is a great and open field for the application of modern scientific methods and one in which a rich harvest cannot fail to be reaped. Hitherto, opportunities have been lacking; there are no big marine laboratories in the tropics, while deep-sea expeditions have only been able to make isolated observations.

This long-desired opportunity has at last been provided by the Australian Great Barrier Reef Committee, which two years ago invited Great Britain to send out an expedition to make a thorough biological investigation of the Great Barrier Reef of Australia. The organisation of this expedition was undertaken by the British Association at the recent meeting at Leeds, and a committee, consisting of members of the Sections of Botany, Geography, Geology, and Zoology, to which were later added several Australian representatives, was instituted for this purpose.

If the necessary funds can be raised, the expedition will leave this spring, and work on the reef will be carried on continuously for at least a year. The leader of the expedition will be Dr. C. M. Yonge, Balfour Student in the University of Cambridge. Mr. F. S. Russell, of the Plymouth Marine Biological Laboratory, will be in charge of the plankton investigations and other work of the boat party for the first six months. Mr. Tandy, of the British Museum (Natural History), is expected to be the botanist, concerned especially with the calcareous algæ; and the Royal Geographical Society is considering how best to provide the services of a surveyor for the expedition. The full plan also includes a chemist and hydrographer, who will study the chemical and physical conditions of the sea water, while an experienced zoologist has expressed his willingness to take charge of the reef work. In addition, there is the promise of considerable assistance from the Universities of Brisbane and Sydney, and from the Australian Museum at Sydney; the British Committee lays the greatest stress on this, in view of the continuation of such studies in subsequent years.

With the exception of the work of the geographer, the investigations proposed will be purely biological. The geology of the reef has already received considerable attention from Prof. H. C. Richards, of the University of Brisbane, who has been the prime mover in all recent work on the reef. It is hoped that the surveying ship of H.M. Australian Navy will be able to assist in the accurate surveying and charting of the region where the expedition will work.

The plan of operations may be conveniently summarised under four headings. First, there is work on the reef, and this will include an ecological survey of the corals and their associated organisms, both animal and plant, their food and mode of feeding, their rate of growth, and their seasons of reproduction. Conditions on various parts of the reef, exposed to very different factors, will be compared and correlated with differences found in the plankton and the sea water. This work will be conducted by a 'reef' party of probably two zoologists and the botanist.

Closely connected with the above work will be an examination, as detailed as conditions will allow, of the bottom fauna and flora and the deposits, between the reef and the mainland and, so far as possible, on the outer side of the reef. For this purpose dredges and the Agassiz trawl will be used, and also quantitative grabs and bottom samplers. An important part of this work will be the determination of the zoning of life at increasing depths, information which is urgently needed for the proper working out of the contents of the bores made into reefs.

This work, and that of the third set of investigations, concerned with plankton and sea water, will be carried out from a powerful motor-boat which has been kindly offered, together with a smaller boat for work round the edge of the reef, by the Navy Yard at Sydney. The variations of the plankton—seasonally, diurnally, and at different depths—will be studied by means of samples taken with water-bottles, fine and coarse silk tow-nets, and stramin nets. Mr. Russell, who will have assistants, will employ the methods which have yielded him such excellent results in Great Britain, so that the findings will be directly comparable with those obtained in our temperate seas. A series of stations will be selected for this work, and water samples will be taken at the same time from which accurate determinations of temperature and salinity, of the nitrate, phosphate, silica, calcium, and oxygen content, and of the hydrogen-ion concentration will be made by the chemist. Variations in these will be correlated with variations in the plankton.

The fourth line of research will, it is hoped, tie together all the work into one connected whole. It will consist of a detailed study of the mode of feeding and digestion in the different corals, and of their food throughout the year. The relative extent to which corals depend upon plankton for food or are nourished by the unicellular algæ which live symbiotically in their tissues will be investigated. This is a matter of fundamental importance and one on which our knowledge is extremely scanty. The method of calcium deposition in corals, as a result of which the skeleton is formed, will also be studied.

Finally, the economic possibilities of the reef will

receive thorough attention. At present there is an extensive trade in pearl shell and trochus, in bêche-de-mer and in turtles, and the possibility of increasing these by methods of cultivation and of establishing a sponge fishery—of native or, if feasible, imported sponges—will be examined. The commercial potentialities of the fisheries will be estimated so far as opportunities permit. The Great Barrier Reef is immensely rich in life and should prove a source of vast wealth if properly exploited, and for this a thorough biological survey is the essential preliminary.

Obituary.

Mr. R. A. Herman.

CAMBRIDGE mathematicians of the past forty years will have learnt with deep regret of the sudden death of Mr. Herman, of Trinity, on Nov. 29 last, at the age of sixty-six years. Versatile and skilful, Herman devoted to teaching powers that were ample to have made him one of the celebrated mathematicians of his time, and his monument must be sought in the multitude of his pupils who have won distinction for themselves.

Herman took the Tripos in 1882, and was described at the time as the last 'real' Senior Wrangler, for the Tripos was about to be divided, and the title, though surviving until 1909, depended after Herman's year on only the first part, the second part being a postgraduate examination. After gaining in due course a Smith's Prize and a Trinity fellowship, Herman went to Liverpool as professor, but he stayed there only two years, and returned in 1886 to Cambridge, where he spent the rest of his life. He was given the honorary degree of LL.D. at St. Andrews in 1920.

At the time of Herman's return, and until 1909, mathematical teaching in Cambridge was of two kinds: in theory the ground for the Tripos was covered by college lectures, but in practice success depended on the private coach. Herman served a full period of office as a college lecturer, and he was a University lecturer for many years, but it was as a coach that he became famous. Reputation in this field was difficult to acquire, but Herman had a genius for teaching which won its reward when J. E. Wright was Senior Wrangler in 1900, and from 1903 until 1909 one or more of his pupils, alone or bracketed, headed the list: of the last eleven Senior Wranglers, he coached nine.

For a few years after 1909, force of custom still sent the best scholars to be coached, but the new regulations put the premium on specialisation, and the use which Herman could make of his powers under the changed conditions was still uncertain in 1914. During the War he was engaged on various routine tasks; he lost his only son, reported missing and never heard of again, and suspense and grief affected his subsequent career. After the War he continued to read and to enjoy mathematics, but his diminished energy found sufficient scope in his University lecturing.

Herman was beyond question a great teacher, at once conscientious and inspiring, methodical and brilliant. His revision papers were miracles of thoroughness, and by means of weekly problem papers he imparted all that it was possible to impart of his own facility in the problem-solving that was formerly essential to distinction in Cambridge examinations. As a mathematician he was an artist to the finger-tips, scrupulously rigorous, little satisfied by a mechanical solution, and quick with praise when he saw beauty. There was no branch of Tripos mathematics in which he was not proficient, and there were many subjects in which his knowledge extended far beyond the range of any examination. He was an astronomer in a university where astronomers flourish, his only book was on geometrical optics, and he was an authority on the most difficult problems of discontinuous motion in fluids, but it was to differential geometry as investigated by kinematical methods that he was most devoted.

A teacher's fame is local and ephemeral, but so long as any of Herman's pupils are alive he will be remembered with gratitude and affection.

Mr. J. H. Durrant.

THROUGH the death at his residence at Putney on Thursday, Jan. 19, of John Hartley Durrant, entomological science loses a worker who has long been known for his extensive knowledge, not only of the Microlepidoptera, but also of entomological literature and matters in general connected with taxonomy and nomenclature. Mr. Durrant was born at Hitchin on Jan. 10, 1863. He was one of the few remaining fellows of the Entomological Society of London who could date their association with that Society back to 1883, when he became a member. In 1886 he took charge of the late (the sixth) Lord Walsingham's extensive collection of Microlepidoptera at Merton Hall, Norfolk, and when this collection, which comprised some 260,000 specimens, was transferred, together with the Walsingham entomological library, to the British Museum (Natural History), he became a member of the scientific staff there.

Mr. Durrant was closely associated with the late Lord Walsingham in the preparation of the Microlepidoptera volumes of both the "Fauna Hawaiiensis" and the "Biologia Centrali-Americana," and he was personally responsible for the completion of the latter work after the transfer of the Walsingham library and collections to the British Museum. He was a most careful worker, and one has only to look at the manner in which the extensive synonymies given in the "Biologia" are drawn up, to be impressed by the evidences of painstaking care and sound judgment there exhibited. In an interleaved copy of the volume on the Microlepidoptera of the "Biologia Centrali-Americana," as well as in his note-books, there is also evidence that he was an accomplished artist, many of his sketches

being remarkable for both their accuracy and their beauty.

Mr. Durrant was intensely interested in all matters concerning entomological nomenclature, and he was responsible, with Lord Walsingham, for the compilation of what are now familiarly known as the "Merton Rules." Herein is displayed such evidence of acute insight and sympathetic appreciation of the needs of the systematist as could only be manifested by minds accustomed to face and overcome obstacles inherent in a science that has made steady and comparatively rapid progress through many changes, during a period of nearly two hundred years, since its firm establishment by Linnæus. On the formation of the British National Committee on Entomological Nomenclature in 1913, Mr. Durrant fittingly became its first secretary, retaining that office until 1924.

Mr. Durrant was one of the foremost authorities in Great Britain on the Microlepidoptera, and always showed a keen interest in small moths of economic importance, even when outside the scope of his special work. He was particularly attracted to the Pyralid genus Ephestia, the species of which are injurious to various food-stuffs, and his knowledge of these destructive pests resulted in his association with Major-General Sir W. W. O. Beveridge in the "Army Biscuit Enquiry," a report on which was published in 1913, and, in consequence of the value of the results obtained, reprinted during the War by the Trustees of the British Museum. It has been asserted on good authority that improved methods of preparing and baking Army biscuits, adopted as the result of these researches, have resulted in the saving of a considerable sum of money annually.

For ten years Mr. Durrant was on the editorial board of the *Entomologist's Record and Journal of Variation*, and his extensive knowledge of obscure scientific literature was always at the service of his fellow-editors and the many others who consulted him. Well known to all who visited the Entomological Department at the British Museum, he was an equally familiar figure at the meetings of the Entomological Society, which he attended regularly until the last year or so, when failing health made him avoid venturing out at night. Although apparently a man of strong constitution, his strenuous activities in connexion with the work of the British Red Cross Society during the War, when he served with the Natural History Museum Section of the 31st London V.A.D., added to the loss of his only child during the same period, seem to have affected his health, and to some extent to have hastened his end. Of genial disposition, friendly to a degree, his warm greeting will long be missed by all who knew him, and not least by those who were most closely associated with him in his various activities.

W. H. T. T.

Dr. William W. Fyvie.

Through the death, from pneumonia, of Dr. W. W. Fyvie, at Aberdeen on Jan. 17, after a short illness, the science of physics, particularly in the branch of radio communication, has lost one who gave his best in her service; and his Alma Mater, whom he served throughout practically the whole of his graduate career, mourns a son who by his labours enhanced her prestige and brought honour to her name.

Dr. Fyvie was essentially an experimentalist. He showed his ability in this direction very early in his career, for when he graduated in 1904 he did so as the most distinguished graduate of his year in practical physics. Six months after graduation he joined the staff of the Natural Philosophy Department of the University of Aberdeen, then under the supervision of the late Prof. Niven. For some years, owing to his time being mainly occupied with the routine work of the Department, he had little opportunity of developing any particular line of research of his own. Gradually, however, he began to devote more and more time to the study of radio telegraphy. This interest was fostered by Prof. Niven, who had himself done much work in this subject in its earlier stages. As a result the Department became one of the then comparatively few stations permitted both to send and receive radio signals. The outbreak of the War put an end temporarily to their activities, but with the cessation of hostilities the work was again resumed.

The problem which interested Fyvie most at that time was that of telephonic reception, and his energies were turned towards finding the best method for accomplishing this end. Within more recent years he applied himself assiduously to the explanation of the variation of signal strength at sunrise and sunset, and to the problem of 'fading' in general. About twelve months ago he evolved a theory of 'fading' in terms of the interference of reflected waves which accounted excellently for a large number of observations, but he refrained from publishing it until he could satisfy himself of its applicability to all conditions, and he was still working actively on the problem when he died.

The loss of Dr. Fyvie will be felt by many generations of students, to whom he was always a popular and inspiring teacher; while those who knew him intimately, knew him for a man of sterling worth, always ready and willing to spend himself on behalf of his friends.

We regret to announce the following deaths:

Mr. Miller Christy, author of a "Handbook of Essex," "Birds of Essex," and other publications on the archæology of Essex, on Jan. 25.

Prof. J. L. Heiberg, of Copenhagen, the historian of Greek mathematics and natural science, a corresponding fellow of the British Academy, on Jan. 4, aged seventy-two years.

Prof. H. A. Lorentz, For. Mem. R.S., and Copley medallist in 1918, for many years professor of theoretical physics in the University of Leyden and one of Nature's "Scientific Worthies," on Feb. 4, aged seventy-four years.

Dr. T. Adrian Palm, who put forward the view that rickets is due to deprivation of sunlight so long ago as 1890, and was the author of contributions to medical literature on diseases and customs in Japan.

News and Views.

IN his presidential address to the fifteenth Indian Science Congress, delivered at Calcutta on Jan. 2, Dr. J. L. Simonsen outlined the early history of the Congress, the first meeting of which was held in 1914. Reviewing the present position of education and research in India, he found matter for congratulation in the advance of the spirit of research in the Indian universities, but deprecated the fact that, with few exceptions, the degree standard has been considerably lowered during the last few years. He attributed this change to the recent University Acts, which have *transferred the detailed control of* courses of study and standards of examination from the professorial staffs to bodies of laymen. In order to overcome the difficulty of coping with large numbers of students who regard a collegiate career merely as a stepping-stone to government appointments, Dr. Simonsen advocated the extension of Civil Service examinations to all grades in the clerical departments of government. Such a competitive system, although not free from defects, "would liberate the universities from their present thraldom and enable them to devote themselves to their true function, the advancement of learning."

IN the special section of his address, Dr. Simonsen directed attention to the importance of the study of natural plant and animal products. He instanced the work of Annett and his collaborators on the relationship of the alkaloidal content of poppy juice to the age of the plant and to external features, such as the nature and previous treatment of the soil. While commending work of this kind, he deplored the general neglect in India of the chemical study of natural products: "Is it presumptuous to suggest to the organic chemists of India that they should study intensively the unique wealth of material which lies at their door, and devote less time to the study of problems of theoretic interest only?" As an example of the value of collaboration between organic chemists and botanists, he alluded to the two grasses known as 'Sofia' and 'Motia'; although these are both classified as *Cymbopogon Martini*, Stapf, the first yields the valuable palmarosa oil, while the second gives a comparatively valueless ginger-grass oil. Dr. Simonsen suggested that a detailed botanical and chemical examination of the many Indian Cymbopogon grasses would probably lead to results as interesting as those obtained by Baker and Smith in their work on the differentiation of closely related species of Eucalyptus, and that such work might throw light on possible relationships between the chemical constituents of a specific oil and characteristics of soil and climate.

THE annual report presented on Dec. 8 to the Regents of the Smithsonian Institution of Washington recorded active progress in all departments, limited only by lack of funds. Thus more than thirty expeditions took the field, and among their chief results were the obtaining of first knowledge of Dutch New Guinea, one of the few unknown areas remaining on the earth's surface; an archæological and anthropological reconnaissance of Alaska, during which a plan of more intensive exploration was prepared; the collection from Tanganyika of some 2000 live animals combining interest to the public and scientific importance; the inauguration of a third solar observatory for the measurement of solar radiation in the eastern hemisphere; the systematic collection of mineral specimens from Mexico, of ferns from Jamaica, of natural history material from Haiti. This in spite of the fact that, as the report says: "Almost no unrestricted funds for field work were available, each expedition being separately financed either by the generosity of some friend of the Institution or through a co-operative arrangement with some other organisation whereby the costs and collections were shared. Such a programme of field work is of necessity haphazard."

IT is to be hoped that some increased support from the Government as well as from individuals may be the result of the conference of distinguished men of science and leaders of industry held at the Smithsonian a year ago under the *chairmanship* of Chief Justice William H. Taft. As an organiser and leader of work in pure science, and as the controller of the national collections in art and science, the Smithsonian fulfils a national duty. Its international services are appreciated in all civilised lands. During the past year the International Exchange Service handled 590,879 packages, an increase of 110,103 over the previous year's total. We note with more interest than sympathy that the Smithsonian still has hopes of re-starting the International Catalogue of Scientific Literature. The bibliographers who met at the International Institute seem to labour under no such delusion and are the more practical in consequence.

THE Manchester Geological Society was founded in 1838, and the earlier volumes of its *Transactions* contained a large number of important papers dealing with pure geology. In course of time, however, the Society devoted its energies more and more to mining matters, and eventually came to be one of the bodies incorporated in the Federated Institute of Mining Engineers. Not unnaturally, the people of Manchester and district continued to feel a desire for a local geological society; a proposal to form a geological section of the original society was not found practicable, and finally the Manchester Geological Association was founded as an independent body, but nevertheless in close touch with, and with the full benediction of, the older society, and the rooms and library of the latter at Queen's Chambers, 5 John Dalton Street, Manchester, were placed at its disposal on very liberal terms.

THE first number of the *Journal* of the new Manchester Geological Association has recently appeared. It includes a presidential address by Prof. O. T. Jones, and three detailed papers on various Carboniferous topics. Prof. Jones's address, entitled "The Foundations of the Pennines," is of high interest. By a series

of ingenious deductions he arrives at the conclusion that this foundation must be chiefly pre-Cambrian, but the argument cannot be summarised in a few words. Father Waddington, S.J., dealing with the district round Stonyhurst, offers some trenchant criticism of the validity of the stratigraphical term Pendleside Series, both locally and generally. He shows that the only true Pendlesides are conterminous with the Bowland Shales of Phillips: the Pendleside Limestone, from which the group was named, lies outside it according to modern zonal work, and the name should be dropped altogether. Mr. J. W. Jackson describes the succession below the Kinder Scout Grit in North Derbyshire, and Mr. A. Bray deals with the carboniferous sequence in the Colne district. This publication gives evidence of much energy and enterprise on the part of the new society, which also conducts excursions to places of geological interest. We wish it a long and successful career.

THE impression of persistent stormy, mild, wet weather, with a preponderance of south-westerly winds over Great Britain since the severe frosts of last December, is reflected in the weather summary for January issued by the Meteorological Office as a supplement to the *Daily Weather Report.* This weather was due to an unbroken succession of depressions, the majority of which followed a north-easterly track outside the Hebrides, although a few moved nearly due east across the northern districts of Great Britain and dispersed on approaching an anticyclone over northern Europe. For dwellers in towns, where shelter from rain is so easily secured, and a few hours of strong wind afterwards suffices to give dry conditions under foot, this stormy type of weather is perhaps the least unpleasant at a time of year when anticyclones, if accompanied at first by clear skies, soon lead to dull or foggy weather. The sunny periods that normally occur with the arrival of polar air behind a retreating depression can give a monthly duration of sunshine well above the average, as the figures for last month prove. At Ross-on-Wye it was the sunniest January for at least fourteen years, and in many other parts of the country sunshine was also in pronounced excess. The general mildness, resulting from an almost complete absence of easterly winds, is shown by the mean temperatures for Kew, Aberdeen, and Valentia. Gales giving rise to gusts of upwards of 75 and even 80 miles an hour were unusually frequent. It was one of these, blowing from between west and north-west across the southern part of the North Sea, that was partly responsible for the disastrous floods in London on the night of Jan. 6.

THE excess of rainfall, which was the most remarkable feature of the weather for the month of January, appears to have been particularly marked in Scotland: at Stornoway the total of 268 mm. was the highest for January since records began there in 1873; and at Eskdalemuir, where 394 mm. fell, it was the wettest month of any since at least 1911. New monthly rainfall records were also made at various places in the Lake District. According to the *Westmoreland Gazette* of Feb. 4, the highest gauge of the Manchester Waterworks at Ullscarf registered 683 mm.; at The Wray, Grasmere, the rainfall was 620 mm., the previous highest being 575 mm. in February 1894; at Ambleside it was 595 mm. for the first 28 days, the previous record being 578 mm. in October 1903; at Windermere it was 421 mm.; and at Sedburgh it was 376 mm., the previous record being 369 mm. in August 1891; at Kendal it was 368 mm. for the first 28 days, the previous record being 319 mm. in October 1874. It is stated that January has easily passed all rainfall records for the first month of the year.

WE learn from the Kew Observatory that on Jan. 22, at about 6.12 P.M., a rather strong shock (which may be classed as an earthquake of intensity 5 on the Rossi-Forel scale) was felt in a small district including Hanley, Burslem, and Cobridge in North Staffordshire. A typical experience was that of Mr. F. J. Rathbone, of 321 Waterloo Road, Hanley, who wrote in a letter to the Meteorological Office: "I was lying on a couch in the living-room when there came a terrific 'Bump' and the whole house rocked. A large mirror, hanging over the mantelpiece (which I was facing), quivered violently, and light on the tiles round the fire-place shimmered rapidly, showing, I think, evidence of considerable disturbance at the foundations of the house. The shock was of very short duration, just as though a giant, using a mammoth hammer, had struck one mighty blow at the earth right under me: it might have been the result of a mine explosion or of a great subsidence of earth, but I have not heard of either of these latter happening." The brevity of the shock, its comparatively high intensity, and its small disturbed area (probably not more than a mile or two in diameter) indicate that the focus was small and at a very slight depth below the surface. They suggest that the tremors were caused by a small slip of the strata along a fault between Burslem and Hanley, a slip due to the withdrawal of the coal or of water from the mines. Such local earth-shakes are frequently felt in the mining districts of Great Britain.

MR. HOWARD CARTER has now dismantled the great canopic shrine in the innermost recess of the tomb of Tutankhamen and has examined the magnificent canopic chest and its contents. The result is shown in a series of illustrations which appear in the *Illustrated London News* of Feb. 4. In the accompanying letterpress, it is stated that the shrine was more than six feet in height and occupied a floor space of some five by four feet. It stood on a sledge. The canopy was supported by four uprights, and on each of the four sides was a statuette of a tutelary goddess with outstretched protective arms. Within was a canopic chest of semi-translucent alabaster standing upon a silver-handled sledge, and with a tutelary goddess carved in relief at each corner. The massive lid in the form of an entablature was fastened down with four seals attached to gold staples. Within were four receptacles with human-headed covers in alabaster sculptured in the likeness of the king. Within these

again were the four exquisitely inlaid golden coffins which contained the viscera. These miniature coffins are exact replicas of the great gold coffin that enclosed the body of the king, but are even more elaborately inlaid in the feather design. Each bears the formula of the goddess and genius to which it belongs, and the texts pertaining to its protectors are engraved on the inside. It is interesting to note that owing to the carelessness of those who were responsible for erecting the canopy the protective deities were misplaced, Nephthys being placed on the east side where Selket should have been, and Selket on the south side in the place of Nephthys.

On Feb. 2, Sir William Bragg gave the first of a course of lectures at the Royal Institution on "Faraday's Note-books," and dealt with ice and regelation. Sir William stated that the manuscript note-books of Faraday, which have not yet been published in full, show that in September 1842 he made a number of experiments on certain curious properties of ice. He had noticed that pieces of ice put together into a bowl may be melting as a whole, while at the same time they freeze the water just round their points of contact, and so join themselves together by solid bridges of ice. It is well known that ice is crystalline, and when a crystal grows, the new molecules have to take their places in correct alignment. Molecules of water are apt to hold back from crystalline arrangement, unless there is something to make the first step easy; a molecule near a piece of ice may be induced to join up to the crystalline structure already existing, and still more so if ice surrounds it. In the long arguments on glacier motion which took place in the middle of last century, much use was made of Faraday's experiments and ideas. But it was then believed that a single crystal of ice could not be distorted. It was not until 1890 that M'Connell showed that a single crystal of ice can be made to yield, certain layers of atoms sliding over one another. Just so with a metal; single crystals of various metals are remarkably pliable. A copper bar can be so made as to yield easily in one's fingers; yet if so moved once or twice, the single crystal breaks up into many small crystals and the bar regains the strength which is usually the property of a copper bar. The problem of the glacier closely resembles the problem of the flow of a metal. When this new fact is taken into account, the importance of Faraday's early work is more readily understood.

In a Friday evening discourse on "Photosynthesis," delivered by Prof. E. C. C. Baly at the Royal Institution on Feb. 3, he stated that the conversion of carbonic acid directly into sugars and starches is one of the simplest of all the vital processes from the chemical viewpoint; yet, although it is known that it is effected by means of sunlight, there have been apparently insuperable difficulties in the way of its explanation. The greatest difficulty of all, perhaps, is that on any theory based on previous knowledge gained from the study of light reactions in the laboratory, the plant cannot absorb directly from sunlight sufficient energy for the synthesis to take place. Experiments in the University of Liverpool have shown that the explanation is in reality very simple; the definite factor is the existence of a surface on which the synthesis can take place. It has been found that if a coloured surface capable of absorbing carbonic acid is present, then on exposure to sunlight the carbonic acid is converted into sugars and more complex carbohydrates; the energy is supplied partly by the surface and partly by the sunlight. Thus photosynthesis of sugars is closely analogous to that achieved by the living plant, since it is known that a suitable surface exists in the leaves and, moreover, for the same area of surface the quantities of sugars produced in the leaf and in the laboratory are very similar. Furthermore, the same sugars are produced in both. Not only do these results offer an explanation of vital photosynthesis, but they also suggest that the key to the mystery of all vital chemistry has been found, and that this differs from the chemistry of man's achievement by virtue of the very large amounts of energy involved. The chemistry of life would seem to be one of high energy, whilst that of man's endeavour is the chemistry of low energy.

Great Britain was the first to give a single authority the responsibility for the conduct of a national service of broadcasting. Since it started in November 1922, a large number of nations has adopted similar systems. The United States, however, is a notable exception, as it clings to systems based on private enterprise. In a paper on the design and distribution of radio broadcasting stations for a national service, read by Captain P. P. Eckersley to the Institution of Electrical Engineers on Feb. 1, the progress made is discussed and future possibilities are pointed out. It is estimated that 90 per cent. of the listeners in rural areas in Great Britain rely upon Daventry. A listener in an area close to the station, that is, within the 'wipe-out' area, can be guaranteed a continuous and perfect service, but those outside this area are liable to interference. The Swedish engineers have proved that waves travelling over forests attenuate much more rapidly than waves passing over water. The provision of alternative programmes more than doubles the value of a broadcasting service. It not only tends to satisfy a larger number of persons, but each programme also can be given artistic unity as there is no need to consider any compromise. Telephone lines have proved most valuable in this connexion, and probably give the best solution for interlinking distant stations. The British Broadcasting Corporation, in conjunction with the Marconi Company, is considering the feasibility of short wave transmission. Many technical problems are discussed in the paper, the low power choke-modulation methods being shown to be the most satisfactory. Since it started, the performance of 5 G.B. has given every satisfaction. The B.B.C. is at present engaged in considering methods of improving the service.

The electrodeposition of nickel, silver, and gold were amongst the earliest applications of electricity

to practical purposes. Recent researches have not only greatly speeded up the times required for the processes, but have also produced a far superior type of deposit. In addition, many new metals are now being deposited on a commercial scale, several of which have special valuable properties. A thin layer of zinc or cadmium protects steel from corrosion. Tin produces a silver white surface, and is used for improving the appearance of a metal. The metal, however, which is most experimented on at present is chromium. Its most important properties are its great hardness and its ability to keep bright and clean for long periods. Stainless steels and rustless irons are indebted to this element for their freedom from tarnish. In the *Electrical Review* for Jan. 13, S. Wernick gives a useful survey of the applications, properties, and the methods of deposition of chromium. It appears that chromium gives the hardest deposit that has yet been produced, being harder than hardened steel. Chromium plate has been found useful in prolonging the life of steel gauges. It has a faint bluish tinge, but takes a brilliant polish, the colour being somewhat similar to polished aluminium. The various solutions used for the deposition generally consist of chromic acid with the addition of a salt. A high current density is employed, and the temperature of the bath should be maintained at about 50° C. The heavy current rapidly heats the bath, so water cooling by lead pipes is necessary, and the rapid evolution of hydrogen produces an objectionable chromic acid spray in the atmosphere. Lead forms a useful and insoluble anode. The present cost of chromium plating is several times greater than nickel plating. Before long a standard specification will doubtless be agreed on, and chromium plating will become a commercial operation.

THE example of Mr. Charles Enderby, who a hundred years ago owned a fleet of sealing vessels sailing from the Thames for Antarctic waters and encouraged his captains to combine discovery with commerce, is now being followed by Mr. Lars Christensen, of Sandefjord, Norway, one of the leaders in modern whaling enterprise. One of Mr. Christensen's whale-catchers, the *Odd I.*, made a most successful dash into the Antarctic west of Graham Land in January 1927, when she reached and circumnavigated Peter I. Island, which had previously only been sighted from a distance by its discoverer, Bellingshausen, in 1821, and by Charcot in 1912. The island was photographed from all sides, and attempts were made to land on it at several points, but no beach could be found beneath the vertical cliffs of volcanic rock which alternate with glacier faces to form its coast.

IN September 1927, Mr. Christensen dispatched a small sealer named the *Norvegia*, under the command of Capt. H. Horntvedt, with a scientific staff of four, including Prof. Olaf Holtedahl and Dr. O. Olstad, for a scientific expedition in sub-Antarctic and Antarctic waters. The *Norvegia* reached Bouvet Island in the South Atlantic on Dec. 1 and landed upon it. The scientific interest of this feat lies in the fact that from its discovery by Bouvet in 1739, doubt and mystery have surrounded the island. Cook and Furneaux searched for it in vain in 1772; Cook again failed to find it in 1775, and although Enderby's sealers reported the island, on which they landed, in 1808 and 1825, Sir James Clark Ross sought for it without result in 1843, and Lieut. Moore, R.N., was equally unsuccessful in 1845. Not until 1898 was the existence of the island settled by the German scientific expedition under Prof. Chun in the *Valdivia*, and although the island was photographed, a landing was impossible. Better photographs were taken by the German expedition in the *Meteor* in February 1926, but rough weather made it impossible to land. None of the later expeditions has found more than one island in the neighbourhood, though the Admiralty charts continue to show Thompson Island as reported in 1825. After refitting at South Georgia, the *Norvegia* is proceeding towards Enderby Land, the objective of Sir Ernest Shackleton in the *Quest*, which has never been seen by any expedition since Biscoe discovered it in 1831.

MESSRS. CARL ZEISS, Winsley House, Wells Street, London, W.1, inform us that on Jan. 16, in the presence of the Ministers of Finance and Education, Signore Mussolini signed a contract for the erection of a Zeiss planetarium in Rome. The inauguration will take place on Oct. 29 next, and will be made the occasion of special ceremony. It is intended to erect the planetarium building in a prominent position, and the open space in front of the main station is said to be under consideration for the purpose. The city of Moscow has also recently contracted for a Zeiss planetarium. It is intended to erect the instrument in the building of the former Moscow Circus, situated in the centre of the city. A hemispherical projection surface measuring 26·6 metres in diameter is now being installed, and there will be seating accommodation for about seven hundred spectators. It is expected that the planetarium will be on view in May next.

SIR ERNEST RUTHERFORD, O.M., Pres. R.S., represented the Royal Society at the funeral of Prof. H. A. Lorentz at Haarlem on Thursday, Feb. 9.

IT is announced in *Science* that Prof. T. C. Chamberlin, of the University of Chicago, has been awarded the Penrose Gold Medal of the Geological Society of America.

DR. A. W. HILL, Director of the Royal Botanic Gardens, Kew, who is on a visit, made possible by a grant to Kew from the Empire Marketing Board, to the botanical, agricultural, and forestry institutions of Australia, New Zealand, and Java, has been given the degree of D.Sc. by the University of Adelaide.

AN exchange of greetings by radio telephony between the presidents of the Institution of Electrical Engineers and the American Institute of Electrical Engineers will take place on Thursday, Feb. 16, at 3.30 P.M. The message from America will be received in the Council Room of the Institution, but arrangements are being made for a repetition of the message

in the lecture theatre by means of a loud-speaker. Immediately after the exchange of greetings, a kinematograph film, lasting about fifteen minutes, and illustrating the new Anglo-American telephone service, entitled "Voices across the Sea," will be exhibited in the lecture theatre. This will be repeated at 6 P.M.

A new book on the "New Quantum Mechanics" is to be published shortly by the Cambridge University Press. It is the work of Mr. G. Birtwistle and deals with the development of the subject during the past two years. New and hitherto unpublished speculations of Prof. Niels Bohr are promised.

Messrs. Watkins and Doncaster, 36 Strand, W.C.2, announce for early publication "A Revised Handbook of British Lepidoptera," by E. Meyrick. The work is a new form of the author's handbook of 1895, completely revised and remodelled, and largely rewritten, with about 100 additional species, and the classification and nomenclature corrected and brought up-to-date.

Applications are invited for the following appointments, on or before the dates mentioned:—A rural industries assistant, from persons with a knowledge of fur-producing rabbits, under the Somerset Rural Community Council—The General Secretary, 14 Hammet Street, Taunton (Feb. 18). A lecturer in pure and applied chemistry at the Leicester College of Technology—The Registrar, Colleges of Art and Technology, Leicester (Feb. 20). A professor of physics at the University College of Hull—The Secretary, University College, Hull (Feb. 24). A post under the Meteorological Branch, Department of Scientific and Industrial Research, Wellington, New Zealand—The High Commissioner for New Zealand, 415 Strand, W.C.2 (Mar. 6). A senior lecturer in physics at the Huguenot University College, Wellington, South Africa—The Registrar, University College, Wellington, Cape Province, South Africa (Mar. 30). A radiologist electrologist under the Government of Hong Kong—The Private Secretary (Appointments), Colonial Office, Richmond Terrace, Whitehall, S.W.1.

Our Astronomical Column.

Another Test of the Einstein Bending of Light.—It was suggested by Prof. Chas. Lane Poor and others that the observed light bending at the eclipses of 1919, 1922 might be due not to the Einstein effect but to abnormal refraction in the terrestrial atmosphere, produced by the fall of temperature about the time of totality. While it was unlikely that this would act radially from the centre of the sun throughout totality, it was thought advisable to test the suggestion at the Sumatra eclipse of 1926. This was done by Dr. Miller and Dr. Marriott, their method being to obtain the diameter of the moon by photography during totality. The effect if present would affect the moon as well as the stars, while the Einstein effect would only act on the stars.

A recent *Science News Bulletin* issued by Science Service of Washington reports that the measures have now been completed and the moon's diameter has its normal value, thus making the suggestion of the effect being due to terrestrial refraction improbable. A slip in the account in the *Bulletin* should be corrected. It speaks of the Einstein shift as drawing the star-images closer to the sun; actually it pushes them out from it.

Recent Solar Activity.—Although solar activity was considerable during 1927, the rapid rise which characterised the years 1924–26 has received so sudden a check that the average spotted area for 1927 is somewhat less than that of 1926. The appearance of a naked-eye spot has not been reported in Nature since mid-November, but recently there have been several spots, which, although barely large enough for inclusion in this category, have been of interest to observers who regularly watch the sun's disc. In this respect mention should be made of the following spots (the date is given of their passing the sun's central meridian, together with their latitude): (1) Dec. 27, 1927, 12° N.; (2) Jan. 3, 1928, 8° S.; (3) Jan. 22, 15° N.; (4) Jan. 25, 8° N.; (5) Jan. 30, 21° S. On occasions, some of these spots were visible as naked-eye objects to the keenest vision.

In connexion with spot No. 4, Mr. Newbegin, observing at Worthing with his prominence spectroscope, reports that on Jan. 30 he saw a large metallic prominence of the 'rocket' type in the vicinity of this spot near the sun's west limb. The prominence extended to a height of 130″ above the limb, and the displacement of spectral lines indicated considerable motion outwards. The spot itself was not very active, but the *C*-line of hydrogen was reversed faintly, and there were signs of small displacements of the line. It may be added that the 'rocket' type of prominence is one in which streamers shoot out from a common centre which is almost invariably over a sunspot, and that the presence of metallic lines (*e.g.* sodium, iron, magnesium) in the spectrum of the prominence is indication of considerable disturbance. The prominence under observation by Mr. Newbegin showed increasing metallic activity from Jan. 30 until Feb. 1, when it had nearly disappeared around the sun's limb. No unusual terrestrial magnetic disturbance appears to have been recorded when the spot and its attendant prominence was on the disc. Mr. Newbegin adds that on Feb. 2, as many as twenty prominences were seen around the limb.

Bright Meteor on Feb. 3.—Mr. W. F. Denning writes that a fireball was seen from his garden by two observers on Feb. 3 at $7^h\ 56^m$ P.M. It was about twice as brilliant as Venus and pursued a rather long flight in 4 seconds from $99° + 40\frac{1}{2}°$ to $27° + 53\frac{1}{2}°$. The radiant point was in the constellation Hydra (which was rising at the time in the east by south) at $148° - 14°$, and this position was only just above the horizon at the moment of appearance of the meteor. This radiant in Hydra is in well-defined activity during the months October to February and has been frequently observed. A mean of 15 determinations of the radiant point gives the position at $148° - 11°$. It is important to hear of another observation of the bright meteor. Several small meteors were recorded from this shower on Jan. 22 last, and the radiant seems to be one of those long-enduring and fixed positions which appear abundantly distributed over the heavens according to observations during the past half a century.

Research Items.

BRONZE AGE URNS FROM SOUTH DEVON.—What further excavation may prove to be an important discovery relating to the Bronze age is described by Mr. H. G. Dowie in the *Proceedings of the Torquay Natural History Society* for 1926–27. In the course of excavations for a cess-pit at Slapton, South Devon, in July last, two urns were unearthed, and afterwards two stone cists were found. One urn was broken and a majority of the sherds dispersed, but enough have been recovered to show that, apparently, it was undecorated. It was of reddish-brown paste imperfectly fired, with a black core. A fragment of rim suggests a diameter of 9 in. The second urn contained a material of gray colour but no bones. It measures five inches high and is of the same paste as the first. Of the cists, one was in a dilapidated condition. Beneath and around a stone once forming part of the cist were burnt bones, pieces of charcoal, and several human teeth. The second cist was in perfect condition. It lay 25 inches below grass, and consisted of a flat stone for base, five flat stones for uprights, and a cover stone measuring 12 inches by 10 inches. It was almost cylindrical. Burnt bones were found within. The distance between the cists was 4 ft., and the general dispositions of the finds was as if there had been two parallel rows of interments running north-east and south-west. There is no trace of a barrow. The form of the second urn is interesting. Although it approaches the class of early Bronze Age pottery known as 'Food vessel,' in profile its form belongs to the succeeding class of cinerary urn. The decoration of the collar is the alternately shaded triangle. Along the lower curve runs a series of diagonal punctuations. The decorative motive on the collar, though uncommon, is wide spread. The occurrence of an example at Carnac suggests that Slapton may be the terminus of a sea route.

DISTRIBUTIONS IN NORTH-WEST AMERICA.—Mr. Ronald L. Olson has made a study of the types of adzes, canoes, and houses of the Indian tribes of the north-west coast of America, which is published by the University of Washington as No. 1 of vol. 2 of its Anthropological Series. Mr. Olson's thesis is that, historically, variation is as important as the invention of an entirely new trait. He has therefore taken the three cultural traits mentioned, analysed them in detail, and traced their distribution. Of the adze, the most important tool in wood-working, there are three types in the area, the elbow, the straight, and the D-shaped; their relation is difficult to see. The elbow-shaped type may be an intrusion. The adze, however, is a distinctive north-west trait as opposed to the axe, which is in use over the greater part of America. It may be an Asiatic element, and the occurrence of an elbow form, identical with the American, in Polynesia, suggests an extra American origin. The dug-out canoe is found outside the area over much of California, on the Columbia in Washington, and on all but the upper reaches of the Frazer. On the north it is found only along the coast, excepting for the one instance of the Athabascans of the extreme north-west of British Columbia. It is unknown in Alaska outside Tlingit territory. In north-east Asia it has a wide and sporadic distribution. Both the birch bark and the dug-out canoes of Asia may have spread from America. Their wide distribution in America points to a great antiquity. The rectangular plank-house is confined to the north-west coast in the south, but occurs on the upper Frazer and in eastern Washington. It is found in Alaska, while there are comparable types in north-east Asia and in the Amur region, where the resemblance is very close. The general conclusion is that the basic features of the three traits are probably not developments of the north-west coast area, but the restriction of certain qualities to the area is a strong presumption in favour of these being the contribution of tribes in the area.

THE MOTHS OF TRINIDAD.—A catalogue of the Trinidad Lepidoptera Heterocera (Moths) forms No. 3 of the *Memoir of the Department of Agriculture of Trinidad and Tobago* (1927). The authors, Mr. W. J. Kaye and Sir Norman Lamont, Bart., mention that since 550 species of butterflies form the rich fauna of those insects recorded from the island, the number of moths here listed (1016) cannot be considered large. It can be safely assumed that we do not know half of the smaller species of the Pyralidæ, Geometridæ, or Noctuidæ. On the other hand, the Sphingidæ with 54 species, Syntomidæ with 83 species, and Castriidæ with 6 species, are tolerably well represented, and additions thereto are not likely to be numerous. From an economic point of view the number of injurious species is not large, and 28 species of moths pertaining to eight families are listed as habitually or occasionally pests to agriculture or horticulture. The catalogue is evidently very carefully compiled, and should prove useful, not only to entomologists resident in the West Indies, but also to students of geographical distribution elsewhere.

BEETLES INJURIOUS TO TIMBER.—A useful pamphlet devoted to this subject has recently been issued as *Bulletin No. 9* of the Forestry Commission (London: H.M. Stationery Office) by Dr. J. W. Munro. Certain Longicorn beetles and pin-hole borers are essentially forest insects, since they attack timber just after it has been felled, abandoning it after it has become dried and seasoned. The powder-post and furniture beetles, on the other hand, attack seasoned timber, the former occurring in timber yards and the latter infesting old furniture, rafters of ancient buildings, etc. A good and well-illustrated account of these several kinds of beetles is given and the types of damage sustained clearly explained, while suggestions are made regarding preventive and remedial measures. The losses occasioned by beetle-attacks to the roofing timbers of Westminster Hall and certain other public buildings are a matter of serious concern to those in charge of the preservation of ancient buildings. There is evidently a good deal of research still to be carried out before a speedy and trustworthy method of treatment can be devised. At present methods require to be periodically applied, even over several years, and no chemical preparation is known which will eradicate beetles from infested timber in a single application.

INDIGENOUS FOREST TREES OF SOUTH AFRICA.—In a recent paper (*Trans. Roy. Soc., South Africa*, **14**, Part 4) Dr. J. Phillips deals with the ecology and distribution of the large Proteaceous tree *Faurea M'Naughtonii* Phill ('Terblanz'). This tree has the curious distribution of other of the species of the comparatively small area of indigenous forests of South Africa. The species occurs in a single area of about 1000 acres in the Lilyvlei Forest of the Gouna Forest Reserve, Kynsna. It is also recorded from several isolated centres in the Elliotdale, Lusikisiki, and St. John's districts, from Ngomi Forest in Northern Natal, and from Mariep's Kop in the Transvaal. At Gouna there are about 12,000 trees above

1-inch diameter at breast height, and on the 1000 acre portion the absolute frequency of plants under 15 ft. in height and 1-inch diameter is 1·1 per square yard. The percentage frequency of Faurea above 1-inch diameter on the 1000-acre portion is 2·61 per cent. The tree occurs as a dominant in small associations termed the '*Faurea M'Naughtonii*—other spp. associations,' the co-dominants being *Podocarpus Thunbergii* Hook and *Olea laurifolia* Lamk. It is, however, more generally found as a sub-dominant in the extensively developed '*Podocarpus-Olea laurifolia*—other spp. association.' In the Transkei and in Natal the tree is less locally abundant, and is not a dominant in any community. From the forestry point of view it has been established that the tree is moderately light demanding, and is tender in isolation in youth. The dispersal of the fruits (a single-seeded, long villous nut), the author says, is over very short distances, the long hairs being very inefficient aids to flight, whilst water and animals have little influence; the result being the aggregation of regeneration on the crown-influence-zones of the parents. Flowers are produced in considerable abundance, pollination being effected either by a species of Apis or the flowers are self-pollinated. The seeds take from one and a half to three months to germinate, the germinative capacity being ½ to 1 per cent only. It is held that the species is gradually extending its limits at Gouna, where the Forest Department has set aside 200 acres as a scientific reserve.

IRON ORE IN SOUTH AUSTRALIA.—The "Mining Review" issued by the Department of Mines of South Australia for the half-year ended June 30, 1927, contains an interesting account of iron mining at Iron Knob, Iron Monarch, Iron Prince, and Iron Baron, which are operated by the Broken Hill Proprietary Company. This Company has constructed a railway line of 3 ft. 6 in. gauge, some 33 miles long, connecting the iron ore deposits with the Port of Whyalla, whence the ore is shipped to the steel works of the Broken Hill Proprietary Company at Waratah near Newcastle, New South Wales. The ore bodies consist mainly of hæmatite with some magnetite, and the quantity of ore proved available for open working is approximately 150 million tons. The ore as shipped contains 65·67 per cent. of iron and 1·69 per cent of silica. A full description is given of the methods of blasting, breaking, and handling the ore, its transportation to the Port and handling at the Port, whilst there is also a brief description of the steel works in New South Wales. It is stated that from the commencement of operations up to Nov. 30, 1926, more than 2¼ million tons of steel ingots have been produced at these works.

GENESIS OF KAOLINITE-BEARING NODULES.—In the *Proc. Geol. Assoc.*, pp. 518-547, 1927, Mr. Serge Tomkeieff describes with an admirable wealth of petrographical detail the kaolinite-bearing ironstone-nodules which occur in the Coal Measures near Newcastle-upon-Tyne. The second half of the paper discusses the various problems that arise in connexion with the genesis of the deposit, and as this part of the investigation is based on sound geology and a clear appreciation of physical and colloidal chemistry, the result is a contribution to petrogenesis of wide and unusual interest. An outline of the processes involved is as follows: (*a*) Deposition of fine laminated mud with an original pore space of nearly 90 per cent.; (*b*) segregation of colloidal hydrated iron carbonate and hydrated alumino-silicates in the form of nodules under the protective action of humic acids, the nodules being thus of the penecontemporaneous class; (*c*) gradual crystallisation of the colloform nodules from the outside inwards, with subsequent cracking of the interior due to syneresis; (*d*) gradual compression of the shale; (*e*) infiltration of solutions into the crack-spaces and deposition of kaolinite and calcite. It is suggested that the kaolinite represents materials that were in colloidal solution, and that, as they lost water, they formed a colloidal precipitate,

$$2H_4SiO_4 + 2H_3AlO_3 - 5H_2O = H_4Al_2Si_2O_9,$$

which gradually passed into a finely crystalline aggregate. The interesting observation is recorded that a bleached Cheviot granite from under a thick covering of peat contained no trace of kaolinite.

DIVISIONS OF THE ALPS.—At the congress of Italian geographers, held at Genoa in 1924, a commission was nominated with the task of forming a scheme for the nomenclature of the region and districts of the Alps. This work was much needed in order to give precision in writings on the Alps, for there has been hitherto considerable divergence in the application of various names. A map in the *Geographical Journal* for January gives the findings of the Italian commission and is accompanied by a short critical article by Mr. D. W. Freshfield. The principle adopted by the commission was that geological, climatic, linguistic and political boundaries must be ignored if the nomenclature is to have real practical value. Only orographical considerations have been kept in mind and, where possible, rivers and passes rather than mountain crests have been utilised as boundaries. For details, reference must be made to the map, but it may be noted that with a few exceptions the districts as now defined correspond more or less closely with those adopted by W. A. C. Coolidge in the "Encyclopædia Britannica."

THE STANDARD OF LENGTH.—When Arago took part sixty years ago in the conferences which led to the construction of the standard metre of the newly founded Bureau international des Poids et Mesures, he expressed himself most enthusiastically on the advantages of a unit of length defined in terms of the wave-length of a line of the spectrum of a particular element, for example, the red line of cadmium, and since his day others have expressed the same opinion with equal enthusiasm. But the work of spectroscopists during the last twenty or thirty years has shown that there are many circumstances and conditions which affect the wave-length of a line of an element, by small amounts it is true, but each year almost has added to the known conditions which must be satisfied if the standard line is to be obtained. It is mainly on this account that M. A. Pérard, of the Bureau, after an examination of the facts, comes to the conclusion in a paper in the *Travaux et Mémoires* of the Bureau, that for the present the old platinum standard must serve as the definition of the unit of length, nor can quartz serve as a substitute for platinum.

PASSIVE METALS.—An X-ray examination of finely divided iron, nickel, and chromium, conducted by F. Krüger and E. Nähring at Greifswald, has shown conclusively that films of oxide thicker than 10^{-7} cm. are not present on the surface of a passive metal. The diffraction pattern of an inert sample is identical with that of a chemically reactive specimen, and exhibits not only no extra lines where those of the oxides would be expected, but also shows those of the ordinary metal in their usual positions, proving that the pre-existing lattice has not undergone appreciable distortion. The plate which accompanies their paper in the *Annalen der Physik* (No. 23) shows distinctly the pattern of nickel oxide (NiO) superposed on that of

nickel, when in order to test the sensitivity of the method, a mixture of the two substances was taken which contained only 2 per cent. of the former.

USE OF THE GEIGER ELECTRICAL COUNTER.—The conditions under which this instrument can be used to enumerate β-rays accurately have been studied by Dr. N. Riehl in Fräulein Meitner's laboratory in Berlin, and are described, together with some allied work on radium *D* and radium *E*, in the *Zeitschrift für Physik* of Jan. 13. An important point overlooked by previous investigators is that in order to record with certainty a fast β-particle, producing less than about ten pairs of ions per cm. at atmospheric pressure, the density of gas in the ordinary type of counter must be increased. Dr. Riehl considers that neglect of this factor, and the application of an unduly large correction for reflection at the source, make previous estimates of the number of β-particles from radium *E* too small, and gives 1·2 as a new minimum value; in other words, about one in six of the particles constituting the continuous spectrum with speeds up to about 0·94 that of light are of secondary origin. The radiation from radium *D*, on the contrary, could only be partially recorded when the stopping power of the celluloid window of the counter was reduced to 0·45 mm. air-equivalent, and apparently the bulk of the primary β-rays from this element have velocities less than one-fifth that of light.

MINERS' LAMPS.—The flame of a modern safety lamp is quite visible through the glass cylinder which now forms the lower part of the lamp, and the candle power of the lamp varies from 0·8 to 1·2. The problem of increasing this candle power has been under consideration by the Safety in Mines Research Board for some time, and Paper No. 40 just issued by the Board (London: H.M. Stationery Office) gives an account of the work of Prof. R. V. Wheeler and Mr. D. W. Woodhead in this direction. They find that by using a blend of petroleum spirit with paraffin and mineral colza, an increase of 35 to 40 per cent. in the candle power is obtained. By increasing the height of the wire gauze chimney, using a wider mesh, a thinner wick with its top concave upwards and by surrounding the upper part of the flame by a short length of glass tubing open at top and bottom, the candle power can be raised to 2·75. It is to be hoped that these possibilities will become widely known and that lamp manufacturers will quickly place these improved lamps on the market.

THE PHOTOGRAPHIC DETECTION OF FALSIFIED DOCUMENTS.—Prof. Carlo Bonacini contributes an article on this subject to the *Rivista Fotografica Italiana*, a translation of which appears in the *British Journal of Photography* for Jan. 20. He finds that a photograph made by means of the infra-red shows chiefly superficial details, while the ultra-violet brings out detail more in the body of the document. This method demonstrated in one case that underneath the visible number was another number, invisible: that it had been effaced by chemical means, but had evidently left a clear trace in the fibres of the paper. He also confirms the work of Colson, that a document written in an easily oxidisable ink (as iron gallate), if left for a sufficient time in contact with a gelatino-bromide plate, will cause desensitisation where the ink is, so that if the plate is developed after a brief exposure to light, the writing will be shown transparent on a grey background. Prof. Bonacini finds that by this means one can reproduce an inscription that has been bleached by chemical means. In an example, the visible inscription being written with an ink made with a dye, this method revealed only the original writing that has been bleached and was quite invisible. He enumerates certain details in connexion with these methods that need further investigation.

HIGH TEMPERATURE EQUILIBRIA.—An ingenious method for the investigation of high temperature equilibria has been developed by C. H. Prescott, Jr., and W. B. Hincke, and some new results are recorded in the November issue of the *Journal of the American Chemical Society*. The furnace employed consisted of a thin graphite tube about one-third of a centimetre in diameter, supported on tungsten rods and mounted in a bulb in a thermostat. The materials were placed in the tube and the temperature raised by passing a heavy current through the graphite. An optical pyrometer was used to determine the temperature. The equilibrium between thorium oxide, thorium carbide, and carbon monoxide was investigated between 2000° and 2500° K. at pressures varying from 2 cm. to 2 atms. The thorium carbide, ThC_2, produced was a yellow crystalline substance which hydrolysed in a short time to a buff-coloured powder even over phosphorus pentoxide. Its melting-point is in the neighbourhood of 2773° K. The aluminium oxide and carbon system was similarly examined. The data obtained were utilised to calculate the free-energy and heat-content changes attending the reactions:

$$ThO_2 + 4C = ThC_2 + 2CO;$$
$$2Al_2O_3 + 9C = Al_4C_3 + 6CO.$$

CIRCUIT BREAKING AT HIGH PRESSURES.—The new problems which electrical engineers have to consider are mainly connected with high pressures and methods of breaking circuits supplying large amounts of electric power. The use of high pressure is made necessary by the greater distances the power has to be transmitted. Problems connected with underground cables up to pressures of 100 kilovolts and overhead wires up to 380 kilovolts have been practically solved, but engineers are still chary about adopting them. The solutions for high pressures cannot be obtained by a simple proportional increase of the dimensions of apparatus and cables. Entirely new electro-technical problems are involved which need exhaustive and prolonged study in the laboratory before the engineer can safely proceed to carry out high-pressure schemes involving the control of huge amounts of power. The question of the rupturing capacity of large oil-break circuit breakers can only be solved experimentally. Not even a roughly approximate theory has yet been given to indicate the effects that would be produced by increasing the number of breaks in a circuit or increasing the speed at which the contact pieces separate. This is a rich field for research and offers excellent prospects of technical developments. In *A.E.G. Progress* for October, Dr. Rengier discusses the relative advantages of multi-break interruption and explosion chambers in circuit breakers for use in polyphase systems. The arc which occurs on the separation of the contacts converts the oil in its neighbourhood into gas and vapour. As the oil gas mixes with the metallic vapour, the metallic vapour arc alters into a gas arc. The gas, which is under considerable pressure, offers increased resistance to the maintenance of the arc. On the other hand, the high gas temperature diminishes the resistance. The author shows that by fitting the oil circuit breaker with 'explosion chambers,' increased security can be obtained as the energy liberated in the apparatus is diminished.

Geology in Great Britain.

THE *Summary of Progress of the Geological Survey* [1] for the year 1926 is more than usually interesting, because it contains not only the annual report of the Geological Survey Board and that of the Director, but also a series of appendices in which are presented the results of some of the more important investigations made during the year under review.

Revision of the six-inch maps is being actively carried on in most of the British coalfields. Sixty-four maps were published last year, together with a number of memoirs, some of which are noticed briefly below. The appendices include accounts of the Silurian rocks of Wenlock; the Carboniferous Limestones of Cumberland and the Isle of Man; the Barnsley Seam; the Pliocene of the Surrey Downs; the Ochil Fault; and, perhaps most noteworthy of all, a long technical paper on "The Use of the Torsion Balance in the Investigation of Geological Structure in South-West Persia." This very able report, by W. E. P. McLintock and J. Phemister, provides a welcome account of the method of investigating deep-seated structures by means of the Eötvös balance, and also of some of the actual results achieved by the Anglo-Persian Oil Company. The latter is to be congratulated for its generosity in consenting to the publication of a report which the Board rightly felt would be of outstanding interest to geologists generally.

A memoir on the Wrexham District [2] describes the area represented on Sheet 121, an area that lies mainly within the county of Denbigh and includes the densely populated belt of the Denbighshire coalfield. The geological sequence described ranges from the Bala formation to the top of the Millstone Grit, which, in this neighbourhood, is roughly equivalent to the upper part of the Carboniferous Limestone. Special attention is devoted to the tectonic features of the district, and to the chief fossil localities.

The Stafford memoir [3] describes the area of Sheet 139, an agricultural district of red Keuper Marl and lighter Bunter and Glacial soils that lies between the Potteries and the South Staffordshire coalfield. The formations present include small patches of Carboniferous Limestone and Middle Coal Measures, but the Triassic rocks are dominant. Petrologists will be specially interested in the account of the Dyke of Butterton and Swynnerton, a dyke which is remarkable in that it cuts Triassic rocks. Various mineral products are described, including salt and brine; and the chief sources of water supply are discussed.

The area of the Rossendale Anticline [4] stretches west from the Pennines into Lancashire and embraces the high ground between the towns of Blackburn, Burnley, Todmorton, Rochdale, Bury, and Bolton. The structure and stratigraphy of the local Carboniferous rocks are described in more detail and greater precision than have hitherto been possible, palæontological methods of classification and correlation having been successfully adopted. The zonal forms of the difficult Millstone Grit series recently worked out by Mr. W. S. Bisat have been critically checked in this area. Other chapters are devoted to the glacial deposits and to various mineral products, of which coal is, of course, the chief.

The country around Ipswich [5] is of extraordinary geological interest, a fact which is partly due to and partly proved by the active research which it has stimulated in recent years. It typifies the late Cretaceous, Tertiary, and Pleistocene geology of East Anglia, and, thanks to the labours of Mr. J. Reid Moir, it has yielded a more complete series of worked flints than any other district in Britain. Dr. G. Slater has found in the glacial formations structures of which the investigation has led to most valuable and far-reaching results. Prof. P. G. H. Boswell has made many authoritative contributions to the geology of the district. His life-long interest in the area, and the inevitable linking of his name with the history of its investigation, make it particularly appropriate that his services should have been enlisted by the Survey to prepare the official memoir. The hand-coloured map is now replaced by a new colour-printed edition of Sheet 207, the price of which is two shillings.

[1] "Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the year 1926." Pp. xi+202+6 plates. 4*s.* 6*d.*

[2] Explanation of Sheet 121: "The Geology of the Country around Wrexham. Part 1: Lower Palæozoic and Lower Carboniferous Rocks." By C. B. Wedd, Dr. B. Smith, and Dr. L. J. Wills; with a Contribution by G. W. Lamplugh. Pp. ix+179+4 plates. 4*s.* 6*d.* net.

[3] Explanation of Sheet 139: "The Country between Stafford and Market Drayton." By T. H. Whitehead, E. E. L. Dixon, R. W. Pocock, Dr. T. Robertson, and T. C. Cantrill. Pp. vii+128+5 plates. 8*s.* 6*d.* net.

[4] Explanation of Sheet 76 (Rochdale): "The Geology of the Rossendale Anticline." By W. B. Wright, Dr. R. L. Sherlock, D. A. Wray, W. Lloyd, and L. H. Tonks. Pp. viii+182+7 plates. 4*s.* 6*d.* net.

[5] Explanation of Sheet 207: "The Geology of the Country around Ipswich." By Prof. P. G. H. Boswell. Pp. vi+121+4 plates. 3*s.* 6*d.* net.

All the above publications are published by H.M. Stationery Office, London, and the Ordnance Survey Office, Southampton.

A New Reflex Micrograph.

THE increasing use of the microscope for routine tests, and as an instrument of control in the factory, has resulted in directing the attention of makers and users to the production of microscopes of the projection type. The use of such instruments obviates the eyestrain that arises from prolonged and continuous observation at the eyepiece of an ordinary microscope. A new type of instrument—the Ramsden reflex micrograph—which has been designed by Lieut.-Col. J. V. Ramsden, and is marketed by Messrs. Micrographs, Whiston, Ford, Shrewsbury, and by Messrs. James Swift and Son, 81 Tottenham Court Road, London, W.1, constitutes a combined projection microscope and photomicrographic outfit embodying several novel features. In its mechanical design and construction, the instrument entirely departs from the traditional form of microscope stand.

The microscope tube carrying the objective and the ocular, with the objective pointing upwards, is fitted into a long bush in the box-like metal body of the instrument. Vertical guide bars mounted at one side of the body carry a lamp-house which contains a source of light for use when transparent objects are being examined. By means of a mirror mounted on the vertical guides, the rays of light from the lamp are reflected through the microscope on to a metallic mirror, from which they are reflected on to a screen so placed as to be convenient to the eye and close to all the controls for the operation of the instrument. The screen is shaded by a hood into which a mounted magnifying lens may be inserted when it is desired to examine the aerial image or to obtain more critical focussing.

When a photographic record of the image is required, the screen is withdrawn and a photographic plate inserted in its place. A recess in the metal of the body permits of the insertion of a ruled glass plate just below the screen or the photographic plate, by means of which objects may be measured at a glance or records of the measurement may be obtained on each

photograph. The title, or a description of the object under examination, may also be obtained on the plate at the same time as the object is photographed. A card on which the title has been written is placed on a slide which is inserted through an opening in the side of the body. The card is illuminated by a lamp within the body and its image projected by a lens on to the photographic plate.

The rack and pinion movement of the usual type of microscope has been replaced by a spiral screw of 1 mm. pitch cut on a cylindrical steel rod. This rod passes through an adjustable hollow pillar which is mounted vertically at one side of the body. The stage and the sub-stage are clamped to this pillar and can be moved up or down by turning the divided head at the top of the rod. Fine adjustment is effected by the rotation of an eccentrically mounted steel disc operating a lever, the short arm of which raises or lowers the pillar carrying the stage.

For the observation of opaque objects the instrument is provided with two horizontal guide bars mounted on the top of the body. These carry a second lamp house and also a condensing system. Vertical illumination is obtained by means of reflectors of the Beck universal type which can be slipped into a mirror holder mounted on the microscope tube in such a manner as to be capable of being moved backwards and forwards, and of being tilted in any direction. Entire control of the illumination is thus obtained.

The instrument described can be used for metallurgical, biological, or petrological work. Simpler types have been designed for use in routine work, where a universal instrument is not required. Geometric bearings have been adopted for all sliding parts so as to secure ease of movement and accuracy of adjustment. The instrument is built throughout on the lines of a precision machine tool. The design obviates the introduction of any delicate part, and the construction is such that the instrument may, if necessary, be put into the hands of an unskilled operator without fear of damage.

A New Bottom-Sampler for Oceanographical Research.

PROF. MARTIN KNUDSEN has published (*Meddelelser fra Kommissionen for Havundersøgelser*, Serie: Fiskeri, Bind 8, Nr. 3, 1927) an account of a new instrument which he has designed for obtaining samples of the sea bottom, together with the animals living therein. It is specially designed for use on hard bottoms, such as compact sand, where it has been realised that the instrument in most general use, the Petersen grab, is seriously lacking in penetrative power. The new sampler is filled by means of a pump which surmounts it, and the catch is retained by an ingenious 'tipping' device. The pump is operated from on board, being driven by a drum which is made to revolve by the same cable that serves for lowering and hauling the machine. An excellent feature of the sampler is that, when operating properly, it provides a sample which is stratified as *in situ*.

An accompanying paper (Nr. 4 of the same publication) by Dr. A. C. Johansen gives an account of the preliminary trials of Prof. Knudsen's sampler and furnishes a quantitative comparison of the samples obtained by this method with samples collected at the same time and under the same conditions by means of the Petersen grab. The trials show that the new instrument samples the sea-floor to a depth of 12·0-25·0 cm., as compared with a penetration of but 0·5-3·0 cm. by the Petersen grab. The area sampled is 0·1 square metre, and tables are given comparing the catches with those by two Petersen grabs sampling 0·1 square metre and 0·2 square metre respectively.

The quantitative results of these comparison tests are very striking. The average amount of bottom material per unit area taken by the Knudsen sampler on sandy bottom was found to be more than twenty times that taken by the smaller Petersen grab and more than ten times that taken by the larger. The average weight of animals captured per unit area was about five times that taken by the smaller grab and about four times that by the larger. The alcohol weight of the animals taken in one comparison off Fanø was for the Knudsen sampler about thirty times that obtained with the smaller grab and more than twenty times that with the larger, whilst the bulk of the species taken were totally unrepresented in the grab hauls, showing conclusively the vital importance of penetrating far enough into the bottom to obtain the burrowing species.

There is, therefore, ample evidence of the success of Prof. Knudsen's bottom sampler and of its importance and value for quantitative investigation of the sea bottom. The sampler is necessarily somewhat complicated and as described would probably be difficult to operate in other than calm and shallow waters. The principles embodied in it, however—utilisation of pressure to fill the sampler and the 'tipping' device for retaining the catch—will be of great service to all concerned in the elaboration of methods for investigating marine bottom populations.

Science and Primary Production.

IN his presidential address to the Australasian Association for the Advancement of Science, at Hobart, on Jan. 16, Mr. R. H. Cambage referred to the great need for the further application of science to primary production. This embraces such fundamental utilities as the production of grain, fruit, butter, wool, and meat, and it is a matter for satisfaction that the Commonwealth and State Governments, as well as private bodies, are showing increased appreciation of the value of science to these problems. A few years ago a thorough knowledge of dairy bacteriology and its application to the production of butter, resulted in increasing the output of first grade butter in New South Wales from 48 to 96 per cent.

When referring to wheat Mr. Cambage said: "It is difficult to find anything among the primary products of Australia which owes more to science than wheat production. This is a matter of national concern, and it is most comforting to know that the great pioneering work carried out by William James Farrer is not only being continued at Departmental experiment farms and Universities, but with most progressive results. New and better drought and rust-resisting varieties of wheat and other grain are being produced, and experiments are being made for the purpose of breeding rust and flag-smut-resisting plants which will also have other good characters."

Reference was made to the action of the pastoralists in arranging for the Australian Pastoral Research Trust to receive a contribution at the rate of two shillings

a bale of the 1927 wool-clip, with the hope of raising £200,000 for scientific research in connexion with the industry. This action Mr. Cambage regards as a most definite advance in Australia in the recognition of the benefits of science.

The Federal Government recently invited five leading pastoralists to act as a committee to inquire into the conditions of the pastoral industry in Australia, and advise on the best methods of conserving the national wealth represented by the industry. This provides further evidence that the authorities concerned are quite alive to the necessity of abandoning the old happy-go-lucky methods of trusting to chance in regard to seasons, but rather look for the introduction of some reasonable scheme of insurance that may have for its object the avoidance of excessive losses rather than the making of enormous profits.

Mr. Cambage concluded the first portion of his address by saying that it is the desire of the Australasian Association for the Advancement of Science, which includes New Zealand, to inspire and stimulate a science sense in the public mind, and this, he believes, can best be done by demonstrating how the principles of pure science may be applied successfully to familiar economic problems.

University and Educational Intelligence.

BIRMINGHAM.—The annual meeting of the Court of Governors is to be held on Feb. 23. The Vice-Chancellor, in his report to be presented to the Court, gives the usual statistics, which show that the number of students for the year 1926–27 was the lowest since the post-War boom. The number for the current session, however, shows an increase.

The sixth annual report of the Joint Standing Committee for Research is a record of the work accomplished and in progress during the session, and indicates a healthy activity in all faculties. Among the donations recorded is one from "a Firm in Birmingham" for research in the recent history of industry in Birmingham and the Midlands. This research is being carried out by the Faculty of Commerce. The anonymous charitable trust which has hitherto subscribed £600 per annum to meet the stipend of the reader in geography, has now decided to hand over to the University sufficient capital to produce the necessary income annually, thus putting the readership on a permanent basis.

CAMBRIDGE.—Dr. D. R. Hartree, St. John's College, and Mr. T. M. Harris, Christ's College, have been elected to fellowships at Christ's College. Mr. L. R. Jones, Emmanuel College, has been elected to the Nita King Scholarship for research in the etiology, pathology, and prevention of fevers.

The Council of the Senate has presented to the University a report proposing to open to women candidates from Girton and Newnham College, on the same terms as to men, practically all the scholarships, studentships, and prizes at present confined to members of the University.

LONDON.—Mr. M. E. Delafield has been appointed, as from a date to be determined later, to the University chair of chemistry as applied to hygiene tenable at the London School of Hygiene and Tropical Medicine. He was educated at Merchant Taylors' School and at Jesus College, Cambridge (Scholar and Exhibitioner). From 1910 until 1916 he was engaged in medical practice, and from 1920 until 1925 he was Deputy Medical Officer of Health for the Metropolitan Borough of Stoke Newington. Since 1925 he had been head of the Department of Public Health and Hygiene at University College. He has acted for some time as one of the sectional editors of the *Bulletin of Hygiene*.

The following doctorates have been conferred: *D.Sc. in Biochemistry* on Mr. H. G. Reeves (King's College) for a thesis entitled "Researches on Intermediate Carbohydrate Metabolism—the Preparation, Properties, and Physiological Significance of dl-Glyceric Aldehyde"; *D.Sc. in Zoology* on Mr. B. K. Das (Imperial College (Royal College of Science)), for a thesis entitled "The Biology and Post-larval Development of some Air-breathing Fishes of India"; *D.Sc. in Engineering* on Mr. H. W. Swift, for a thesis entitled "Orifice Flow," together with seven subsidiary contributions.

Dr. E. L. Kennaway has been awarded the William Julius Mickle Fellowship for 1928 in respect of the work he has carried out on cancer research during the past five years. The Fellowship this year is of the value of about £275.

OXFORD.—In a Convocation held on Jan. 31, the annual reports of the Committees for Anthropology and Forestry were presented to the House, and leave of absence was granted to the Savilian professor of geometry, Prof. G. H. Hardy, in order to enable him to exchange work for the next two winter terms with Prof. O. Veblen, of Princeton University. On the same day a vote of thanks was accorded to Sir John Findlay, Bart., for a gift to the Lewis Evans Collection of Scientific Instruments of a valuable silver microscope made by George Adams for King George III.

Alternative decrees for dealing with the Bodleian Library will be proposed in Congregation on Tuesday, May 8 next.

DR. GUSTAV HERTZ, professor of experimental physics in the University of Halle, has been appointed to succeed Prof. Kurlbaum as professor of physics at the Technische Hochschule, Berlin.

FIVE Fellowships, each of the annual value of £200 and tenable for two years, are being offered to graduates of the University of Wales. Applications should be sent to the Registrar, University Registry, Cathays Park, Cardiff, not later than June 1.

APPLICATIONS are invited by the London School of Hygiene and Tropical Medicine for the Wandsworth scholarship for research in tropical medicine, value £370 per annum, plus travelling and subsistence allowance for work overseas. The latest date for the receipt of applications by the Secretary, School of Hygiene and Tropical Medicine, Malet Street, W.C.1, is April 29.

LEPLAY House Educational Tours Association is organising three tours for the coming Easter vacation: to the Balearic Islands, under the leadership of Mr. G. Morris; to Normandy with Mr. W. Keesey; to Montpellier with Prof. P. Geddes. Particulars can be obtained from Miss Margaret Tatton, Leplay House, 65 Belgrave Road, Westminster, S.W.1.

THE annual examinations will be held at Faraday House Electrical Engineering College on April 3–5 for a Faraday Scholarship of fifty guineas per annum, tenable for two years in College and one year in manufacturing works, and for a Maxwell Scholarship of fifty guineas per annum, tenable for one year in College and one year in works. Exhibitions may also be awarded. Particulars can be obtained from the Registrar, 62-70 Southampton Row, London, W.C.1.

Calendar of Customs and Festivals.

February 14.

ST. VALENTINE'S DAY.—St. Valentine, priest and martyr at Rome under Claudius II., the patron saint of lovers and more particularly of girls, for no reason which is very apparent from his legend. Traditionally he is characterised by the attribute of chastity. The most noteworthy event in his life is the restoration of her sight to the blind daughter of the Roman official Asterius, in whose house he was confined, which led to the conversion of the whole household. They were afterwards martyred with him. The obscure and indeed almost incongruous coupling of the saint with lovers has been explained as a substitution by the church of his festival for one observed at about this time by the Romans, more specifically said to be a feast of Juno Februata, in which boys and girls pledged themselves to one another. It is doubtful how far this explanation has the warrant of antiquity. St. Francis de Sales is said to have forbidden the custom of valentines, that is of giving boys in writing the names of girls to be waited on and admired by them, and substituted billets with the names of certain saints to be honoured and imitated. Another tradition bases the association on the fact that the saint's martyrdom took place at the time of the great Roman festival of purification, on Feb. 15—the Lupercalia. The legendary connexion with Roman observances associated with the spirit world is also indicated in the belief, noted in the old Romish calendar quoted by Brand, that ghosts walk on the night of Feb. 14.

In popular custom, the traditional observances of the day go back to at least mediaeval times. The custom of choosing valentines obtained in the fifteenth century, as is shown by one of the Paston letters, and there are references to it in the poems of Charles of Orleans, written while he was captive in England, and in Lydgate, Chaucer, and Gower, and frequently in poets of later days. In the poets, as in rustic tradition, the day is also associated with the pairing of birds. Similar customs were noted in France, and, though scarcely relevant, mention may be made of a belief embodied in a quatrain in a French almanack for 1672 on the virtues of blood-letting on St. Valentine's Day.

The pledging of lovers on St. Valentine's Day might be by chance, the first member of the opposite sex seen on the morning of Feb. 14 being the Valentine, or it might be a matter of deliberate choice. The most widely prevalent early form of the custom, however, was by lot, each member of a party—first the boys, then the girls—drawing a slip of paper on which the name of a member of the opposite sex was written. The difficulty of the double lot was overcome by preference or by the lot drawn by the boy prevailing. In its less sophisticated form the lot of the valentine was regarded as a good omen of the pair becoming man and wife. The choice of a valentine, whether deliberate or fortuitous, entailed some obligation on the man to confer gifts on his valentine—an obligation which in Scotland was reciprocal, and perhaps originally was so universally. The gifts were sometimes of considerable value, such as the jewel of the value of £800 given to Miss Stewart by James, Duke of York, at the Court of Charles II. Pepys, who mentions the drawing of valentines on several occasions, also dwells on the expense to which he was put by the presents involved. The custom of sending presents to the valentine survived well into the nineteenth century. Pepys also records the drawing of mottoes for the valentine in addition. This is one of the earliest references to the literary form of valentines, which later came to be sent anonymously, and from being poetical degenerated into the comic or even the obscene, before it practically died out, at any rate as a generally observed custom, in the latter part of the nineteenth century.

Young people greeting their parents and others with "Good morrow, valentine," the first thing in the morning, before themselves addressed, were said to 'catch' their valentine. A present followed. In Norfolk the 'catch' had to be effected before sunrise; otherwise the would-be catcher was 'sun-burned.'

Other customs associated with St. Valentine's Day are of some significance. Its connexion with the pairing of lovers made it a time especially suitable for divination in connexion with love affairs. Various methods were practised, such as a triple drawing of lots, or by the number of objects seen through a keyhole, or by casting various names on paper wrapped in clay pellets into water. A ritual not dissimilar from that enjoined on the eve of St. Agnes, including the eating of an egg which had been stuffed with salt, was observed in order to obtain a vision of the future consort. Girls were told to pray, with their legs crossed, to St. Valentine on this day for good luck. Another method of divination practised on the eve of St. Valentine was to scatter hempseed on the way home, after a vigil in the church porch, while reciting a charm. This evoked the image of the future mate raking up the hempseed into a winding-sheet. Here, as often, divination is close to the spell.

In some parts of the country the children roamed from house to house singing a valentine song for coppers. In Herefordshire they decorated themselves with wreaths and lovers' knots thrown to them from the house first visited; but one of their number, the youngest and a boy, was decked out more gaily than the rest. This brings the valentine into touch with the central figure of spring festival processions.

A Derbyshire custom was 'sweeping the girls.' If any girl were not kissed or visited by her sweetheart early in the morning, it was because she was 'dusty.' She was then swept with a broom and well kissed by the young men in the house or from the neighbourhood.

Finally, a curious custom from the west of England may be noted. Three single young men went out together at daylight with a clap net to catch an owl and two sparrows in a neighbouring barn. If they were successful, and could bring the birds to the house before the women had risen, they were entitled to three pots of purl in honour of St. Valentine.

The obvious difficulty in attempting to associate St. Valentine in any way with the popular customs and beliefs observed on his day and the character of the observances themselves, notwithstanding their sophistication in many respects, point not only to a pagan but also to a very remote origin. It is obviously a pairing custom; but scarcely to be related, as an anticipation, to the strict observance of the ecclesiastical fast of Lent, when marriage or a formal betrothal could not be solemnised; nor does it appear cognate to the carnival, though it may have a common forerunner with that period of license. The fortuitous mating, which was sometimes thought to portend, and often did lead to, a wedding, the divination, and especially the triple lot, the interchange of gifts, which probably at one stage represented a forfeit for non-compliance with custom, suggest a derivation from a ceremonial period of unrestricted and universally imposed sexual intercourse such as is found among primitive peoples at stated seasons as part of a religious ritual for the promotion of fertility in the animal and vegetable world.

Societies and Academies.

LONDON.

Royal Society, Feb. 2.—**A. V. Hill**: The air-resistance to a runner. The air-resistance to a model of a running man has been measured in a wind-channel, and found to be $0 \cdot 45\ \rho v^2 A$, where ρ is density of air, v relative velocity, and A projected area of model in direction of motion. This is $0 \cdot 00170\ v^2 A$ lb. weight (v feet per sec., A sq. ft.). The projected area of a runner is approximately = square of his height $\times 0 \cdot 15$. For a runner on a still day the air never provides more than 5 per cent. of total resistance, the remainder being in his own muscles and limbs. A following wind of 10 miles an hour will increase speed about 3 per cent.; a similar head-wind will diminish speed about 5 per cent. The correction for air-resistance is too small to affect materially the equations previously found for the acceleration of a runner at the beginning of a race.

S. M. Manton: On the embryology of a mysid crustacean, *Hemimysis Lamornæ*. Germ layers and the general rudiment are differentiated externally on the germinal disc. Gastrulation takes place by immigration from a blastoporal area. The mesoderm forms in three ways. A row of eight mesodermal teloblasts give rise to the trunk mesoderm; a pair of head bands of mesoderm supply the naupliar segments and in front of these a pair of pre-antennulary somites is formed. Cœlomic cavities appear in all except antennulary, mandibular, and maxillulary segments. The yolk cells or vitellophags represent true endoderm. They form secondary yolk pyramids and give rise directly to mid-gut epithelium. The liver is formed from posterior parts of head mesoderm bands. The endoskeletal system is ectodermal, as is also much of the musculature. The antennal gland is mesodermal, except for the short ectodermal exit tube.

G. M. Findlay: Immunological and serological studies on the viruses of fowl-pox and vaccinia. Three strains of fowl-pox virus have been studied: two are pathogenic for the fowl only; one is pathogenic for fowl and pigeon. All attempts to render these three strains pathogenic for rabbits, rats, calves, and ducks have failed. One attack of fowl-pox produces immunity. In the fowl any one of the three strains completely immunises against the others, but in the pigeon previous treatment with the strains pathogenic for fowl produces only partial immunity against the strain pathogenic for pigeon and fowl. Vaccinia virus passaged in the fowl does not become converted into fowl-pox virus, and remains pathogenic for rabbit and rat. Vaccinia virus and fowl-pox virus do not show any cross-immunity in the hen. Anti-vaccinia serum from hen has no viricidal action on virus of fowl-pox, nor has anti-fowl-pox serum viricidal action on the virus of vaccinia. While fowl-pox virus easily passes through a Berkefeld filter, vaccinia virus, even after repeated passage in the hen, is still largely held back. No evidence was obtained showing any close relation between virus of vaccinia and the three strains of fowl-pox virus investigated.

E. Sprawson and F. W. Bury: The chemical evidences of the organic content of human enamel. Previous analyses of enamel differ widely, from an unmeasurable trace of organic matter to 16·56 per cent., most of the work being on enamels of lower animals. An attempt has been made, after eliminating carbonates, to estimate quantitatively the residue of carbon and total nitrogen present. If present as some form of protein, these should show the same ratio to each other as in protein, and from the amount of either found, the percentage of protein in enamel can be calculated. Specimens of human enamel were obtained from deciduous young permanent and adult permanent teeth. New tests, qualitative and quantitative, of particular delicacy and accuracy, showed both carbon and nitrogen to be present—nitrogen to an extent indicating a maximum organic content of 0·15 per cent., carbon indicating up to 0·21 per cent.

R. J. Ludford: Studies in the microchemistry of the cell (1). When sections of suitably fixed material are submitted to mild hydrolysis, treated with fuchsin-sulphurous acid, and thoroughly washed in sulphurous acid, the nucleo-proteids of cells are stained an intense purple or violet colour. Chromatin alone is stained in the cells. In sections through a tar tumour and surrounding skin, no difference was apparent in the amount of chromatin of normal and malignant cells. It was not found possible to correlate any relationship between amount of chromatin in tumour-cell nucleus and rate of growth of tumour. Large nuclei often contain approximately the same amount of chromatin as do small, but the giant nuclei which occur in some tumours, and are apparently formed by fusion of smaller nuclei, contain large masses of chromatin.

R. J. Ludford: Cytological studies on the viruses of fowl-pox and vaccinia. Virus bodies produced by vaccinia on the skin of the chick are exactly the same as those of fowl-pox, in structure, in origin, and in the development. Vaccinia virus produces in the epidermal cells of the rat's cornea inclusions closely resembling those of the chick, but differing fundamentally in the absence of covering osmophil substance, characteristic of virus bodies of the chick. Vaccinia virus can be transmitted from rat's cornea to the skin of the chick, where it results in the formation of characteristic virus bodies. Chick virus does *not* bring about the same result in epidermal cells of rat's cornea. One strain of fowl-pox was found to produce in epidermal cells of the pigeon the same type of virus bodies as in the chick, but was without action on epidermal cells of the rat's cornea.

Mineralogical Society, Jan. 10.—**L. J. Spencer**: Potarite, a new mineral discovered by the late Sir John Harrison in British Guiana. Small nuggets and grains of a brittle white metal have been found very sparingly by diamond-washers in the neighbourhoop of the Kaieteur Falls on the Potaro River. This mineral, previously erroneously described as 'allo-palladium,' was proved by Harrison to be a compound of palladium and mercury, PdHg, with a density (15·0-16·1) considerably higher than that of either of the component metals. There is a crystalline structure which on the surface of one nugget is shown as indistinct cubic octahedra. The original 'allo-palladium' from the Harz Mts., supposed to be a hexagonal modification of palladium, could not be procured for a re-examination; it is probably the ordinary cubic palladium.—**H. V. Ellsworth**: A simple and accurate constant-volume pyknometer for specific gravity determination. The pyknometer of 10 c.c. capacity is made of silica-glass, thus possessing several advantages over one made of ordinary glass. The stopper is perforated by a capillary and is continued into a graduated side-tube, which dips under water while the apparatus is cooling. The volume of the contained water to the graduations on the side-tube can be readily and accurately determined to 0·0002 c.c.—**W. Campbell Smith**: The optical orientation of labradorite from County Down (Ireland) determined by the Fedorov method. The labradorite from basaltic dikes at St. John's Point, Ardglass, Co. Down, of which the chemical composition and refractive indices were published in 1912, has been

studied by the Fedorov method and the optical orientation determined.

Geological Society, Jan. 11.—**G. M. Lees**: The geology of south-eastern Arabia. South-eastern Arabia consists of two separate tectonic and stratigraphic provinces: (1) A foreland where, as at Dhofar, ancient gneiss is overlain by a 'Nubian' type of desert-sandstone. (2) An orogenetic zone of typical Alpine character. The relation of Oman to the Zagros arc is discussed. The characteristic zone with red and green radiolarites and shales and basic igneous rocks occurs again in Persia, and forms great tracts of country south-west of Kerman. Here also Upper Cretaceous rocks are strongly unconformable. One great branch of the Cretaceous orogenetic zone of Central Persia must, therefore, have passed southwards into Oman. The Upper Cretaceous-Tertiary geosyncline broke down across the older strike, and pursued an independent direction parallel to the present Persian Gulf-Mekran coast. The late Pliocene movements also followed this trend, the influence of the older tectonics only being shown in the marked swing of the strike between Bandar Abbas and Jashk. Such a complete independence of these two phases of Alpine movement is unique. The Oman orogenetic zone may be followed through Masirah Island to Ras Madhraka, where it passes southwards into the Arabian Sea. The Kuria Muria Islands belong already to the foreland. A further movement, though of much less intensity, took place in Oman in post-Miocene time. South of Sur these folds strike north-west and south-east, and appear to pass out to sea at Ras al Hadd, independent of, and across, the older structures. Perhaps these folds form a continuous loop with the Kirthar Range of Sind, but no connexion can have existed between the latter and the Cretaceous orogen of Oman. The Triassic, Lower, and Upper Cretaceous fossils are described.

PARIS.

Academy of Sciences, Jan. 3.—**V. Smirnoff**: Orthogonal polynomials with one complex variable.—**Florin Vasilesco**: Some points in the theory of harmonic functions.—**Georges Valiron**: A general theorem on meromorph functions of positive order.—**L. Escande**: The technique of reduced models of barrages with overflow weir. Four models of the weir were made on a reduced scale, 1/19·5, 1/100, 1/150, and 1/300 of the actual weir, and the actual flow determined for each as a function of the head of water. The four curves shown do not coincide exactly. The yield shown by a model is less than the actual flow on full scale, the extrapolation error being on the side of safety. The divergence increases as the model is made smaller.—**L. Hirschauer and A. Talon**: The formula for the ultra-rapid propulsion of extra-light vehicles on rails.—**René Darbord**: The reactive power.—**M. Geloso and Mlle. L. S. Lévy**: Researches on selective adsorption.—**A. Wahl and J. Rolland**: The chlorobenzoylacetic esters.—**Mme. Ramart-Lucas and F. Salmon-Legagneur**: Intramolecular transposition by photochemical action. Isobutyl bromide after exposure to the radiation of a mercury arc lamp for four hours is partially converted (4 per cent.) into tertiary butyl bromide: after forty-eight hours' exposure, 13·5 per cent. is converted. The reaction is considered from the point of view of the hypothesis of semivalence.—**M. Gignoux**: A layer of Triassic vegetation near Saint-Jean-de Maurienne (Savoie).—**Albert Morel and Léon Velluz**: Contribution to the study of the biochemical synthesis of the glycerides. The reversibility of the diastatic action of the cytoplasm of castor-oil seed.—**Constant Mathis**: The identity of the spirochæte of the shrew mouse and the human spirochæte of Dakar. All the experimental work described tends to prove the identity of these two diseases. It only remains to find the agent of transmission from the animal to man.

ROME.

Royal National Academy of the Lincei, Nov. 6.—**G. Giorgi**: Doppler phenomenon of acceleration.—**S. Minetti**: The necessary and sufficient conditions for an entire function to be of a certain genus and of a certain order.—**S. Cherubino**: The notion of parity and the real character of real Abelian varieties.—**G. Vitali**: A covariant derivation in generalised absolute calculus (2).—**M. Pastori**: Bernouilli's surfaces.—**G. Gherardelli**: An observation on the Jacobian series of a linear series.—**B. Caldonazzo**: Certain properties of permanent liquid motions, the vortices of which are normal to the velocity.—**Lodovico Straneo**: The conditions of validity of some developments of functional operators.—**C. Cannata**: Contribution to the ballistic theory of variable stars.—**G. Tiercy**: The problem of the colour index in astronomy.—**G. Piccardi**: Relationships between the ionisation potentials of homologous elements. In the case of helium and the alkaline-earth metals, the relationship between the atomic number and ΔV, the difference between the ionisation potential of an element and that of the corresponding fundamental element—that is, the element having a single electron in the external orbit on which the element concerned has its peripheral electrons—is expressed by a continuous curve (1). In the zinc-cadmium-mercury group, passage from an element with one electron to one with two electrons (of the same orbit *s*) is accompanied by an increase in the ionisation potential which is a well-defined function of the atomic number. For other groups of elements, the laws connecting ionisation potential with increase in the number of electrons in the same orbit are obtained by multiplying the ordinates of curve (1) by 1 for the quadrivalent elements (C group), 2 for quinquevalent and sexivalent elements (N and O groups), 3 for the halogens, and 5 for the rare gases.—**A. Ferrari and C. G. Fontana**: Structure of silver chlorate. The lattice of this salt consists of a tetragonal cell of dimensions $a = 8{\cdot}48$ A. and $c = 7{\cdot}91$ A., containing eight molecules.—**L. Settimj**: Chemical composition of certain food species. The results of analyses are given for the following common Italian foods: tinned meats of various ages, fresh lean beef, cheese, stockfish, lean bacon, and dried mushrooms (*Boletus edulis*).—**C. Antoniani**: The influence of superphosphate on the reaction of the soil. When applied to neutral or almost neutral bare soils free from lime, superphosphate effects a gradual but slight acidification; the opposite results recorded by other investigators are influenced by the presence of a growing crop or by other factors.—**U. Panichi**: Independent elements of symmetry of the first and second species.—**E. Benedetti**: Certain modifications in the course of alcoholic fermentation due to the action of the oscillating electromagnetic field on the yeast (2). The alteration produced in the course of alcoholic fermentation by subjection of the yeast to an oscillating electromagnetic field for 35-40 minutes varies with the frequency of the oscillation. With a low frequency (272·7 kilocycles), the fermentation is accelerated, the extent of the acceleration increasing for some hours and then remaining virtually constant. A similar, but less marked effect is observed with a frequency of 400 or 500, whilst for the value 1200 the fermentation is retarded.—**T. Terni**: Histological modifications in the thymus of

birds resulting from castration and from old age.—**C. Gorini**: Investigations on disgenesic milk.—**V. Puntoni**: Elimination of the virus of rabies by the digestive tract. The results of experiments on dogs indicate that the old theory of the salivary elimination of the virus of rabies should be replaced by a more comprehensive theory, according to which the whole of the mucus and almost all the glands of the digestive tube must be regarded as surfaces for the elimination of this virus.—**A. Galamini**: The action of ethyl alcohol on the renal secretion. When ingested in the proportion of 0·5-0·75 c.c. per kilo of body weight, alcohol of 95 per cent. concentration, diluted to double its volume with water, invariably exerts a diuretic action, varying in degree with different individuals. The quantity of alcohol eliminated with the urine in successive periods follows the quantities of alcohol present in the blood at an interval of about 30 minutes, and reaches a higher level.

VIENNA.

Academy of Sciences, Nov. 10.—**L. Moser** and **J. Singer**: Determination and separation of rare metals from other metals (10). Three new gravimetric determinations of beryllium and separations based on them. By gallo-tannic acid in the presence of ammonium acetate, beryllium can be separated from iron, aluminium, chromium, titanium, zirconium, thorium, tungsten, and vanadium. A dense beryllium hydroxide can be precipitated by the hydrolysis of the beryllium ion with ammonium nitrite in the presence of methyl alcohol. A third method involves the formation of $Be_2P_2O_7$, similar to the magnesium method. A crystalline precipitate of the ammonium salt is obtained in the presence of weak acids (acetic or citric).—**R. Schwinner**: The structure of the mountains east of the River Lieser in Carinthia.—**L. Waldmann**: Geological structure of the Moldau-Danubian primitive rocks on the map sheet Gmünd-Litschau; also report on the geological survey of the Moravian primitive rocks in Lower Austria.—**A. Marchet**: Report on researches on the eruptive rocks of Gleichenberg in East Styria. Chemical analyses of trachite and andesite have been made.

Nov. 17.—**O. Halpern**: Quantum statistics.—**M. Holly**: Fishes from Kamerun - a new species of silurid.—**L. Kölbl**: Alpine tectonics of the Altvater hills.—**E. Chwalla**: The stability problem of a circular arc in a plane.—**W. J. Müller** and **K. Konopicky**: The theory of passivity: a theory of polarisation as to anodic covering and passivity of metals. A mathematical equation is given, and the cases of copper, iron, nickel, and chromium considered. The potential of the metal does not alter, but the apparent alteration of potential is to be traced to a change of resistance due to extension of a surface layer.—**A. Müller** and **A. Sauerwald**: New synthesis and purification of hexamethylenimine.—**E. Bersa**: Actinobiological researches. The action of Röntgen rays on the nuclear division of the root tips of *Zea mais*. There is a transitory depression of the frequency of cell division, but vegetative growth is not markedly altered. Also the influence of Röntgen rays on the respiration of the root-tips of *Vicia faba*.—**A. Zinke**, **K. Funk**, and **H. Ipavic**: Researches on perylene and its derivatives (16).—**A. Ginzberger** and **H. Zerny**: Expedition to the Lower Amazon, Pernambuco, and Para.

Nov. 24.—**A. Müller** and **E. Rölz**: A new and simple preparation of 1, 7-dioxy-*n*-heptane (heptamethyleneglycol) and 1, 7-dibrom-*n*-heptane.—**D. B. Anderson**: The structure of collenchyma cell-wall deduced from micro-chemical investigations. The cell-wall collenchyma of *Solanum lycopersicum* is neither chemically nor physically homogeneous, but consists of lamellæ which are alternately pectin and cellulose. Normal collenchyma between crossed Nicols appears to be doubly refracting. After treatment with ammonio-cuprous oxide, cellulose is removed, and the cell-walls are isotropic. The lamellæ can be separated after treatment with potassium iodide and sulphuric acid.—**A. Winkler**: New results of inquiries into the inner Alpine tertiary.

WASHINGTON, D.C.

National Academy of Science (*Proc.*, Vol. 13, No. 11, November).—**Arthur A. Noyes** and **Arnold O. Beckman**: A periodic table of the structure of atoms and its relation to ion formation and valence. A chart has been prepared from spectroscopic data showing the number, the quantum states and the energies of removal of the electrons from the outer shells of the atoms and ions of the first twenty-six elements. Atomic numbers are the abscissæ, and the square roots of the energies absorbed in the removal of the electrons from the atoms, in terms of the energy absorbed in removing the electrons from the hydrogen atom, are the ordinates. The chart indicates the mode of ion formation and is suggestive as regards valencies.—**Oliver R. Wulf**: The magnetic behaviour of ozone. An armature of pyrex glass (20 cm. long × 8 mm. diameter) was suspended from a balance so that the lower end came between the poles of a large electromagnet. The force exerted on the armature was measured when the armature was surrounded by air, oxygen, and an ozone-oxygen mixture. Experimental conditions produced effects comparable with the deviations to be measured, so the pyrex armature was replaced by a tube of soda glass containing oxygen at atmospheric pressure. The results showed that ozone is diamagnetic and its volume susceptibility is a small fraction of that of oxygen.—**Morgan Ward**: General arithmetic.—**W. L. Ayres**: On the structure of a plane continuous curve.—**E. T. Bell**: On the arithmetic of Abelian functions.—**G. A. Miller**: Groups whose operators are of the form s^bt^a.—**Joseph Kaplan**: The continuous spectrum of hydrogen. Horton and Davies observed that hydrogen at pressures less than 1 mm. of mercury, when excited by electrons of less than 15 volts velocity, becomes suffused with a blue glow with no atomic or molecular lines. This continuous spectrum appears to arise when the molecule, in the first electronic state and possessing more than 0·5 volt of vibrational energy, splits into two atoms.—**Arthur Edward Ruark** and **Harold C. Urey**: The impulse moment of the light quantum. It is suggested that the light quantum has a property corresponding to the spin of the electron. Various consequences of such a property are worked out and experiments likely to afford evidence of its existence are suggested.—**H. Bateman**: The symmetry of the stress-vector obtained by Schroedinger's rule.—**H. B. Vincent**: Some extensions of theory and measurement of shot-effect in periodic circuits.

Official Publications Received.

BRITISH.

Proceedings of the Royal Society of Edinburgh, Session 1926-1927. Vol. 47, Part 4, No. 25: The Structure and Movement of the Atmosphere as affected by Diurnal Variations. By A. H. R. Goldie. Pp. 320-358. 2*s.* 9*d.* Vol. 47, Part 4, No. 26: Some further Notes on the Salmon (*Salmo salar*) of the Moisie River (Eastern Canada). By W. J. M. Menzies and P. R. C. Macfarlane. Pp. 359-365+1 plate. 9*d.* (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 66, No. 373, January. Pp. 89-161+xxx. (London: E. and F. N. Spon, Ltd.) 10*s.* 6*d.*

The Collection and Preparation of Herbarium and Timber Specimens. By J. Burtt Davy and L. Chalk. Pp. 28. (Oxford: The Imperial Forestry Institute.)

Commonwealth of Australia. First Annual Report of the Council for Scientific and Industrial Research for the Period from the 18th April 1926 to the 30th June 1927. Pp. 64. (Melbourne: H. J. Green.)

The Institute of Journalists. Grey Book, 1928 (revised to December 1927). Pp. 184+xviii. (London.)

Report of the Botanical Survey of India for 1926-27. Pp. 10. (Calcutta.)

The Physical Society and the Optical Society. Catalogue of the Eighteenth Annual Exhibition of Electrical, Optical and other Physical Apparatus, January 10, 11 and 12, 1928. Pp. 134+xxii. (London.)

The Observer's Handbook for 1928. Edited by C. A. Chant. Twentieth Year of Publication. Pp. 72. (Toronto: Royal Astronomical Society of Canada.)

The South African Journal of Science. Vol. 24: Being the Report of the South African Association for the Advancement of Science, Salisbury, 1927, 29 June to 4 July. Pp. xliv+626. (Johannesburg.) 30s. net.

Report of the Fan Standardisation Committee appointed by the Institution of Heating and Ventilating Engineers, June 1927. Pp. 28. (London.) 2s. 6d. net.

Memoirs and Proceedings of the Manchester Literary and Philosophical Society, 1926–27. Vol. 71. Pp. 122+xliv+7 plates. (Manchester.) 12s.

Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society. Edited by H. Munro Fox. Vol. 3, No. 1, January. Pp. 91. (Cambridge.) 12s. 6d. net.

Blaise Pascal: an Address delivered by Sir Philip Hartog at the Convocation held on the 23rd December 1927. Pp. 26+ii. (Lahore: University of the Punjab.)

Agricultural Research Institute, Pusa. Bulletin No. 170: Seasonal Variations in the Germ Content of Milk at Pusa. By J. H. Walton. Pp. 12+2 plates. (Calcutta: Government of India Central Publication Branch.) 6 annas; 8d.

FOREIGN.

Proceedings of the United States National Museum. Vol. 72, Art. 12: Crystalline Carnotite from Utah. By Frank L. Hess and William F. Foshag. (No. 2708.) Pp. 6. (Washington, D.C.: Government Printing Office.)

Pisma Marjana Smoluchowskiego, z Polecenia Polskiej Akademji Umiejętności zgromadzone i wydane przez Władysława Natansona i Jan Stocka. Tom Pierwszy. (Œuvres de Marie Smoluchowski, publiées sous les auspices de l'Académie Polonaise des Sciences et des Lettres par les soins de MM. Ladislas Natanson et Jean Stock. Tome Premier.) Pp. xv+612. Pisma Marjana Smoluchowskiego, z Polecenia Polskiej Akademji Umiejętności zgromadzone i wydane przez Władysława Natansona. Tom Drugi. (Œuvres de Marie Smoluchowski, publiées sous les auspices de l'Académie Polonaise des Sciences et des Lettres par les soins de M. Ladislas Natanson. Tome Deuxième.) Pp. iv+650. (Krakowie: Drukarnia Uniwersytetu Jagiellońskiego; Paris: Ch. Béranger.)

Department of Commerce: Bureau of Mines. Technical Paper 420: *Geophysical Methods of Prospecting; a Brief and Elementary Account* of the Principles Involved. By A. S. Eve and D. A. Keys. Pp. iv+26. (Washington, D.C.: Government Printing Office.) 10 cents.

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft. 108 Jahresversammlung vom 1 bis 4 September 1927 in Basel. Pp. 138+282+57. (Aarau: H. R. Sauerlander et Cie.)

Videnskapsselskapet i Kristiania. Resultater av de Norske Statsunderstøttede Spitsbergenekspeditioner. Bind 1, Nr. 2: On the Mollusca of the Tertiary of Spitsbergen. By J. P. J. Ravn. Pp. 28+2 plates. 1.60 kr. Bind 1, Nr. 3: A Burning Coal Seam at Mt. Pyramide, Spitsbergen. By W. Werenskiold and Ivar Oftedal. Pp. 14+1 plate 1.20 kr. Bind 1, Nr. 4: The Spitsbergen Reindeer. By Alf Wollebæk. Pp. 71+6 plates. 10.00 kr. Bind 1, Nr. 5: Lichens from Spitsbergen, I. By Bernt Lynge. Pp. 21+2 plates. 2.50 kr. Bind 1, Nr. 6: The Coal Deposits and Coal Mining of Svalbard (Spitsbergen and Bear Island). By Adolf Hoel. Pp. 92+8 plates. 10.00 kr. Bind 1, Nr. 7: Contributions to the Biology of the Spitsbergen Char. By Knut Dahl. Pp. 12. 1.00 kr. Bind 1, Nr. 8: Notes on the Geology of Northwestern Spitsbergen. By Olaf Holtedahl. Pp. 28+7 plates. 5.50 kr. Bind 1, Nr. 9: Lichens from Bear Island (Bjørnøya) collected by Norwegian and Swedish Expeditions, chiefly by Th. M. Fries during the Swedish Polar Expedition of 1868. By Bernt Lynge. Pp. 78+2 plates. 5.80 kr. Bind 1, Nr. 10: Hopen (Hope Island), Svalbard. By Thor Iversen. Pp. 44+10 plates. 7.50 kr. Bind 1, Nr. 11: Mollusken aus den Redbay- und Greyhookschichten Spitsbergens. Von Werner Quenstedt. Pp. 107+4 Tafeln. 8.50 kr. Nr. 12: The Downtonian and Devonian Vertebrates of Spitsbergen. By Erik A:son Stensiö. Part 1: Family Cephalaspidae. A, Text. Pp. xii+391. B, Plates. Pp. iii+112 plates. 60.00 kr. (Oslo: Jacob Dybwad.)

Proceedings of the Imperial Academy. Vol. 3, No. 9, November. Pp. xxi-xxiii+579-636. (Tokyo.)

The School of Surveying of the American Geographical Society of New York. Pp. 16+2 plates. (New York City.)

Diary of Societies.

SATURDAY, FEBRUARY 11.

MINING INSTITUTE OF SCOTLAND (at Heriot Watt College, Edinburgh), at 3.—D. C. Gemmell: Supporting Underground Roadways with Steel Arches.—Papers open for discussion:—An Improved Face Conveyer, A. V. Reis.—The Transport of Injured Persons Underground, D. Davidson.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—H. C. Colles: Musical London from the Restoration to Handel (1660–1759) (2).

FÉDÉRATION BRITANNIQUE DES COMITÉS DE L'ALLIANCE FRANÇAISE (at London Day Training College), at 3.15.—M. Moureu: Marcelin Berthelot (Lecture).

HULL ASSOCIATION OF ENGINEERS (at Technical College, Hull), at 7.15.—W. A. E. Woodman: The Lubrication of Prime Movers.

MONDAY, FEBRUARY 13.

CHARITY ORGANIZATION SOCIETY (at Denison House, 296 Vauxhall Bridge Road), at 3.30.—Sir William H. Hamer, Dr. E. Graham Little, and Dr. H. Nockolds: Discussion on the Voluntary Hospitals and the Public Authorities. Chairman: Lord Dawson of Penn.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Dr. C. Crossland: The Island of Tahiti.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. A. Abrahams: The Physiology of Violent Exercise in Relation to the Possibility of Strain.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Miss Mary Chadwick: The Child's Early Discrimination between Sound and Speech.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Centre) (at Queen's Hotel, Birmingham), at 7.—C. R. F. Engelbach: Works Re-organisation to Increase Production.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—H. B. Poynder: Some Practical Considerations in the Design of Automatic Equipments for Heavy Traction Sub-stations.

CERAMIC SOCIETY (at North Staffordshire Technical College, Stoke-on-Trent), at 7.30.—F. West: Practical Experience of Firing Refractory Materials with Oil.—C. E. Jackson and A. Heath: Florida Clay in China Bodies.

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30—D. R. Tullis: Further Notes on Aluminium Alloys.

ROYAL SOCIETY OF ARTS, at 8.—H. Gough: Fatigue Phenomena, with Special Reference to Single Crystals (Cantor Lecture) (I.).

INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) (jointly with Society of Chemical Industry (Edinburgh and East of Scotland Section)) (at North British Station Hotel, Edinburgh), at 8.—Dr. Kermack and Dr. C. P. Stewart: Report upon the Preliminary Investigation into Personal Errors in Chemical Determinations.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Bristol).—A. H. Law and J. P. Chittenden: Higher Steam Pressures and their Application to the Steam Turbine.

TUESDAY, FEBRUARY 14.

ROYAL SOCIETY OF MEDICINE (Psychiatry Section) (at Maudsley Hospital, Denmark Hill), at 4.—Clinical Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. A. P. Newton: The Dependent Empire and the British Commonwealth of Nations, 1870–1926.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—C. Dalley: Causes of Fires in the Petroleum Industry and Methods of Prevention.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—T. Thorne Baker: Television and Electric Image Transmission.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Burnley Section) (at Municipal College, Burnley), at 7.15.—Mr. Goodyer: Semi-Steel.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Centre) (at Broadgate Café, Coventry), at 7.30.—C. R. F. Engelbach: Works Re-organisation to Increase Production.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—D. S. Munro: Modern Electric Wiring, particularly as applied to Small Houses.

QUEKETT MICROSCOPICAL CLUB (Annual General Meeting), at 7.30.—Presidential Address.

HULL CHEMICAL AND ENGINEERING SOCIETY (at Photographic Society, Grey Street, Hull), at 7.45.—J. B. Upton: Westinghouse Brakes.

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN, at 8.—C. E. Corfield and P. A. W. Self: The Correlation of Analytical Data and Accuracy in Dispensing.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Prof. F. G. Parsons: The Increasing Size of the Skull.

WEDNESDAY, FEBRUARY 15.

SOCIETY OF GLASS TECHNOLOGY (in Applied Science Department, Sheffield University), at 2.30.—W. Singleton: The Analysis of Opal Glasses.—J. T. Howarth and Prof. W. E. S. Turner: The Study of a Fundamental Reaction in Glass Making.—David Starkie and Prof. W. E. S. Turner: Note on the Ultra-Violet Ray Transmission of Colourless Bottle Glass.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Holborn Restaurant), at 2.30.—S. B. Horrocks: Presidential Address—Discussion on Report of the Fan Standardisation Committee.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—A. Fleming: Lysozyne, a Bacteriolytic Ferment normally present in Tissues and Secretions.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.30.—W. T. Shaddock: New Training Bank at South Haven, Poole Harbour.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—E. C. McKinnon: Storage Batteries in Relation to Modern Supply to Electric Lighting and Power.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (Newcastle-upon-Tyne), at 7.15.—L. C. Burrill: Floating Docks.

MERSEYSIDE AQUARIUM SOCIETY (at 1 Falkland Road, Egremont), at 7.30.—G. A. Dunlop: The Science of the Sea.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Dr. J. Glasspoole: The Distribution over the British Isles of the Average Number of Days with Rain during Each Month of the Year.—Memoirs to be discussed:—The Single-layer Problem in the Atmosphere and the Height-integral of Pressure, by L. F. Richardson and R. E. Munday.—The Variance of Upper Wind and the Accumulation of Mass, by L. F. Richardson, D. Proctor, and R. C. Smith.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—D. J. Scourfield: A New Type of Aquarium Microscope.—Prof. J. T. Wilson: Description of a Convenient Table for Microscopy.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Sir E. Owen Williams: Bridges.
ROYAL SOCIETY OF ARTS, at 8.—Capt. Sir Beachcroft Towse: The Education of the Blind.
ROYAL SOCIETY OF MEDICINE (Social Evening), at 9.15.—Col. W. P. MacArthur: Some Medical References in Pepys.
INSTITUTION OF MECHANICAL ENGINEERS (Liverpool Branch) (jointly with Liverpool Engineering Society).—Prof. C. J. Hawkes: The Marine Oil-Engine (Thomas Lowe Gray Lecture).
INSTITUTION OF MECHANICAL ENGINEERS (Sheffield Branch).—E. G. Herbert: Cutting Temperatures: Their Effect on Tools and on Materials subjected to Work.
INSTITUTE OF CHEMISTRY (Manchester and District Section).—Prof. J. R. Partington: Some Manchester Scientists.

THURSDAY, FEBRUARY 16.

EUGENICS SOCIETY (at Rembrandt Hotel, Brompton Road).—2.30 to 6.—Exhibitions. Demonstrations: Miss O. C. Lodge, Health and Education; Eldon Moore, Agricultural Shows.—At 7.15.—C. J. Bond: The Distribution of Natural Capacity in the Population and the Need for National Stocktaking (Galton Lecture).
ROYAL SOCIETY, at 4.30.—Prof. A. Fowler and E. W. H. Selwyn: The Arc Spectrum of Carbon.—R. H. Fowler: The Chemical Constant of Hydrogen Vapour and the Failure of Nernst's Heat Theorem.—A. H. Wilson: (*a*) The Ionised Hydrogen Molecule; (*b*) A Generalised Spheroidal Wave Equation.—O. H. Walters and S. Barratt: The Alkaline Earth Halide Spectra and their Origin.—*To be read in title only*:—Prof. T. R. Merton: On a New Effect in the Electric Discharge.—S. W. Watson and M. C. Henderson: The Heating Effect of Thorium and Radium Products.—C. C. Farr and D. B. Macleod: Some Physical Properties of Gas-tired Sulphur.—Prof. H. F. Baker: Note on the Paper 'Commutative Ordinary Differential Operators' by J. L. Burchnell and T. W. Chaundy.—L. S. Ornstein, W. Kapuscinski, and J. G. Eymers: Intensity Measurements in the Secondary Spectrum of Hydrogen.—P. A. M. Dirac: The Quantum Theory of the Electron (II.).
LINNEAN SOCIETY OF LONDON, at 5.—E. Heron-Allen: On the Further Researches of J. J. Lister upon the Reproductive Processes of *Polystomella crispa* L.—M. A. C. Hinton: False Killer-Whales in the Dornoch Firth.—Mrs. L. Hunter: Alcyonaria of the Abrolhos Islands.
LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—W. N. Bailey: Transformations of Generalised Hypergeometric Series.—P. Hall: Note on Soluble Groups.—Prof. L. J. Mordell: (*a*) The Magnitude of the Derivate of a Function; (*b*) A Summability Convergence Theorem.—G. Temple: The Computation of Characteristic Numbers and Characteristic Functions.—E. C. Titchmarsh: On Conjugate Functions.—F. J. W. Whipple: On Series allied to the Hypergeometric Series with Argument −1.
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: From Faraday's Note Books (III.). The Colours of Gold.
CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Sir Humphry Rolleston, Bart.: Child Guidance.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—A Cinematograph Film entitled Voices Across the Sea, illustrating the New Anglo-American Telephone Service.—D. S. Munro: Modern Electric Wiring, particularly as applied to Small Houses.—A. J. Milne and R. H. Rawll: The Domestic Applications of Electricity.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Dr. G. P. Douglas: Experiments on Model Air-Screws at High Tip Speeds.
SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Birmingham University), at 7.—Papers by Dr. W. J. Hickinbottom and Dr. E. L. Hirst.
CHEMICAL SOCIETY, at 8.—R. S. Morrell and S. Marks: Studies in China Wood Oil. Part II. The Oxidation of b. Elaeostearic Glyceride.—W. M. Madgin, J. B. Peel, and Prof. H. V. A. Briscoe: Cryoscopic Evidence of Compound-formation in Mixtures of Organic Liquids.—Prof. H. V. A. Briscoe and J. B. Peel: The Preparation and Properties of Selenophene, Tetrabromoselenophene and Tetrachloroselenophene.
LANCASTER ASTRONOMICAL AND SCIENTIFIC ASSOCIATION (at Storey Institute, Lancaster), at 8.—Dr. T. Green: Colour in Nature.
ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.), at 8.15.—Dr. A. R. Paterson: The Provision of Medical and Sanitary Services among Rural Populations in Tropical Africa.
INSTITUTION OF MECHANICAL ENGINEERS (Birmingham Branch).
INSTITUTION OF MECHANICAL ENGINEERS (Manchester Branch).—Major W. Gregson: Waste Heat Recovery.

FRIDAY, FEBRUARY 17.

GLASGOW UNIVERSITY ALCHEMISTS' CLUB (jointly with Andersonian Chemical Society) (at Glasgow University), at 3.30.—Debate.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. I. C. Mann: The Regional Differentiation of the Vertebrate Retina.
SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (jointly with Manchester and Fuel Sections) (at Liverpool University), at 6.—H. H. Thomas: An Examination of the Influence of Various Factors on the Products of Carbonisation of Coal.
INSTITUTION OF MECHANICAL ENGINEERS (Annual General Meeting), at 6.—Major W. Gregson: Waste Heat Recovery.
INSTITUTE OF MARINE ENGINEERS, at 6.30.—Annual Meeting.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Informal Meeting of Pictorial Group), at 7.—J. D. Johnston: Changing Ideals in Pictorial Photography.
JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—St. John Plevins: Oil Production.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Rev. Dr. E. M. Walker: The University: Its Ideals and its Problems.
SOCIETY OF DYERS AND COLOURISTS (London Section).—M. C. Lamb: The Dyeing of Gloving and Clothing Leathers.
SOCIETY OF DYERS AND COLOURISTS (Manchester Section, jointly with Junior Section).—F. Scholefield: The Standardisation of Fastness of Coloured Textiles.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Sheffield).—Conference on The Electrodeposition of Silver:—Dr. E. B. Sanigar: Recent Work on Electrodeposition of Silver.—A. E. Nicol: Silver Plating.

SATURDAY, FEBRUARY 18.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Newcastle-upon-Tyne), at 2.30.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—H. C. Colles: Musical London from the Restoration to Handel (1660–1759) (III.).
PHYSIOLOGICAL SOCIETY (in Department of Physiology, University, Manchester).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 11.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—M. A. Phillips: In the Haunts of the Sea-birds.

MONDAY, FEBRUARY 13.

GRESHAM COLLEGE, at 6.—G. P. Bailey: Modern Science and Daily Life: The Inter-relationship of the Elements.
EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—E. P. Weller: Factors affecting Farm Profits.
UNIVERSITY OF LEEDS, at 8.—Dr. Ll. Wynn Jones: Recent Advances in Experimental Psychology: Doctrines and Methods established during the last twenty-five years.

TUESDAY, FEBRUARY 14.

GRESHAM COLLEGE, at 6.—W. H. Wagstaff: Geometry. (Succeeding Lectures on Feb. 15, 16, and 17.)
BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at Royal Society of Arts), at 8.15.—Prof. J. Laird: The Possibility of Rationalism in Ethics.

WEDNESDAY, FEBRUARY 15.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.30.—Dr. W. M. Feldman: Medico-Legal Aspects of Jewish Life.

THURSDAY, FEBRUARY 16.

UNIVERSITY OF LEEDS, at 8.—A. N. Shimmin: Economics in Everyday Life: The Process of Earning a Living.

FRIDAY, FEBRUARY 17.

KING'S COLLEGE, at 5.30.—K. Kyriakides: Social Life in Cyprus in the Middle Ages.

SATURDAY, FEBRUARY 18.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Amulets and Magical Figures of the Ancient Egyptians.

CELEBRATION.

FEBRUARY 14 AND 16.

BICENTENARY OF JOHN HUNTER (at Royal College of Surgeons of England).
February 14, at 4.—Sir Holburt Waring: Hunterian Oration.
February 16, at 5.—G. C. Peachey: London Homes of the Hunters (Thomas Vicary Lecture).

CONFERENCE.

FEBRUARY 21 TO 24.

CARBONISATION CONFERENCE (in Birmingham and Midland Institute and Queen's College, Birmingham).

Tuesday, February 21 (in Birmingham and Midland Institute).
At 10.30 A.M.—
W. J. A. Butterfield: The General Scope of the Gas Industry.
T. Hardie: Some Phases of Modern Practice in Gas Manufacture.
T. Hardie: Presidential Address to the Southern Association of Gas Engineers and Managers.
M. Barash and T. C. Finlayson: Continuous Vertical Retorts.
N. J. Bowater: Vertical Intermittent Chamber Ovens for Gas Manufacture.
R. H. Ruthven: Intermittent Vertical Chambers.

Wednesday, February 22 (in Birmingham and Midland Institute).
At 10 A.M.—
C. P. Finn and R. Ray: The General Scope of the Coke Oven Industry.
G. J. Greenfield and G. H. Harrison: Modern Coke Oven Practice.
E. C. Evans: Coke Research and the Steel Industry.

Thursday, February 23 (in Birmingham and Midland Institute).
At 2.30—
T. F. E. Rhead: Steaming in Vertical Retorts.
A. T. Green: Gas Works Refractories.
Dr. A. Parker: Gas Works Effluents.

Friday, February 24 (in Queen's College).
At 10 A.M.—
Sir Arthur Duckham: The Handling, Preparation, and Utilisation of Gas Works Coke.
J. Roberts: Blending in the Gas and Coke Oven Industries.
At 2.15—
F. S. Sinnatt: A General Review of Low Temperature Carbonisation.

SATURDAY, FEBRUARY 18, 1928.

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Science and Leadership.

SOME instruction in science is now provided at most of the secondary schools in Great Britain. Such instruction, in the case of the boys' schools, usually takes the form of an introduction to chemistry and physics, while in girls' schools botany and chemistry are frequently the only branches of science taught. For various reasons, which have so often been the subject of reference in these columns that they need not be repeated now, those pupils who show any aptitude for science are mostly led for the last two years at school to tread the path of specialisation on their journey to the universities. They arrive at the universities embryo chemists, physicists, or botanists, where they are hatched out as full-fledged specialists destined to act as guides to others along the same narrow paths, or to apply their specialised knowledge to industry or in one or other of the public services. Only the comparatively few forsake the paths of specialisation and find scope in leadership and control for the exercise of the particular qualities of mind engendered by the study of science.

The demand for early specialisation in science is as vicious in principle and as harmful in its effects as the demand for any form of early vocational training for the children of the less favoured classes of the community. The revolt against the old-fashioned classical education was successful because the teaching of the classics had become so specialised that the main object of the study was obscured. It encouraged the worst forms of pedantry: it was de-humanised. There is abundant evidence that the teaching of science is suffering from the same disease. The spirit of science, the systematic observation of facts, the conception of hypotheses, to be discarded if they cannot be verified over a complete range of observations, or enunciated as universal if they stand such test, the constant challenge to established precedents and authority, is apt to be obscured by a mass of technical trivialities which passes for scholarship. The influence of scientific discovery upon man's outlook and activities is too often ignored by teachers of science. They incline to look at their several subjects from the inside, and thus not only lose sight of the unity of purpose of the whole range of scientific study, but also fail to appreciate the important impacts of this study upon our common stock of ideas.

At the recent meeting of the Science Masters' Association, Prof. W. A. Bone opened a discussion on "Industrial Openings in Scientific Technology."

He reminded his audience that the profound change in conditions during the past twenty-five years had increased the need in every branch of industry for scientific control and direction, not only in the actual processes of manufacture but also over the whole range of activities precedent and subsequent to the production of finished goods. The nation that could think farthest ahead and adjust its system accordingly was the nation that would deserve success. It behoved us, therefore, as a nation, to ensure that our industrial leaders were men trained in scientific method and in modern scientific thought, who could foresee change and prepare for it. At least seven years' training was necessary, three years studying fundamental science subjects before graduation, to be followed by four years of specialisation.

Within the limits of the subject under discussion, it was obviously difficult for Prof. Bone to deal with the more general applications of the principles he enunciated for industry. This is a pity. As we have already suggested, the teaching of science in schools and most universities is vitiated by over-specialisation, with the resulting tendency to produce experts in the narrowest sense of the term. What is most needed at the present time is an appeal to the science masters in our schools to break with a bad tradition, and by broadening the basis of instruction in science, particularly by the inclusion of biological studies, to extend the mental horizon of their pupils. University teachers will then be the better enabled to equip science students for the responsibilities attaching to the most coveted positions, not only in industry and finance but also in the spheres of higher administration in State and local government services, the various colonial services, and even the judiciary.

Most of us will subscribe to the view that no person can be considered well educated who lacks the equipment to discern the principal forces which are operating to mould our environment. Undoubtedly some knowledge of science and some training in scientific method are essential for such discernment. For the control and direction of affairs, more than this general training is and should be required. It is doubtful whether anyone who lacks the capacity for independent and perspicacious inquiry should be entrusted with the cares of leadership. The field of research is sufficiently extensive to provide abundant opportunity for testing such capacity. It behoves us to follow some such procedure in choosing our leaders, rather than continue to leave it to chance circumstance to produce them.

To prevent misunderstanding, let us state definitely that it is not contended that the creative research workers of any country should be hampered by administrative duties. Such research workers are sufficiently rare to be given every form of encouragement to extend the bounds of knowledge. Their requirements are met by giving them all the facilities they need for their work, the greatest amount of freedom from external control, and freedom from pecuniary worries. It does not follow that we agree with the oft-repeated assertion that such men are unfit for administrative control. The success of Newton as Master of the Royal Mint is by no means the exception which proves the accepted rule. Our view is that no country can afford the luxury of diverting them from the pursuit of new knowledge and its dissemination. Their gift of vision is the world's greatest asset: their function is leadership in a supreme degree. Happy the community that is intellectually equipped to appreciate their genius and possesses the will to follow them.

It is the other types of research workers for whom we consider more varied and abundant opportunities should be given for the exercise of their talents. They may be concerned with the critical examination of discoveries being made in a particular field of knowledge with the view of their application, or they may be engaged on what is embraced by the term 'development work.' But because of the existing prejudice in Great Britain against the so-called experts, they are rarely placed in a position to accept full responsibility for the execution of their ideas. Possibly this prejudice is more ingrained in the hierarchy of the Civil Service than elsewhere. Cases are on record where administrative officers have come to decisions on technical questions without even consulting the technical advisers of the department. It is repeatedly asserted in administrative circles that a man with intensive knowledge of a particular subject is incapable of unbiased judgment on any matter within its scope upon which there may be difference of opinion. Consequently, when a Royal Commission was appointed to inquire into the state of the coal industry, its members included no scientific authority. It is true that the Commission was assisted by a scientific assessor, but no actual member of the commission was competent to examine the scientific experts who gave evidence before it. We are assuming, of course, that finance and economics cannot be regarded as exact sciences.

Obviously there are historical reasons for the prejudice against the expert in the State service.

The prejudice, however, should be attributed to the expert's virtues rather than to his vices. The State machine is activated by bias—the bias of one or other of the political parties. The scientific expert who is faithful to his training must deal with facts objectively and not subjectively. Like the lawyer, it is his function to weigh evidence, but unlike the lawyer it is not his function to select only those facts which support his preconceived hypotheses. If the weight of evidence is against his hypotheses, he must find others. It is only natural that the politician, and the administrative head of a department who has to serve him, often to the extent of writing a memorandum demolishing all the arguments in a memorandum on the same subject which he had prepared a few months before under a different regime, should display a preference for the legalistically minded adviser. The scientific expert cannot be expected to be so accommodating.

Ethical considerations apart, let us assume that the present machinery of government is such that it demands for the smooth working of certain of its parts a type of administrative officer whose function is to serve as a buffer to lessen the shock of impact of impartial judgments on the political heads of the State machine. It does not follow that every part of the machine must be subject to the same control. The State has made itself progressively responsible for providing certain services, the efficient administration of which is entirely dependent upon the way our available resources of technical skill and scientific knowledge are utilised. It is farcical to pretend that they can best be utilised by those who are ignorant of those resources, any more than it is safe to assume that the ignorant will seek impartial advice or be unbiased in their judgments. We suggest that the present machinery of government is in need of overhaul. An attempt should be made to differentiate clearly between those departments whose principal functions are political, and those whose activities are governed solely by financial considerations. It is not denied that successful administration depends upon a knowledge of the administrative system, but we fail to understand why this knowledge cannot be acquired by those who have had the advantage of the broad training we suggest in the methods and principles of science.

As we have already said, many desirable changes in the teaching of science would be effected if the choice of career of science students were not so limited. Their predetermination to specialisation is bad for them and worse for the country which has built up the tradition. In the continental countries there is no such tradition. Men trained in science occupy the highest positions in the State and industry. This may account for the rapidity with which the scientific discoveries of our countrymen are applied to industry in Germany, and possibly afford an explanation for the slow development of the tropical possessions of Great Britain in comparison with the rapid development of those of the Dutch.

It is high time a survey were made of the positions for which candidates, in addition to that ill-defined quality—personality—should possess a sound knowledge of science. We can think of none where this knowledge would not be an advantage. It would lend reality to finance, to the direction of industry, to the administrative services, and even to politics. It would increase our respect for the law if the judges in the special courts dealing with technical matters were themselves able to differentiate between what is and what is not science. It would be worth while trying the experiment of appointing scientifically trained men as governors of our non-self-governing dependencies, instead of distinguished soldiers, sailors, or politicians. But it is unlikely that any such survey will be made until there are far more members of the House of Commons who have a knowledge of and abiding interest in science and faith in its methods. It would hasten the day if more teachers of science appreciated the social implications of their studies and led their students to realise that modern statecraft must be based upon a comprehensive study of the sciences.

The Clinician and Chemotherapy.

Principles and Practice of Chemotherapy: with Special Reference to the Specific and General Treatment of Syphilis. By Prof. John A. Kolmer. Pp. xvi + 1106. (Philadelphia and London: W. B. Saunders Co., 1926.) 55*s*. net.

HITHERTO most of the literature of chemotherapy has been written by chemists, or at least by investigators with a bias towards chemistry. It is wont to consist of descriptions, in series, of complex organic compounds contributed by the chemist, to which his biological colleagues, the pharmacologist and the parasitologist, add 'toxicities' and 'curative doses,' the latter being the minimum quantity of each substance found necessary to cure some particular infection induced experimentally in one of the lower animals. If the ratio between the two factors is favourable for any member of the series, that substance becomes a possible candidate for clinical trials, so that the clinician has the last word in deciding whether the work of his chemical and biological colleagues is

to have the chance of becoming a practical success. Such practical successes are rare, and are far more limited in their application than is generally believed, even by that restricted public which concerns itself with matters of scientific interest.

Fortunately, the contribution which chemotherapy makes to the welfare of humanity is not measured solely by these occasional therapeutical bull's-eyes, but by the steady growth of systematised knowledge of the mode of action of drugs, which its study inevitably ensures, and this accretion of knowledge is just as likely to come from clinical failures as from clinical successes, and perhaps even more from investigations which have no immediate practical end in view. The paucity of these successes is perhaps responsible for the suggestion now and then made that chemotherapy is not living up to the expectations that were formed regarding it when its greatest achievement, salvarsan, was introduced into medicine now nearly twenty years ago. Conferences of learned societies are often useful as a means of gauging current impressions, and it is noticeable that at the present time such conferences dealing directly or indirectly with therapeutics are often much more concerned with the contributions made by biology and biochemistry than with those attributable to the study of chemotherapy. There are fashions even in science and in medicine.

It is all to the good, therefore, that a clinician like Dr. Kolmer should have been inspired to produce at this juncture the book now under notice. It puts on record the clinician's view, generously tempered by that of the laboratory worker—for Dr. Kolmer has the good fortune to fulfil both functions—of the present position and future prospects of chemotherapy in relation to clinical medicine. Throughout the book, indifference to, or an intimate and extensive knowledge of, the chemistry of synthetic drugs appears to be assumed, for this side of the subject is left severely alone, only two graphic formulæ, those of salvarsan and neosalvarsan, being given in the whole book. Those interested in chemotherapy can, however, well afford to dispense with such details, which are readily obtainable elsewhere.

The author's preoccupation with the treatment of syphilis and the important position which this disease naturally takes in any exposition of clinical medicine based on chemotherapy, accounts for the large amount of space, more than 600 pages, devoted to it, and bio-chemists and biologists will welcome this full discussion, especially of the possible and probable reactions of anti-luetic drugs in the body.

Perhaps the most interesting section of the book is that concerned with the chemotherapy of bacterial and mycotic diseases. It is well known that in spite of unremitting work in this direction, especially in Germany, and more recently in the United States, very little progress has been made, and it is difficult to decide whether the workers who persist in such investigations are long-sighted optimists or merely misguided enthusiasts. Dr. Kolmer discusses the methods of investigation available and the pitfalls which beset even the most wary in drawing conclusions from the results of experiments in these cases. He then deals with such progress as has been achieved in the use of dyes for local and general infections, ethylhydrocupreine and its relatives in the treatment of pneumococcal and other bacterial diseases, and finally with the compounds of such metals as mercury, copper, arsenic, gold, etc., which have been the subject of so many forlorn hopes for the cure of tuberculosis. The section gives a fair and unbiased account of what has been done, and in view of the generally discouraging results, Dr. Kolmer takes a surprisingly cheerful view of the possibilities of chemotherapy even in these diseases.

The section on trypanosomal diseases is made the means of a very thorough discussion of trypanocidal tests, which have become so important a part of chemotherapeutical work and a subject to which Dr. Kolmer has himself made valuable contributions.

The other sections are neither so full nor so up-to-date as the three just alluded to. Experts on tropical diseases will scarcely regard 25 pages as adequate for the discussion of malaria, even if it has only recently become amenable to chemotherapeutical investigation, or 30 pages sufficient to describe all the work that has been done with surprisingly successful results in some cases, in "leishmaniasis, amebiasis, piroplasmosis, schistosomiasis, and other protozoan and metazoan diseases of man and the lower animals." It seems odd that kala azar, for example, can be dealt with without mention of the valuable work done by Dr. Napier in India in clinical trials of antimonial drugs, which has led to great improvements in treatment in the last few years. Medical men, in writing about the treatment of malaria, generally contrive to suggest that the supplies of cinchona bark are inadequate, or that the price of quinine is too high, and Dr. Kolmer is no exception to this rule. The fact is that for some years cinchona bark was over-produced, and if this had been

allowed to go on, many of the plantations would have gone out of existence. The planters in Java very wisely took steps to control output, just as British rubber-producing companies have had to reduce the output of rubber to avoid a similar catastrophe. To anyone who feels doubtful about the wisdom of such a course, the excellent address dealing with this subject which Sir Thomas Holland gave a short time ago to the Royal Society of Arts may be commended.

The book is very well produced, and contains few misprints or mistakes in chemical nomenclature; it can be cordially recommended to chemists and biologists concerned with chemotherapeutical work as affording the kind of information which is particularly difficult to obtain and collate, except by laborious search through medical literature. Dr. Kolmer not only provides this information, but also presents it with illuminating comments.

T. A. H.

Physics for Students.

(1) *Physics for Colleges.* By Prof. H. Horton Sheldon, Prof. C. V. Kent, Prof. Carl W. Miller, and Prof. Robert F. Paton. Pp. vi + 655. (London: Macmillan and Co., Ltd., 1927.) 16*s.* net.

(2) *The Elements of Physics.* By Prof. Alpheus W. Smith. Formerly published under the title of "The Elements of Applied Physics." Second edition. Pp. xviii + 660. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1927.) 17*s.* 6*d.* net.

(3) *Light.* By F. Bray. Pp. xii + 284 + 6 plates. (London: Edward Arnold and Co., n.d.) 6*s.*

(4) *Light.* By Vivian T. Saunders. Pp. vii + 320. (London: John Murray, 1927.) 6*s.* net.

(5) *Studies in Optics.* By Dr. A. A. Michelson. (The University of Chicago Science Series.) Pp. ix + 176 + 7 plates. (Chicago, Ill.: University of Chicago Press; London: Cambridge University Press, 1927.) 10*s.* net.

IN spite of the multitude of text-books on physical science, there always seems room for the ingenious author to produce a new volume. Amongst the problems he has to solve is included that of finding a method of so presenting his subject as to maintain the interest of the reader; for all educational experts are agreed that the power of remembering what is read depends upon the degree of interest that is aroused in the mind. The element of wonder may be excited in various ways, and the books noticed below serve to illustrate some of the methods which may be employed. Another difficult question which confronts the author is that of determining to what extent recent investigations and modern theories should be treated, and if they are adopted, to know at what point in the exposition the new material or method is to be introduced. For example, in a work on electricity, should the electron theory be made the basis of the treatment, or should it be discussed separately after developing the older theory? The answer to such a question must obviously depend on the purpose in view and on the class of reader for whom the book is intended.

(1) Under the editorship of Prof. Horton Sheldon, this text-book of "Physics for Colleges" has been compiled by four authors, each one of whom is engaged in teaching physics in an American university. Each author has been responsible for one section of the book, and has tried to make it a continued story. Thus, in the editor's section on heat and molecular physics, the kinetic theory underlies the whole, and everywhere explanations are based on this. In the same manner the electron theory underlies the section on electricity and magnetism, and wave motion underlies that on sound and light. "This not only unifies each section but it weaves modern physics into the structure of the book instead of leaving it as a mere appendage." It is noteworthy that the authors have been able to include chapters on modern radiation theory, quantum theory, and other modern developments; although the treatment of such subjects is necessarily somewhat slight, it is certainly desirable that the student who includes physics in his college course should be made familiar with recent theoretical and experimental work.

The editor, who has had experience of teaching classes containing hundreds of students, makes one remark which may be laid to heart by writers of text-books: "An attempt has been made at every turn to minimise those things which tend to influence the student to memorise, and to magnify those things which tend to induce him to use logical methods of thinking. Thus italics, bold-faced type, etc., have been avoided in the body of the text, as the student usually tries to memorise such portions of a book."

(2) In making a minor change in the title of his text-book, Prof. Alpheus Smith has not altered either the purpose or the method of the work. It is intended for students who are primarily interested in the practical applications of physics, and the author has been very successful in illustrating such applications to agriculture, engineering, physiology, and everyday life. The method employed has involved some curtailment in the number of

scientific facts recorded, and special stress has not been laid on the historical development of the subject. In the revised edition, additional paragraphs have been provided on sound and light, with illustrative material taken from architectural acoustics, audition and voice sounds, and from the physiological effects of light. Finally, a fifth part has been added giving in concise form a clear and interesting account of the brilliant discoveries and advances made in physics in recent years. The illustrations are numerous and, in general, excellent; in a few instances, however, photographs of apparatus show only the external appearance, and details of construction are lacking. Of special excellence are the photographs of sound waves produced by bullets or electric sparks.

(3) Mr. Bray's book on light was begun when the author was a science master at Clifton College, and was designed to satisfy the requirements of a general education and to enable a boy to pursue the study of light in a logical manner up to the modern developments of the wave theory. The author has been successful in his aim of producing a readable text-book, and he is to be commended for having devoted so much attention to the historical side, which, as he points out, provides a wide field of interest and fascinates both old and young.

The first chapter is an interesting historical survey of the science of optics, and the account given of the theories of light put forward by the early Greek philosophers is suggestive when the reader is already familiar with the most recent theories of radiation. More detailed history accompanies the accounts of the important principles laid down in each chapter, and five full-page plates give portraits of distinguished discoverers in optics. There are numerous diagrams, and also a large number of experimental verifications and determinations. The chapter on optical instruments is of special value, and we note that Schuster's method of focusing the telescope and collimator of a spectrometer is described.

Part II., which forms about one-third of the volume, is concerned with the development of the wave theory and is prefaced by an elementary treatment of simple harmonic motion and wave motion. The chapters on interference, diffraction, and polarisation are well written, and we find a brief reference to Bohr's theory of the origin of spectra in the last chapter. In view of recent progress, the statement that very little is known of the 'band spectrum' should be revised in a new edition.

(4) Mr. Saunders, of Uppingham, has written a text-book on light of somewhat similar character to that by Mr. Bray, for students who are following an elementary but formal course. It is intended to cover the ground required for the usual school examinations, but as it was not considered necessary to give detailed instructions concerning laboratory experiments, the scientific information given and the method of treatment are slightly more advanced than in Mr. Bray's book. For example, in the chapter on photometry we find descriptions of the selenium cell and the photo-electric cell which are receiving much attention in photometric laboratories. It may be pointed out that a photometer head of the Lummer Brodhun type was described by Prof. William Swan of St. Andrews thirty years before its invention in Germany.

It is a little misleading to say of the Gregorian telescope that "the telescope was never actually set up." James Gregory first described his reflecting telescope in "Optica Promota" (London, 1663) at the age of twenty-four. The attempt which he made to get a telescope from the London optician Reive was abandoned because the figure proved so bad. That versatile genius Robert Hooke constructed the first Gregorian telescope, which was presented to the Royal Society in February 1674. It is interesting to find that in the previous year the University of St. Andrews had commissioned "Mr. James Gregorie, professor of the Mathematical Sciences here to go to London, and there to provide so far as the money already received from our Benefactors will reach, such instruments and utensils as he with advice of other skilful persons shall judge most necessary and useful for the above mentioned design [for providing ane observatory]." As Gregory was a friend and correspondent of John Collins, the secretary to the Royal Society, it is more than probable that he met Hooke, the curator, during his visit to London, and discussed the telescope with him. Later, several Gregorian telescopes were made by Short, and one of these is now in the Natural Philosophy Department of the University of St. Andrews, marked James Short, Edinburgh, 1736. The same form was generally employed in the eighteenth century.

The latter part of the book is devoted to the wave theory of light, with descriptions in the last two chapters of electromagnetic radiations and spectral series. The chart from "Phases of Modern Science," showing the great range of electromagnetic waves, is reproduced, and an interesting elementary account is given of Bohr's theory of the hydrogen atom.

(5) Prof. A. A. Michelson, who was included in Nature's list of Scientific Worthies on Jan. 2, 192[illegible], has done a valuable piece of work in giving a résumé, under the title "Studies in Optics," of his

own investigations on the subjects of interference, diffraction, and the determination of the velocity of light. His fertile mind, equipped with the necessary theoretical knowledge (derived largely from the work of the late Lord Rayleigh), seems to possess an almost uncanny power of translating ideas into practice. The book is based on the undulatory theory of light (the difficulties associated with the quantum theory being no more than hinted at), and it begins with a discussion of the interference of light waves and a description of the author's interferometer. Measurements of a small displacement made by this apparatus are from twenty to fifty times as accurate as the corresponding measurements by microscope or telescope. In the measurements of the standard metre in light-waves the accuracy may be expected to be of the order of one part in several million. The special case of interference known as diffraction is next discussed, and a word of praise must be given to the excellent photographs of diffraction patterns reproduced in the plates. The difficult problem of ruling large diffraction gratings has been attacked with marked success by Michelson, who applied interference methods to the measurement and correction of the errors of the dividing engine.

By the application of interference methods in astronomy it has been possible to measure not only the diameters of the satellites of Jupiter, but even the diameter of the red giant star Betelgeuse, which was found comparable with the diameter of the orbit of Mars. Experiments are still in progress at Mount Wilson Observatory to determine as accurately as possible the velocity of light, the value found from observations in 1926 being 299,796 kilometres per second. But it is probable that the negative result of the Michelson-Morley experiment will serve to perpetuate the fame of these experimenters even more than positive quantitative determinations. This zero result is the corner-stone of the theory of relativity, which is held by some to be incompatible with the existence of luminiferous ether. It is significant, however, that Michelson concludes his account of the theory by saying: "It is to be hoped that the theory may be reconciled with the existence of a medium, either by modifying the theory, or, more probably, by attributing the requisite properties to the aether; for example, allowing changes in its properties (dielectric constant, for instance) due to the presence of a gravitational field."

The University of Chicago is to be congratulated on this addition to its Science Series.

H. S. ALLEN.

The Constitution of Glass.

The Constitution of Glass: a Series of Papers reprinted from the Journal of the Society of Glass Technology. Edited by Dr. W. E. S. Turner. Pp. vii + 191. (Sheffield: Society of Glass Technology, 1927.) 7*s.* 6*d.*

IN May 1925 the Society of Glass Technology organised a general discussion to which papers on the nature and properties of glass were contributed by British, French, German, and American authorities. These papers have now been reprinted, with seven pages of "General Discussion on the Foregoing Papers," which are nine in number, since one additional paper appears to have been added to those contributed to the discussion. The volume also includes a paper on "The Viscous Properties of Glass," which was read at a meeting of the Society at the end of 1926, and a report on "The Structure and Constitution of Glass," by Dr. Rosenhain, prepared at the invitation of the Council under the Glass Research Association Trust Deed.

It is this last report that specially invites criticism, since, unlike the earlier papers in the present volume, it does not appear to have been read at a meeting of the Society for which it was prepared, and is therefore published without any accompanying discussion. This is an unfortunate limitation, since the theoretical views now advanced to explain the structure of glass and other amorphous solids gives the impression of having been devised (as indeed the author hints) in pre-War days, when the nucleus atom and the electronic origin of valency were alike unknown, and to have been brought only incompletely into conformity with the implications of these revolutionary doctrines.

Thus we find that the crisp distinction between the 'electrovalent' structure of common salt and the 'bonded' structure of integral molecules, for which the quantum theory supplies such ample justification, is replaced by an amorphous conception of bonds of varying strength and varying length, uniting all the atoms in the mass, with little or no regard to the ordinary laws of chemical combination. This formless picture is rendered rather more confused by the fact that, although the relative constancy of length of the bonds between the atoms is scrapped, the fixity of angles is retained; but a final element of bewilderment is created by an assertion that, when an alkaline silicate is electrolysed, "rupture of bonds between an alkali metal and oxygen must have occurred,"

since the word "must" is surely too strong to use when postulating a rupture of bonds which the modern theory of 'complete ionisation' supposes to be non-existent!

The general reader will welcome the reproduction of a paper on the equilibrium diagram of the soda-lime series of silicates, from the Geophysical Laboratory at Washington, and of a summarising paper on the structure of quartz by Sir William Bragg; and chemists will add this volume to their shelves all the more readily because it is issued in the familiar format in which the *Journal of the Chemical Society* has appeared for more than half a century, and has therefore become by long usage an ideal for chemical publications when the financial assistance of the advertiser is not essential.

Our Bookshelf.

(1) *Applied Magnetism.* By Dr. T. F. Wall. Pp. 262. (London: Ernest Benn, Ltd., 1927.) 28*s.* net.

(2) *Einführung in die Elektrizitätslehre.* Von Prof. R. W. Pohl. Pp. vii + 256. (Berlin: Julius Springer, 1927.) 13·80 gold marks.

(1) DR. WALL gives a good general survey of the subject of applied magnetism and of the theoretical aspects of certain of the questions raised by recent developments of magnetic practice. The bulk of the work is devoted to the problem of obtaining practical control over the magnetic behaviour of the materials used in practical engineering work and to a description of the methods employed in testing the magnetic behaviour of such materials; and the author's own work and experience enable him here to give a tolerably complete, if not always a critical, account of the present state of our empirical knowledge of a now very extensive subject. The treatment of the theoretical parts of the subject is less happy, being both incomplete and, in places, confused; but as this side of the subject is still in a state of flux, this cannot be regarded as detracting seriously from the merits of an otherwise good book.

(2) This book, of a very different calibre from Dr. Wall's volume, is intended mainly as an introductory text-book of electricity and magnetism for students who are out for the ideas rather than their mathematical or technical development, and have to approach them experimentally. It covers the whole range of the subject from electrostatics and magnetostatics, through the usual ideas of current generation and flow, to electrodynamics, radio-activity, and electric waves, with all the thoroughness that is possible within the scope of its number of pages. The treatment is experimental throughout, each idea being derived from the result of an experiment, and suggesting further experiment, and so on throughout the whole subject; but an excellent balance is maintained between the details of the experiments and the description of the facts which emerge from them. Altogether this is a delightful book, one of the most pleasant features of which is the large number of beautiful illustrations, diagrammatic and photographic, which adorn almost every page. G. H. L.

Properties and Testing of Magnetic Materials. By Thomas Spooner. Pp. xiv + 385. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1927.) 25*s.* net.

NEARLY every piece of electrical apparatus has, as Mr. Spooner points out, a magnetic circuit. In the majority of cases this circuit is the governing factor which decides the size, shape, weight, and cost of the apparatus; a knowledge of its laws and the materials from which it may be constructed is therefore very desirable on both technical and economical grounds. Unfortunately, to those not already familiar with magnetic theory, the whole subject is somewhat repellent and irksome. The unlovely names of units and properties (which to the beginner appear far too numerous), the lack of uniformity among different authorities, and a feeling that the whole subject is not quite free from a tinge of empiricism, are among the probable reasons for this state of things. Anyone who feels like this will welcome Mr. Spooner's book.

The introduction gives the ordinary relations and formulæ of the magnetic circuit in very clear and convincing outline, and a useful comparative table of the various units of magnetic induction. The remainder of the first half of the book is a complete résumé of our present knowledge of the magnetic properties of commercial ferro-magnetic materials. The results of researches made by workers in many countries are given very fully, and these are discussed and compared with the author's own experiments. The book is therefore by no means a mere compilation. A very large amount of quantitative information is given—almost every page has a graph from which numerical values may easily be read off. The effects of composition, heat treatment, crystalline structure, etc., are shown, and problems introduced by modern high-frequency apparatus receive consideration.

The second part of the volume is devoted to a complete survey of the apparatus and methods of magnetic testing, with chapters on core losses in commercial machines and on magnetic analysis.

A. L. R.

A Manual of Automatic Telephony. By Charles W. Wilman. (Lockwood's Manuals.) Pp. vii + 223. (London: Crosby Lockwood and Son, 1927.) 7*s.* 6*d.* net.

THE average technical student finds great difficulty in mastering the theory of the working of automatic telephony. In our opinion, this is due to the fact that nearly every book on the subject begins at once by describing in detail some complete automatic system, and the student is lost in what appears to be a hopelessly complicated maze of circuits. Mr. Wilman has appreciated a beginner's difficulties, and so begins with a few simple general

considerations before describing the uses of the various devices used in practice. The diagrams given are very clear, all unnecessary details being omitted, and so the student will have little difficulty in seeing how an automatic system works.

Manual systems in the past have given satisfaction, but there are several advantages in connexion with automatic systems which make them more desirable. For example, connexions can be completed more quickly and can be released instantaneously. Errors due to incorrectly hearing a number are eliminated. There is a large saving in operators' salaries. A twenty-four hours' service can be given in every exchange, and so a large number of small exchanges can economically replace a large exchange. In countries where several languages are spoken, a call may be completed with equal facility whatever language the subscriber speaks. As for many years to come automatic and manual exchanges must exist side by side, the author devotes a chapter to explaining how they can be interconnected. We recommend this book to all readers who want to get an elementary knowledge of the working of an automatic system.

Some Famous Medical Trials. By Dr. Leonard A. Parry. Pp. x + 326. (London: J. and A. Churchill, 1927.) 10*s*. 6*d*. net.

THIS entertaining work contains an account, from the time of Elizabeth to the present day, of thirty odd trials in which medical men figured, usually as defendants. The cases, which, as the author acknowledges in the preface, have not been arranged in any particular order, either chronological or alphabetical, have, with two exceptions from France and the United States respectively, been taken from the criminal annals of Great Britain. Ten cases in which the medical man was brought to trial for treason or other political offences contain nothing of scientific interest, and the same may be said of the crimes of violence, libel, and poisoning. The most instructive cases are those dealing with poisoning, the drugs chosen by the doctors for their victims being arsenic, aconite, hyosine, strychnine, and morphia. Among these may be cited the first case of poisoning by morphia, in which the evidence of Orfila, the celebrated Parisian toxicologist, was the cause of bringing the poisoner, Dr. Edmé Castaing, to the guillotine. Mention may also be made of an interesting chapter on the 'resurrection men,' dealing with the events which gave rise to the amendment of the law with regard to the supply of bodies for anatomical schools and the passing of the Anatomy Act.

Roman Britain. By Gordon Home. (Benn's Sixpenny Library, No. 4.) Pp. 80. (London: Ernest Benn, Ltd., 1927.) 6*d*.

MR. GORDON HOME's account of "Roman Britain" in Messrs. Benn's attractive little "Sixpenny Library" is a model of concise popularisation. Apart from the many difficulties and obscurities which are involved in the study of the period of Roman occupation in Britain, the necessary concentration on technical details in the reports of excavations, and the lack of a comprehensive historical background, have militated against popular interest in this important element in the composition of the cultures of Britain. This is notwithstanding the fact that discoveries relating to the Roman occupation are more frequent and usually tell more than those of any other period of the early history of Great Britain. Mr. Home has provided exactly the background that is needed to promote such an interest. He tells a clear consecutive story in which, without shirking difficulties, he has given a reasonable interpretation, while avoiding controversial details which might confuse his readers as well as be irrelevant to his main purpose. The stress he lays on purely British culture and its gradual interpenetration by Roman influence, as well as the view taken of the state of the country at the close of the occupation, are useful correctives of popular misconception.

Adventures of Exploration, Book 6: North America. By Sir John Scott Keltie and Samuel Carter Gilmour. Pp. iv + 228. (London: George Philip and Son, Ltd.; Liverpool: Philip, Son and Nephew, Ltd., n.d.) 2*s*. 6*d*.

THE volume on North America, which is slightly larger than the earlier volumes, completes this admirable series. Some fifteen notable journeys have been retold without the omission of any important facts and illustrated by carefully chosen pictures from many sources. Each tale has a small sketch map to itself, which are excellent examples of clear maps, with no more names than are needed to follow the text. The voyage of Jacques Cartier begins the book, which goes on to tell among others of Champlain, La Salle, Hudson, Hearne, Mackenzie, Lewes and Clark, Franklin, Peary, Erichsen and Mikkelsen. It is not a complete history of North American exploration, and is not intended to be such, but it is an admirable sketch of the chief stages in the story, and is bound to quicken interest in geography.

The Diary of Henry Teonge, Chaplain on Board H.M.'s Ships Assistance, Bristol, and Royal Oak, 1675–1679. Transcribed from the original manuscript and edited, with an Introduction and Notes, by G. E. Manwaring. (The Broadway Travellers.) Pp. x + 318 + 8 plates. (London: George Routledge and Sons, Ltd., 1927.) 12*s*. 6*d*. net.

WHEN Teonge's diary was first published in 1825, some doubt was cast on its authenticity. The disappearance of the manuscript made it difficult to answer the criticisms, but its rediscovery has now set all doubts at rest. The present edition has been produced from the original manuscript with modernised spelling and a number of notes. The author served as a chaplain in the Mediterranean. In addition to a vivid picture of life in the Navy in the seventeenth century, there are interesting accounts of inland journeys in Syria and Palestine. The book is beautifully produced and illustrated with a few contemporary drawings and engravings, but a track chart might well have been added.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Earth Currents and Terrestrial Magnetism.

THE study of a monograph on earth currents by Dr. D. Stenquist,[1] telegraph engineer, published in 1925 in Stockholm, suggests that telegraphists have it in their power to add much to our knowledge. The early observations by W. H. Barlow and C. V. Walker showed that an intimate connexion exists in England between magnetic storms and disturbances in telegraph lines, and similar observations elsewhere showed this to be a general phenomenon. So much is this the case that the authorities of the Ebro Observatory, Tortosa, accept as their quiet days for the study of the regular diurnal variation of earth currents the international magnetic quiet days selected at De Bilt, provided their records for these days are complete. Further, Messrs. W. J. Peters and C. C. Ennis, of the Carnegie Institution of Washington, have shown that the Ebro earth current data exhibit in a similar way to magnetic data, and to a similar degree, what is known as the 27-day interval, representing, it is believed, the rotation period of the sun's equatorial surface.

Dr. Stenquist gives a variety of statistical data having an intimate bearing on the subject. In particular, attention may be directed to his Table I., p. 26 *l.c.*, giving a total of 53 dates between Nov. 1, 1906, and Oct. 31, 1909, on which a current of at least 15 milliamperes was observed in the central telegraph station at Stockholm. According to Stenquist, this is the smallest current causing serious telegraphic disturbance. As is now pretty generally known, yearly lists are issued from De Bilt giving for each day a magnetic character varying from 0·0 (very quiet) to 2·0 (very highly disturbed). These figures are based on returns from some 30 to 40 magnetic observatories in different parts of the earth. An analysis of these international character figures for the 36 months covered by Stenquist's table led to the following results :

A	2·0	1·9	1·8	1·7	1·6	1·5	1·4	1·3	1·2	1·1	1·0	< 1·0
B	6	4	13	10	14	8	27	25	32	61	71	825
C	6	4	10	6	4	2	5	4	2	3	5	2

A is the international character figure ; *B* the total number of days having each specified character within the 3 years ; *C* the number of these days included in Stenquist's table. The two days on his list with characters less than 1·0 were Oct. 11, 1907, with 0·6, and Oct. 20, 1909, with 0·8. A high value of an earth current may persist for only a short time, while the magnetic character represents the day as a whole. A short portion of a day of character 1·0 *might* be more disturbed than any portion of another day of character 1·5. Thus it was not to be expected that all the days on Stenquist's list would have very high character figures.

What, however, is really significant is that the 23 days of the three years which had magnetic characters of 1·8 or more supplied 20 of the 53 days on Stenquist's list, while the 504 days with characters of 0·5 or less supplied none. It is obvious that if data such as Stenquist's were available for different parts of the world, especially if the directions of the lines in which the high currents prevailed were known, much might be learned as to the prevalence of outstanding earth currents in different regions. A day of high magnetic character is certain to have been highly disturbed magnetically all over the world. But in general the amplitude of disturbance is larger and rapid oscillatory changes are more in evidence in high than in low latitudes. Further, in high latitudes large disturbance is usually in evidence at the same time in all the magnetic elements, whereas in low latitudes disturbance is often mainly confined to the horizontal force. It is obviously important to know from actual observation what the corresponding facts are as regards earth currents.

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[1] "Étude des courants telluriques." Mémoires publiés par la direction générale des télégraphes de Suède.

Light and Sight.

IN the article, "Light and Sight," which appeared in NATURE of Jan. 21, Sir John Parsons accepts as evidence "that the human eye has become specially adapted to sunlight," "the fact that the brightest part of the spectrum, as seen by the light-adapted eye, coincides more or less accurately with the summit of the curve of radiant energy." The implication that the eye has developed in the direction of maximum efficiency as a converter of energy justifies careful examination of the suggestion.

The coincidence in question involves at least three quantities—the sensitiveness of the eye, the amount of solar radiation reaching the earth's surface, and a quantity which serves to define the quality of the radiation. In "the curve of radiant energy" to which Sir John Parsons alludes, the third quantity, the abscissa of a point on the curve, is presumably the wave-length of the light. It is not irrelevant to consider whether the coincidence would be maintained if some other variable were substituted for the wave-length, and, if it should not be maintained, whether special significance can properly be attached to the coincidence observed when this particular variable is adopted.

Physicists will probably have little hesitation in saying that if, in such a connexion, one variable is of greater significance than another, that variable is not the wave-length of the light, but its frequency. The widespread use of wave-lengths is attributable to the convenience, in the experimental analysis of light, of employing apparatus which can be effectively calibrated by measurements of length alone, rather than to any theoretical advantages consequent on this usage. If now we substitute frequency for wave-length, the brightest part of the spectrum on the new basis will suffer a small change, but the highest point of the new energy curve (at least if we may regard the sun as a 'black' body) will lie well outside the limits of the visible spectrum. To me this fact appears conclusive evidence that the utilisation of the greatest possible amount of energy is not the factor which has led the human eye to utilise the particular spectral region to which we find it sensitive, and that the coincidence referred to is fortuitous.

An alternative suggestion may be offered. Many readers of NATURE will recall Prof. R. W. Wood's remarkable landscape photographs taken, some with infra-red light only, and others with ultra-violet light only. The former are notable for the strength of the reflections from directly illuminated surfaces and the blackness of the shadows ; the latter for want of contrast amounting almost to general fog. These effects are due to properties inherent in the

light itself; they are not manufactured by the photographic plates. Corresponding effects would be present were vision excited by these radiations. It is not unreasonable to suppose that any appreciable extension of the visible spectrum at the short wave-length end would impair rather than improve the clarity of the pictures we should perceive. On the other hand, we may suppose that, under more primitive conditions, life would have been rendered more precarious by the increased difficulty of observing enemies lurking in shadows, had there been any considerable shift of the mode towards longer wave-lengths.

There is another coincidence mentioned in the article which may conceivably be accidental. This is the correspondence between the diameters of the retinal cones at their bases and the resolving power of the eye. We may note in passing that close agreement between these lengths would tend to discredit the theory which refers the limit of resolution to the fineness of retinal structures, rather than support it. At least three successive cones must be involved, on this view, in the resolution of two near point images, the total energy falling on the middle cone being appreciably less than that received by either of the outer cones. If we consider curves giving the energy distribution in the diffraction pattern of two sources when resolution is just possible, such as those given by the late Lord Rayleigh, we can readily appreciate that a decided fall in intensity at the centre of the pattern from the peak values is not inconsistent with the reception by the central cone of greater total energy than by each of the outer cones on which the most brilliant parts of the image are formed.

The chief reasons, however, for hesitation in accepting this theory are, on one hand, that it is unnecessary to seek for any explanation of a limit of this angular magnitude in the structure of the retina, for it is imposed by the wave-length of the light to which the eye is sensitive in conjunction with the diameter of the pupil; and on the other hand, that experiments in which this physical limitation does not arise yield figures which suggest that the eye possesses powers of discrimination much more refined than these coarser features of the retinal structure would lead us to expect. Illustrations of these finer ocular powers are afforded by the appreciation of form, the ability to set two straight lines to form a continuous line,[1] and the judgment of distance in binocular vision. Various explanations of these effects may be offered, but the observations at least entitle us to suspend judgment on the relevancy of this coincidence until more rigorous experiments enable us to discriminate between various views in the light of fuller knowledge.

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Jan. 24.

I WAS aware of the highly speculative nature of the explanation of the apparent coincidence of the brightest part of the spectrum with the summit of the curve of radiant energy, plotted with wave-lengths as abscissæ, and I fully appreciate the validity of Mr. T. Smith's arguments. It is essentially a physical problem, and I am glad that my rash statement has aroused the attention of a physicist.

On the other hand, I dealt somewhat at length in my lectures with the problems of the *minimum separabile* and contour discrimination. I came to the conclusion that while the facts relating to the former were not inconsistent with a purely physical explanation, those relating to the latter could not thus be explained at present, but were at least rendered intelligible by physiological and psychological interpretations.

These considerations emphasise the complexity of visual phenomena, and the necessity for the co-operation of physicists, physiologists, and psychologists in their elucidation. Mr. Smith's letter is a welcome indication of the increasing interest which physicists are displaying in the physiological implications of their researches. J. HERBERT PARSONS.

[1] See "The Unaided Eye," by J. W. French. *Trans. Opt. Soc.*, 21, 127; 1919-20.

The Excitation of Spectra by High Frequency Oscillations.

IN a recent letter to NATURE (Nov. 19, p. 726), Mr. J. R. Clarke gives a brief account of some experiments he has made on the excitation of various spectra in mercury vapour. The wording of his note suggests that he attributes the phenomenon cited to the relative shortness of the wave-length of his oscillating system (300 metres). The apparatus he uses is no other than the ordinary one of electrodeless discharge of which the spectroscopic interest has been clearly shown by Prof. E. Bloch and M. L. Bloch (*Journal de Physique*, 4, 333; 1923), whose first experiments were made with mercury in the absence of air, which is useless and even derogatory to obtaining pure spectra. This method has often been used since by these authors and others, most frequently, it is true, with damped oscillations, but M. Balasse recently employed undamped waves of about 155-880 metres (*Comptes rendus*, 1005; 1927) for the excitation of spectra of alkali metals. It may therefore be said that the method described is not merely full of promise, but also that it has already realised all those expectations.

Like the other kinds of discharges, the electrodeless discharge more or less weakens certain lines and strengthens others: in this way, in the case of mercury, the long list of arc lines given by the above-mentioned authors does not show a single line of the *mp* series, of which the strongest lines are, moreover, infra-red and red. This fact, found also by Mr. Clarke, is to be attributed to the kind of discharge employed and not to the shortness of the wave-length.

I have been studying for some time in this laboratory the emission of mercury vapour under the action of very much higher frequency waves, the period of which reaches the order of magnitude of the duration of life of the excited states of the atom. I have ascertained that a $\lambda = 1\cdot 90$ m. oscillator, of very feeble power (20 watts max.), produces an exceedingly brilliant electrodeless discharge in a slightly warmed quartz tube which has been exhausted with great care and sealed after a drop of mercury has been introduced by distillation. The luminous efficiency of this mode of excitation seems to be very high. This tube also lights along Lecher's wires at the maxima of the electric field. I obtained ordinary electrodeless arc spectra, with one or two enhanced lines, the feeble power of the oscillator not enabling me to obtain more. The line 2537 seems to be relatively very strong, but, up to now, I have not observed in these spectra any effect that could be attributed to the shortness of the wave-length. Besides, it is to be noticed that this mode of excitation seems to be extremely sensitive to the presence of organic impurities: a tube with aluminium electrodes which has been carelessly

exhausted, although sufficiently so to give only the green fluorescence of glass when connected to an induction coil, emits close to the oscillator a bluish glow, containing the characteristic bands of carbon impurities and hydroxyl.

For the moment, I have given up the use of these 1·90 m. waves and have built a 5·10 metre wave-length oscillator (about 80 watts), in order to see how the growing pressure of the mercury vapour modifies the spectra obtained. I use either the electrodeless discharge or a discharge with only one electrode (in a different apparatus). In the latter case, in a suitable apparatus, permanently evacuated and provided with a liquid air trap, this projects a glow the length of which may attain 40 cm. The pressure of the mercury vapour is varied by heating the mercury, and the degree of excitation by varying the distance between the electrode and the oscillator. I obtain in this way spectra which depend on the pressure and degree of excitation, and the one-electrode discharge does not give results quite identical with those of the electrodeless discharge. At 80°-90°, for example, the former does not clearly reveal the unclassified lines which Mr. Clarke mentions, except perhaps the line 2540. This fact is peculiarly striking for the line 3984·1; this line shows itself very feebly even in long exposures, though it is strong in the ordinary arc. The unclassified lines are found, however, in the electrodeless discharge. In the one-electrode discharge, the glow is observable in the region where the mercury condenses: it is violet; I was unable to discern any impurity, but found that the red lines 6234·35, 6123·46, and 6072·64 were strong in this light. The spectrum of the whole of the glow, taken longitudinally, shows a strengthening of the series $1P-mD$ and $1P-mS$; this is a pressure, and not a wave-length effect. At a higher temperature (110°-120°) and feeble excitation, I get a green glow which shows the Lord Rayleigh and Volkringer spectra (*Proc. Roy. Soc.*, A, 114; 1927. *Comptes rendus*, 1927, *passim*). I am continuing the study of the development of these spectra at increasing pressure, but, at the above-mentioned temperature, I find in this glow the yellow line 5790·6 ($1P-2D$), and the violet line 4347 ($1P-3D$), which does not agree with Mr. Clarke's observations: he only saw the triplets *s* and *d*. Mr. Clarke, however, does not say what was the pressure of mercury vapour in his experiment.

Briefly, the method described by Mr. Clarke is the well-known one of the separation of spectra by the electrodeless discharge. I am trying to see if this and the one-electrode method, used with very short wave-lengths (1·90 metres and 5·10 metres), give new results. Up to now, I have not noticed any modification in the emitted wave-lengths, which was to be expected, and the relative alterations in the intensity of the lines are effects of pressure or strength of excitation, and not to be attributed to the shortness of the wave-length used.

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The Formation of Citric Acid by *Aspergillus niger*.

In two recent publications (*Jour. Chem. Soc.*, 200, 3044; 1927) we have presented results which are in agreement with the assumption that the conversion of glucose to citric acid by *Aspergillus niger* proceeds according to the scheme: glucose ⟶ gluconic acid ⟶ saccharic acid ⟶ citric acid.

It was suggested by Franzen and Schmitt (*Berichte der Deutschen Chem. Ges.*, 58, 222; 1925) that the precursor of the citric acid of plants is β-γ-diketoadipic acid, arising from saccharic acid by loss of water. They showed that the ester of the diketo-acid is easily converted to citric acid by alkali hydroxide, a transformation of the benzilic acid type:

$$\mathrm{COOH\cdot CHOH\cdot CHOH\cdot CHOH\cdot CHOH\cdot COOH} \xrightarrow{-2H_2O}$$

$$\mathrm{COOH\cdot CH_2\cdot CO\cdot CO\cdot CH_2\cdot COOH} \xrightarrow{+H_2O}$$

$$\begin{array}{c}\mathrm{OH}\\ \mathrm{COOH\cdot CH_2\cdot \overset{|}{\underset{|}{C}}\cdot CH_2\cdot COOH}\\ \mathrm{COOH}\end{array}$$

This observation strongly supports their view, but apart from the recognition of diacetyl $CH_3\cdot CO\cdot CO\cdot CH_3$ (a decarboxylation product of diketoadipic acid) in ethereal oils, no further evidence has been adduced in favour of the participation of the diketo-acid in citric acid synthesis either by higher plants or by moulds.

Owing to the instability of diketoadipic acid, experiments on its behaviour to *A. niger* are not yet completed. Meanwhile, it appeared probable that useful indications on this point could be obtained by studying the growth of the mould on adipic acid. One of us (T. K. W.) has shown that *A. niger* readily oxidises certain fatty acids in the β-position, and therefore might be expected to convert adipic acid to the β-γ-diketo-derivative:

$$\mathrm{COOH\cdot CH_2\cdot CH_2\cdot CH_2\cdot CH_2\cdot COOH} \longrightarrow \mathrm{COOH\cdot CH_2\cdot CO\cdot CO\cdot CH_2\cdot COOH.}$$

If the mould is capable of effecting a 'benzilic-transformation' the production of citric acid might then be expected. This has now been demonstrated. Potassium citrate has been isolated from cultures of *A. niger* on the potassium hydrogen salt of adipic acid, and on potassium muconate,

$$\mathrm{COOK\cdot CH:CH\cdot CH:CH\cdot COOK,}$$

and characterised as the tri-*p*-nitrobenzyl ester in each case. In the adipic acid experiment thallous citrate was also prepared and analysed. The muconic acid may give rise to citric acid by addition of two molecules of water forming β-γ-dihydroxyadipic acid,

$$\mathrm{COOH\cdot CH_2\cdot CHOH\cdot CHOH\cdot CH_2\cdot COOH,}$$

which on oxidation could yield the diketo-acid and finally citric acid. The conversion of fumaric and crotonic acids in the presence of liver tissue to malic and β-hydroxybutyric acids (Dakin, "Oxidations and Reductions in the Animal Body," pp. 49-50) indicates the biological possibility of this suggestion.

The conceivable formation of citric acid from muconic acid by addition of four hydroxyl groups and formation of saccharic acid receives less support from the biological side. Further work is in progress which, it is hoped, may enable the mechanism of citric acid formation from carbohydrates and organic acids to be definitely elucidated.

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Extension of the Irregular Doublet Law.

Recent work in this laboratory has shown that the irregular doublet law, first discovered in 1920 by G. Hertz in the X-ray region, and since then extended by Millikan and Bowen for the optical region, is capable of much wider application. Millikan and Bowen have applied the law for the prediction and identification of spectra of atoms which are stripped

to one or two valency electrons by vacuum discharge, and in the case of higher valence elements, for inner transition lines. But the law can be applied for the prediction of spectra of elements with a larger number of valency electrons giving rise to complicated spectra. The extension of the law in its most general form can be thus enunciated :

If we compare the spectra of a group of successive elements which are reduced by electric discharge to the same electronic constitution (for example, C, N^+, O^{++}, Fl^{+++}, N^{+4}), then frequencies of corresponding lines arising out of a transition in which the total quantum number remains unchanged will form an arithmetic progression.

The law can be very easily illustrated with the atomic chart given by one of the authors (*Phys. Zs.*, p. 470 ; 1927).

$$\begin{array}{ccccc} K_1 & & & & \\ 2 & & & & \\ & L_1 & L_2 & & \\ & 2 & 1 & & \\ & & M_1 & M_2 & M_3 \\ & & [1] \longrightarrow & (1) \longrightarrow & (1) \end{array}$$

In this chart, horizontal transitions refer to $\Delta n = 0$. Thus taking C, N^+, O^{++} . . . we find that the origin of all possible groups of lines can be visualised as follows :

$$\begin{array}{c} L_2L_2 \longrightarrow L_2M_1 \longrightarrow L_2M_2 \longrightarrow L_2M_3 \\ (M_1 \longrightarrow M_2) \quad (M_2 \longrightarrow M_3) \end{array}$$

Now the corresponding lines of the successive elements arising out of the transitions

$$L_2M_1 \longrightarrow L_2M_2, \text{ that is, } ({}^3P, {}^1P) - \begin{pmatrix} {}^3D, & {}^3\bar{P}, & {}^3S \\ {}^1D, & {}^1\bar{P}, & {}^1S \end{pmatrix} \text{ lines,}$$

and

$$L_2M_2 \longrightarrow L_2M_3, \text{ that is, } \begin{pmatrix} {}^3D, & {}^3\bar{P}, & {}^3S \\ {}^1D, & {}^1\bar{P} & {}^1S \end{pmatrix} - \begin{pmatrix} {}^3F & {}^3\bar{D} & {}^3P \\ {}^1F & {}^1\bar{D} & {}^1P \end{pmatrix}$$

will form arithmetic progressions.

Application of this law can be extended to all other complicated spectra.

It follows that if the spectra of two elements, preferably successive, of any group be known, it becomes quite easy to predict the spectra of the remaining elements.

In the group just mentioned, namely, C, N^+, O^{++} . . . the spectra of N^+ has been completely elucidated by Fowler and Freeman, and that of O^{++} is nearing completion thanks to the work of Mihul. (Mihul's levels are wrongly given, though his multiplets are correct. They can be easily reshuffled and correctly fitted to Hund's theory). We can then predict the spectra of C, which is still unknown. Then $L_2(M_1 \longrightarrow M_2)$, as well as $L_2(M_2 - M_3)$ lines which are next in intensity to the fundamental $L_2L_2 \longrightarrow L_2M_1$ $({}^3P, {}^1\bar{D}\ {}^1S) - ({}^3\bar{P}, {}^1\bar{P})$ lines are found to be beyond 8000 A.

In a similar way, spectra of all groups can be predicted and correctly located.

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The Scattering of Wireless Waves.

Observations made during the past year have brought to light a new factor which plays a very considerable part in wireless transmission on short waves, say between 14 and 50 metres. This factor is a very pronounced scattering of the wireless waves from the upper regions of the atmosphere or Heaviside layer.

The existence of this scattering has been brought to light by the use of various types of direction-finding apparatus. The results obtained by the use of these indicate that the energy received at distances beyond the reach of the direct ray, say greater than 100 km., is either partially or wholly scattered. The scattering effect is most marked within the 'skip distance.' As is now well known, the main rays from a short wave transmitter find their target at distances greater than about 200 to 500 miles, these distances depending on the wave-length, season, and time of the day. It is found that the intervening region (between the range of the direct ray and the end of the skip distance) is almost wholly illuminated by scattered radiation, which, being more or less isotropic, gives no indication of direction. Precautions have been taken to eliminate the reflected wave polarised with its electric force horizontal, which on the longer wave direction finders is responsible for directional errors and absence of bearing. The effects observed, therefore, on the short waves cannot be due to this cause.

During the summer months the scattered radiation appears to be more or less isotropic, but recently we have found evidence of anisotropic scattering, which suggests that it is akin to the scattering of light from the sky, so that it is probably partly or wholly polarised in a direction perpendicular to the direction of the incident ray.

Even at long distances the main ray appears to be associated with some scattering estimated to be 1/6 to 1/10 of the amplitude of the main signal. This scattering is a factor on all waves between 14 and 50 metres. The range above this has not been thoroughly investigated, and there appears to be no evidence of scattering in the longer wave band used for broadcasting.

These facts might indicate that the scattering follows Lord Rayleigh's law, increasing as the fourth power of the frequency, except that there is not sufficient numerical evidence to show that it varies in this manner between 50 and 14 metres. Indeed casual observation might indicate that there was very little variation of the scattering ratio in this range.

On the other hand, it may indicate that the mesh of the scattering structure is small compared with lengths of 300-400 metres, but is large compared with 50 metres.

Whatever other conclusions we may draw from this evidence, it seems certain that the Heaviside layer is by no means a uniformly ionised region, but is very patchy, and there is some evidence of the existence of clouds which are small in dimensions compared with the shortest wave-length, that is, 14 metres.

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Research Department,
Marconi's Wireless Telegraph Company, Ltd.,
Chelmsford, Feb. 3.

New Edition of Willard Gibbs's Works and Proposed Commentary.

In 1906 the writings of Willard Gibbs were printed in a collected edition of two volumes entitled "The Scientific Papers of J. Willard Gibbs." Vol. 1 contained all of his papers on thermodynamics, and Vol. 2 the remainder of his published writings with the exception of the book "Elementary Principles in Statistical Mechanics," which had been published only five years earlier and was at that time still available. At the present time both Vol. 1 of the "Scientific Papers" and the volume on statistical mechanics are out of print.

In connexion with a movement started last winter to establish at Yale University a memorial in honour

of Willard Gibbs, provision has been made, through the generosity of a donor who prefers to remain anonymous, for a new and complete edition of Willard Gibbs's writings. This will consist of either two or three volumes, well printed and bound, and will be sold at a very moderate price to encourage a wide distribution. It will probably be published during 1928.

In addition to this reprinting of the original text of Gibbs's works, it is proposed to publish, at some later date, a volume or volumes designed to aid the reader to bridge the well-recognised gap between Gibbs's theorems on one hand, and the actual experimental data of the chemist and physicist on the other. This supplementary material, to be written by competent authorities in the several fields, would aim (*a*) to explain the philosophical background of Gibbs's method; (*b*) to amplify the treatment of points of special difficulty; (*c*) to discuss the evaluation of Gibbs's functions in terms of directly measurable quantities; and (*d*) to furnish a variety of illustrative examples from the literature now available. Such treatment is most needed in the case of the thermodynamic papers, but the plan may be extended to cover Gibbs's writings on other subjects if it seems expedient. The financial support of the undertaking has been liberally provided for, and suitable honoraria will be paid to the authors of the new material.

The undersigned committee, appointed to study this plan, earnestly solicits suggestions and comments from all persons interested, especially with respect to any or all of the following questions:

1. Which of the aims outlined above are the most important?

2. How should the subject matter be subdivided into parts which can be handled by a single author?

3. What persons, irrespective of nationality, are best fitted by ability and training to undertake these different parts?

Letters containing suggestions or criticisms will be welcomed, and may be addressed to the Gibbs Committee, Sterling Chemistry Laboratory, New Haven, Conn.

JOHN JOHNSTON.
WILLIAM F. G. SWANN.
RALPH G. VAN NAME, Chairman.
Yale University,
New Haven, Conn.

Use of Diffraction Effects in Measurements of Stellar Photographs.

THE central area of the image of a star in stellar photographs consists of a cluster of silver granules disposed radially in rapidly decreasing numbers, so that the circular or nearly circular boundary is ill defined. This want of definition is necessarily responsible for a large part of the probable error in the microscopical measurements of the star's co-ordinates.

The images of the brightest stars in some photographs, however, may be observed to be accompanied by radial 'rays,' which proceed outwards from both ends of a diameter of the disc as a narrow band gradually terminating in a vanishingly thin line. These effects are well known to be due to diffraction, and it appears that this occasional defect in the image might be purposely produced and used to increase the accuracy of measurement.

If a thin wire be stretched across the aperture of the object glass of the telescope, a star image when observed with an eyepiece will be crossed by a series of narrow spectra at right angles to the direction of the wire, and presumably the central line of this narrow band of interrupted light passes through the point of maximum intensity in the star image. The closer the wire is to the eyepiece the shorter the spectra become, and finally they vanish when the wire coincides with the image. The same narrow band of light is produced when the wire is placed outside the telescope between the object glass and source.

The effect is not altered by moving the wire in a direction perpendicular to the optic axis, and is still apparent when the wire is just within the boundary of the refracted bundle of light; and therefore the presence of other wires parallel to the first only increases the amount of light diffracted into the narrow band of spectra.

It is obvious that if two gratings be constructed of parallel thin wires and crossed at right angles, the images of stars photographed through them will be crossed by two narrow lines at right angles to one another.

It is conceivable that the micrometer wires of the reading microscope may be set with smaller probable error on the central line of these narrow bands than on the centre of the ill-defined star image itself. It is also possible that the presence of a binary will be more readily perceived by the doubling of the bands than by observation of the confused disc itself, but I have not been able to try this yet. I shall be grateful if any astronomer can inform me if this method has been used for the purposes of measurement.

It may be noted that if a wire or a couple of parallel wires be placed between the object glass and eyepiece of a microscope, the focus of a star-image can be more readily determined than by observation of the ringed disc alone. The very fine narrow band of diffracted light crossing the centre of the disc passes more rapidly in and out of focus than can be observed with the central spot of the disc itself.

ALAN POLLARD.
Imperial College of Science, London,
Feb. 3.

Altered Character in the White-faced Spanish Fowl.

A RUMOUR gained currency last year that the old white-faced Spanish fowl, made classical by Darwin's experiments, was extinct. This is not so—a cock won the first prize in the "any other variety" class at the last Crystal Palace Poultry Show—but it is now very rare. Thus it seems to me worth mentioning that its characteristic points have undergone a great additional development since Darwin's time. The ear-lobes were then already large, fully continuous with the similar white skin of the face, and confluent with the throat-skin behind the wattles, but they did not hang down so far as those. By the 'seventies they did so, in some specimens at any rate, but still retained their character as ear-lobes. This has now been entirely lost; they form but the lateral portions of a great white bib or horizontal dewlap, which extends an inch or two below the wattles, the throat-skin having been much developed in the downward direction also.

It is obvious that this alteration must have been effected by selection within the breed, as no outcross could have been used, no other breed having the white face. Thus we have here one structure definitely changed into another by selection of small variations in about half a century. The cock above mentioned is figured in *Poultry* for Dec. 30, 1927.

F. FINN.
c/o Grindlay and Co.,
54 Parliament Street, S.W.1,
Feb. 5.

A New 18-inch Cœlostat.

For investigations of the sun it is usual to employ spectrographs of considerable weight and length, which it would obviously be impracticable to mount on an equatorial telescope. The plan generally adopted is to place the apparatus in a room where it can be firmly fixed and kept at a constant temperature, and to direct the solar image into it by means of a mirror.

Various instruments have been devised for reflecting the light from a celestial object in a given direction, such as the siderostat and the Foucault and Stoney heliostats, which are arranged to give a double motion to a plane mirror. These all suffer from the defect that they rotate the image and are therefore not suitable for solar work.

The cœlostat is, however, free from these defects. It consists simply of a plane mirror in a metal cell to which are fixed two pivots or trunnions at opposite sides and exactly in line with each other, so that the mirror is rotatable about an axis parallel to its upper plane silvered surface. This axis has to be set truly parallel to the earth's axis, and the mirror is rotated by clockwork at the rate of once in 48 hours in a direction opposite to that of the earth's rotation. If then we look at a star reflected in the mirror, the image will appear to stand still, because the forward motion of the star is exactly counteracted by the backward motion of the mirror, remembering that the reflected ray always turns at twice the angular speed of the mirror. In order that the light can be sent in a convenient direction (usually either vertical or horizontal), it is necessary to place a second mirror in its path.

The following account is a description of a large instrument of this type with an 18-inch plane mirror, which has recently been made for the Commonwealth Solar Observatory at Canberra, New South Wales, by Sir Howard Grubb, Parsons and Co., of Newcastle-on-Tyne.

This cœlostat possesses a number of interesting features. For example, the mirror is made of Pyrex glass, and the driving clock is perpetually wound by a small electric motor. Both the quick and slow motions to the mirror are operated electrically from a distance by suitable magnets and a reversible motor. The complete apparatus weighs 480 lb. It will be mounted with its second mirror of 18 inches aperture on a rotatable carriage at the top of a building, and the beam will pass vertically downwards through a 12-inch objective and thence will be reflected by a 10-inch mirror into a horizontal spectrograph.

A complete cœlostat, therefore, will consist of a mirror mounted in bearings, with some arrangement by which the inclination of its axis to the horizon can be set exactly equal to the latitude of the observatory. There will also be a clock, similar to the driving clock of an equatorial telescope, which may, or may not, be on the same base. It is more compact if all the parts are mounted together, but the vibration of a clock, especially if electrically wound, is often difficult to overcome. It must be possible to increase or reduce the angular speed of the mirror from a distance by a very small amount for guiding while taking a photograph ; and means must also be provided for moving the mirror quickly when making the preliminary rough setting. In the present instrument the quick setting is performed by a small motor with an auxiliary worm and wormwheel, mounted on the mirror spindle and rotating with it ; thus the rough adjustment can be very conveniently performed by the operator from the slit end of the spectrograph.

Fig. 1.—View of cœlostat from east side.

The Mirror.

The mirror is 18¾ inches in diameter and 3 inches thick, weighing about 72 lb., and silvered on the optically worked upper surface. The material chosen was Pyrex glass, made by the Corning Glass Co. of New York. The advantage of Pyrex over common glass is mainly its low coefficient of expansion. When a cœlostat is used in sunlight, the upper surface expands and forces the whole mirror to adopt a somewhat convex shape, which not only produces a marked change of focus, but also introduces astigmatism into the image. An additional advantage of this glass is found in the polishing process, because the heat generated by the polisher does not produce so much change of shape as is the case with ordinary glass. It is more difficult to grind than hard crown, but takes a very fine polish.

The mirror cell consists of a circular cast-iron box, with about ½-inch clearance all round and below the mirror. The glass rests on three brass discs,

4 inches in diameter, mounted by ball and socket on the ends of three levelling screws. This ensures that the mirror will rest rigidly and firmly in the cell. To prevent any lateral movement, the mirror is held by eight equidistant pads about 2 inches square, mounted in pairs on pivoted rockers outside the cell. The two lower rockers, which bear the weight of the mirror disc, are solid and turn on fixed pivots; but the upper rockers consist simply of flat steel springs adjusted by milled screws. After lowering the mirror into place, a gunmetal retaining ring is screwed on the top of the cell and the glass is pushed up into contact with this ring by the three levelling screws. A fourth central screw is also provided which is made sufficiently long to lift the whole mirror right out of the cell for re-silvering.

Massive pivots $1\frac{5}{8}$ inch diameter are bolted to this cell at opposite sides in such a way that the axis of rotation lies accurately parallel to the plane of the upper reflecting face of the mirror.

THE MOUNTING.

The mirror pivots pass through gunmetal bearings at the extremities of a heavy semi-circular casting, which is clamped to a cradle on the main case casting. By loosening this clamp, the whole semi-circular frame can be moved round to alter the inclination of the mirror-axis to suit different latitudes. The thrust due to the weight of the mirror is taken by a ball at the lower end of the axis. Provision is made for a small adjustment in azimuth.

The main wormwheel, or driving circle, which is strung on the upper pivot of the mirror box, is a gunmetal casting 19 inches in diameter, and is cut with 720 teeth. It is driven by a steel worm having a period of four minutes. The drive from the clock (one turn in six seconds), is transmitted to the driving screw by bevel and worm gearing through a vertical shaft the length of which can be varied to suit different latitudes. With the clock mounted on the base, and the large wormwheel of the present instrument, the latitude can only be adjusted over a few degrees, but if the clock were mounted independently a range of from 65° N. to 65° S. could be obtained.

THE SLOW MOTIONS.

Between the clock and the main worm there is inserted an arrangement of gears for providing slow motions to the mirror. The clock shaft rotates once in six seconds, and the vertical shaft rotates at the same speed; after this the system is broken in two places, and at each break is inserted one of Sir Howard Grubb's well-known differential epicyclic gears (Fig. 2). So long as this gear is left free, it will rotate with the shaft and the whole will go round as one unit. By means of an electro-magnet, a small brake can be applied to the disc carrying the planet wheel, and then the clock will turn one of the large gears; this turns the planet about its own spindle, and the planet in its turn drives the other large gear. The numbers of teeth on these gears are 92 and 90; thus on applying the brake an acceleration of about 2 per cent. is obtained. A corresponding deceleration results if the brake is applied to the second (reversed) epicycle. These slow motions are for guiding, on account of the constantly varying refraction of the atmosphere. Pressing a key for three seconds will produce a change in the direction of the reflected ray of 1″.

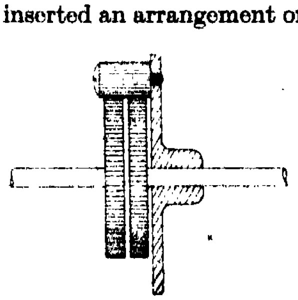

FIG. 2.—Sir Howard Grubb's differential epicyclic gear.

THE CLOCK.

The clock is a distinctly novel arrangement and works extremely well. It is primarily a weight-driven clock with friction governor worked by an endless chain on Huygens' principle, so that the clock may be wound by an electric motor without the necessity of any maintaining power (Fig. 3).

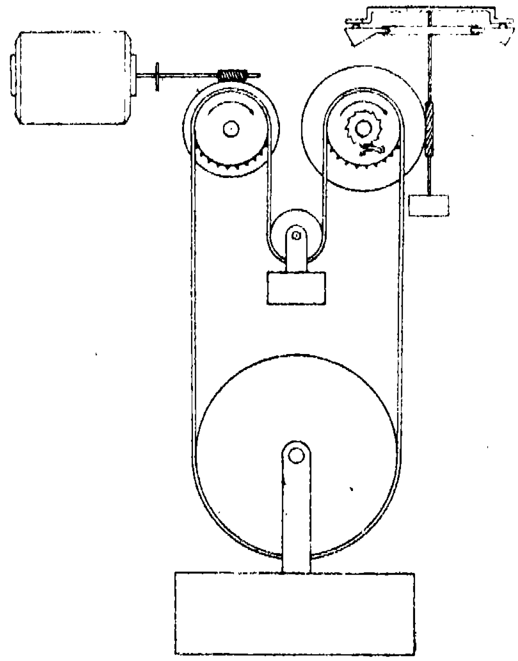

FIG. 3.—General arrangement of the driving clock.

The chain passes over two sprocket wheels, one on the motor winding shaft, and the other on the main clock shaft. On the latter is also a worm-wheel which drives the governor through a reversed worm arrangement. The governor spindle is vertical, and rests on a ball-bearing race to take the thrust of the reversed worm. There are four hinged governor weights which rise up by centrifugal force until the pads on their upper surfaces rub against a brass ring, and the friction then suffices to keep the clock running at a fixed speed. The speed can, however, be altered by an adjusting screw which lowers or raises the whole spindle, and thus allows more or less movement for the governor-weights.

The endless chain also supports two weights, of which the main lower one weighs 11 lb., while the

small upper one of ½ lb. simply serves to keep the chain taut. The up-and-down movement of the main weight operates a small rheostat controlling the speed of the winding motor, so that as the weight rises it introduces more resistance, thus slowing the motor until a balance is obtained. The weight then floats almost stationary, and the motor winds at the

FIG. 4.—Arrangement of clock, gearplate, and driving circle.

same rate as the clock unwinds. A second rheostat is also fitted, so that the motor speed may be approximately adjusted when the instrument is installed.

When the motor is switched off, the main weight continues to fall and the little weight rises until ultimately it will reach the top of its travel and stop abruptly. In order to prevent damage, due to the great inertia of the governor, a ratchet is incorporated in the clock sprocket to allow the governor to run on freely.

The motor armature was carefully balanced by the makers, and as an extra precaution against vibration, the whole motor is mounted on thick pads of Sorbo rubber and the drive is transmitted through a thin flexible coupling.

To ensure the utmost accuracy in the rate of the mirror, the speed is further controlled by a pendulum, using the 'Russell' type of control. Just before the main spindle leaves the clock, a friction clutch is inserted that will slip if anything obstructs the free movement of the spindle. Round the edge of this clutch is a series of six pins which travel past at the rate of one per second, and a steel pawl is so placed that it catches one of these pins and holds it stationary until the pawl is drawn clear by an electro-magnet operated by a pendulum of an accurate clock. In this way the motion is held momentarily until released by the controlling pendulum at the end of each second. It is, of course, necessary to run the cœlostat clock a trifle fast in order that this control should be effective. The arrangement of these various mechanisms is clearly shown in Fig. 4.

THE ELECTRIC QUICK MOTION.

This is a great convenience in setting the mirror from a distance into the correct position at the commencement of observation. To avoid having to unmesh the driving worm, the main wormwheel is loose on the mirror shaft, but the drive is transmitted through a small auxiliary worm and wormwheel which can be turned by an electric motor also mounted on the spindle. In the ordinary way the whole arrangement, including its motor, turns with the mirror once in two days; but when the quick motion is required, this auxiliary motor is started up and the mirror shaft then rotates, independently of the main wormwheel, at the rate of one turn in about two minutes. The motor is, of course, reversible from the distant control switch, and the current is led to it through four slip-rings and wipers. The worm drive for this quick motion can be thrown out of gear when it is desired to turn the mirror by hand.

The Suez Canal in Relation to the Marine Faunas of the Mediterranean and Red Seas.[1]

THE marine faunas of the Mediterranean and Red Seas differed so widely from one another before the opening of the Suez Canal that in many groups, if a species was found in one sea, it was almost certain that it did not occur in the other. Since then there have been a few Red Sea crustaceans found all over the Mediterranean, and a swimming crab is being commercially fished along the North Egyptian coast, where also the Red Sea pearl oyster is common. The intermingling of the two faunas being clearly an object of great interest, the Royal Society provided the requisite funds for the Cambridge Expedition, the first reports of which are now before us. The leader of the expedition was Mr. (now Prof.) H. Munro Fox, who for several summer vacations had worked at the Suez end of the canal, and with him were associated Mr. Robert Gurney, Mr. V. C. Robinson, and Mr. D. N. Twist. Help was also given by the directors of the Orient Line, and the expedition received an unstinted, generous, and most practical welcome from the Suez Canal Company and the Egyptian Government.

Along the line of the Suez Canal are limestones of Cretaceous and early Eocene ages, the arm of the Mediterranean that extended down what is now the Red Sea only coming into existence in the

[1] Cambridge Expedition to the Suez Canal, 1924. (London: *Transactions of the Zoological Society*, 1926. Part I.

Miocene, when the whole area was peopled from the Mediterranean. In the Middle Pliocene a connexion was formed that allowed an invasion of Indian Ocean animals. How and when exactly the Isthmus of Suez was built is not known, but in the Pleistocene there was a freshwater lake over part of what is now the Isthmus, this containing a series of molluscs of species many still living in the Upper Nile.

It was at this period that the fauna of the Gulf of Suez assumed its almost completely Indian Ocean facies, and the fact that it did so is remarkable enough and by itself quite sufficient to make desirable the present study. The Bitter Lakes were once an arm of the Red Sea, the top of which periodically was isolated and dried up, giving alternate layers of salt and sand. The Pharaohs dug a canal connecting the Bitter Lakes and so the Gulf of Suez to the Nile, and this continued more or less open until the eighth century. It was not a traffic route, as the terminal ports were in Egypt itself, and so differs scientifically from the present canal, the connexion being through a long stretch of fresh water, without unbroken journeys by means of which animals attached to ships could pass from one to another area.

The scientific results of the expedition can only appear gradually as groups of animals are worked out. The Bitter Lakes have increased in depth by nearly three metres, owing to sa[illegible]ution, since the canal was opened, but t[illegible]ximum density of their surface waters i[illegible] 1037—bottom 1042 = salinity 1·053—as c[illegible]ed with average densities of about 1027 an[illegible]1 in the Port Said and Suez Roads respectiv[illegible] At Lake Timsah the density varies from 1006 [illegible] 1036, and in places fresh water overlies the sea water, each containing its own organisms. The fauna and flora of the canal are poor, probably due to dredging and the churning up of the water by ships, since piles and mooring buoys show abundant growths. The bottom of the Bitter Lakes is covered, over the salt bed, by black mud devoid of macroscopic life, but the shore regions show a fauna and flora richer in numbers of species and individuals than similar areas at either end of the canal. Rather unexpectedly, there is no sign of stunting or deformity except in the Foraminifera, some organisms showing markedly increased size.

Clearly, to-day salinity is no barrier to migration, to the swimming, crawling, or carrying of adult organisms between our seas, but it may have been in the past, since the density of the Bitter Lakes in 1869 was 1123,—and it may still be to forms only distributable by delicate larvæ or eggs peculiarly subject to changes of osmotic pressure. The amount of hindrance by reason of high temperatures is small, but more data are required. Tugs, coal barges, etc., dirtied by organic growth, a[illegible]equently changed over from the terminal ports and are helpful. Currents deduced by Prof. Fox from density observations show that Bitter Lake water, as affected by Red Sea tides, is [illegible]ried from October to July nearly to Port Said, [illegible] Mediterranean water to beyond Lake Timsah [illegible]ugust and September. Of 12 groups of organ[illegible]s there are found in the Canal 83 Mediterranean [illegible] 234 Red Sea species, but we must await further lists and analyse these into areas, while the breeding dates are all important in respect to currents.

Scientifically, periodic investigations of the Suez Canal flora and fauna should have been made in the past in respect to which there are no data such as are now required. The expedition under discussion has collected all there were and given a definite basis upon which future science can work. It cannot, however, be deemed to have completed its task until its members pay a further visit to the canal to study the conditions from July to September, the months of heat and of northerly currents, one member in advance to collect data on breeding in the previous quarter.

Obituary.

PROF. J. FIBIGER.

It is a tribute to the perennial fascination of the cancer problem that Johannes Fibiger, whose sudden and unexpected death on Jan. 30, at the age of sixty years, is deplored by the medical profession of the world, only became known to the wider medical and lay public through his contribution to its solution. It is eloquent of the importance and value of his work that his death has evoked world-wide tributes to his memory.

Fibiger was appointed professor of pathology in the University of Copenhagen in 1900, and until 1913 was known only to pathologists through his careful work on tuberculosis. In 1913 the accidental discovery of cancer of the stomach in rats associated with the presence of nematode worms in the actual substance of the growth, started him on the intricate and arduous investigation which led to the discovery of the first successful method of experimental cancer production. The magnitude of this achievement is seen in the great expansion to which it has led, in the study of neoplastic growth. The tar cancer work of Yamagiwa, Itchikawa, and Tsutsui was directly inspired by it, and Fibiger himself was quick to discern the experimental advantages of the chemical method, his own researches in the subject doing much to establish it in the forefront of the means at our disposal for probing the caustive factors in malignant disease. Even more directly the offspring of Fibiger's genial discovery, is the method of sarcoma induction in the liver of the rat by the larvæ of *Tænia crassicollis*, worked out by Bullock and Curtiss. The production in animals of X-ray, paraffin, and arsenic cancer easily followed as an extension of the avenues of attack opened by Fibiger.

The substitution of exact experiment in the place of more or less nebulous speculation, to which the discussion of cancer etiology was previously restricted, is now acknowledged by all serious students of the cancer problem as the most precious

and enduring consequence of Fibiger's discoveries. Their permanent value will inscribe his name beside that of Virchow, on whose theory of chronic irritation it has placed the crown of experimental verification.

The recent award to him of the Nobel Prize in Medicine was welcomed by Fibiger's friends and admirers throughout the world. In 1926 he was made Rector of his University, a post which he filled with dignity and distinction. His unfailing personal courtesy and energy were proof even against the tedium of international conventions, and in his addresses, as in his published work, he combined brilliance with accuracy, sanity and restraint with enthusiasm. J. A. MURRAY.

MR. J. E. HARTING.

MR. JAMES EDMUND HARTING, who died on Jan. 16, was the son of a Roman Catholic solicitor and was born in 1844 in Chelsea. He was educated at Downside College and, after taking his B.A. at the University of London, he joined his father's firm and practised for some years as a solicitor. Always attracted to natural history, he continued his observations of Nature, more especially of bird-life, in and around London, and one of his earliest papers, "A list of Waders that have appeared at Kingsbury Reservoir in 1863," appeared in the *Zoologist* for that year. From this time onwards, Nature articles from his pen appeared regularly in the *Field*, the *Sussex Zoologist*, the *Middlesex Zoologist*, and in many other journals, but the great majority were written for the *Zoologist*, and in 1877 he became the editor of this journal, a position he retained until 1896. From 1871 he was naturalist editor of the *Field*, and later shooting editor also. On the opening of the Natural History Museum at South Kensington he was appointed to form the zoological library, and the zeal and energy with which he worked is attested by the magnificent collection of books now in the Museum available for reference.

Among the more important of the many books written by Harting were "The Birds of Middlesex" (1866); "The Ornithology of Shakespeare" (1871); "A Handbook of British Birds" (1872), of which he brought out a new and revised edition in 1901; in 1875 he edited an edition of White's "Natural History of Selborne"; "British Extinct Animals" (1880); "The Birds of Hampstead" (1889); and "Bibliotheca Accipitraria" (1891), this last being perhaps the most valuable of all his works. In addition, however, to the above-mentioned works of a more or less scientific character, he wrote many books indirectly connected with ornithology, such as "Ostriches and Ostrich Farming" (1879) and "British Game Birds and Game Laws" (1912).

As a writer, Harting had the knack of making his subjects interesting even when they appealed only to a small circle of readers, whilst his popular and semi-popular books and articles showed a wealth of knowledge and accurate observation of Nature, recorded with a charm that disarmed even those who disagreed with his deductions. From a scientific point of view, Harting was, unfortunately, so conservative that modern methods annoyed and irritated him. In consequence, he often refused to accept facts which, in his heart of hearts, he knew to be true, or arguments which he knew to be irrefutable. Nevertheless, his recent death leaves the scientific world the poorer, whilst the Nature-lover loses a writer who, whatever he wrote, was always well worth reading.

MR. GEORGE MUIRHEAD, successively factor on large estates in Berwickshire and on the Earl of Aberdeen's properties in Aberdeenshire, and for the last quarter of a century Commissioner on the Scottish estates of the Duke of Richmond and Gordon, had exceptional opportunities for studying the natural history of Scotland in very diverse regions. He made the most of these, and for long had been well known throughout the country on account of the particular interest he showed in bird life, in the artificial rearing of salmon and trout, and in floriculture. More than twenty years ago Mr. Muirhead conducted a series of experiments on the rearing of salmon fry in salt-water ponds near the estuary of the Spey, and succeeded in rearing fry, received from the hatcheries at Gordon Castle, through the smolt to the grilse stage. His most important work was his "Birds of Berwickshire," the two volumes of which, published in 1889 and 1895, comprise much more than the ordinary local fauna, since they include readable accounts of the past history and of the legendary lore of the species found in the county. A few years ago the University of Aberdeen recognised the merit of his work by granting him the degree of LL.D. He died on Jan. 29 at the ripe age of eighty-two years, and is survived by his widow, the eldest daughter of the late Lord Sempill.

WE regret to announce the following deaths:

Prof. P. Carmody, Director of Agriculture and Government Analyst, Trinidad, on Feb. 10, aged seventy-one years.

Dr. R. S. Holway, emeritus professor of physical geography at the University of California, on Dec. 2, aged seventy years.

Dr. W. L. Johannsen, professor of plant physiology in the University of Copenhagen and a foreign member of the Swedish and of the Austrian Academies of Sciences, on Nov. 11.

Mr. Richard Kearton, author of several popular books on natural history, and associated with his brother, Mr. Cherry Kearton, in the kinematography of wild animals, on Feb. 8, aged sixty-six years.

Colonel J. P. Koch, Chief of the Danish Military Air Service, who had taken part in many exploring expeditions in Greenland, on Jan. 13.

Prof. Otto Krug, Director of the Agricultural Experimental Station and Public Institute for the Examination of Foodstuffs at Speyer, on Dec. 25, aged sixty-four years.

Prof. Ludwig Milch, Director of the Institute of Mineralogy and Petrology at the University of Breslau, on Jan. 5, aged sixty years.

The Right Hon. the Earl of Oxford and Asquith, F.R.S., on Feb. 15, aged seventy-five years.

News and Views.

THE funeral of Prof. H. A. Lorentz, which took place at Haarlem on Thursday, Feb. 10, afforded a striking tribute to the honour and esteem in which he was held by all sections of his countrymen. Representatives of the King and Queen, the Government, and municipalities were present, and the funeral procession passed through the streets of Haarlem along a special route, which was lined with people. Not only were the universities and scientific institutions of Holland strongly represented, but there were also representatives of foreign academies, including Prof. P. Langevin, Mme. Curie, Prof. A. Einstein, Prof. J. Verschaffelt, and Sir Ernest Rutherford, the latter representing the Royal Society of London. An eloquent eulogium on Prof. Lorentz was delivered at the graveside by Prof. Ehrenfest, successor of Prof. Lorentz in the chair of theoretical physics in the University of Leyden, and was followed by short addresses by Sir Ernest Rutherford, Prof. Langevin and Prof. Einstein. In these speeches, emphasis was laid not only on the magnitude of his contributions to science both by his teaching and investigations, but also on his fine personality and character and the strong influence for good he had exerted in international scientific affairs.

CONSTERNATION has been aroused by the proposal to build a beet-sugar factory on the banks of the River Wye néar Hereford, which would discharge several million gallons of putrescible effluent daily into this fine and valuable salmon river during the sugar season. Judging by the disastrous effect which this effluent has had upon other rivers, the anxiety is well justified, for they have been depleted of oxygen and coated with sewage fungus for many miles below the point of discharge. While the provision of factories and employment can only be viewed with satisfaction, particularly by the Minister of Agriculture and Fisheries in his former capacity, the pollution of one of our finest and most beautiful salmon rivers can only be viewed with dismay, particularly by the Minister of Agriculture and Fisheries in his latter capacity. Up to the present time it has been found impracticable to render the effluent non-putrescible at a reasonable cost owing to its large volume. Research concerning possible methods of treatment has been recently inaugurated under the auspices of the Department of Scientific and Industrial Research, and is, we understand, in active progress at Rothamstead. Upon the successful issue of these investigations, rendered difficult since the cost of treatment must be small, rests the possibility of working sugar factories on clear rivers, such as the Wye, without destroying not only the fishing but also, and to a marked extent, the amenities of the riverside. In common with all who desire both increased employment and the preservation of our rivers, as such and not as sewers, we wish good hunting to the small band of workers who are attacking this problem.

IN 1926 a copy of Barrow's "Euclidis Elementorum libri XV." (1655) was sold by auction for five shillings. It proved to be Newton's own copy and to be full of his notes. In the Newton memorial volume, prepared under the auspices of the Mathematical Association and published last year (Bell and Sons, Ltd.), the conjecture was hazarded (p. 170) that this was the only relic left of Newton's Cambridge library of at least 2000 volumes. Now comes the startling news that Col. de Villamil has unearthed from a private house in Gloucestershire, where they have been lying for the last two centuries, at least a third of the missing volumes, and that they include some of the books from which Newton must have reaped his early acquaintance with the subject he was to adorn. A short account of the find is given in the *Morning Post* for Feb. 8. The treasure trove includes classical texts, works on alchemy and the chemistry of the day, and on religious topics. Many of them are autograph presentation copies, contain his own signature, and show by copious annotations every sign of having been closely studied.

AMONG the mathematical works which Col. de Villamil has found are Newton's own copy of the "Principia," corrected in preparation for the second edition, to be edited by Roger Cotes; the "English Euclid" mentioned in Brewster's "Life" (i. p. 22), probably Barrow's edition of 1660; Seth Ward's "Idea Trigonometriæ demonstratæ (in usum juventutis Oxoniensis") (1654); Norwood's "Trigonometrie, or the Doctrine of Triangles" (8th edition, 1685); and what is described as Descartes' "Philosophy." Another interesting item is Newton's own Greek-Latin lexicon (1650), bought, according to the fly-leaf, on Mar. 26, 1661, for sixpence. Some of the books belonged to Barrow, *e.g.* his Greek Testament (1653), and his presentation copy of Stillingfleet's "Discourse on Idolatry," etc. A further and detailed account of the contents of this unexpected —or should we say, long-expected—find will be awaited with impatience. Meanwhile Col. de Villamil, who is old enough to have learned his Euclid from Oliver Byrne's coloured diagrams, must be warmly congratulated on the good fortune which has brought in his way so striking a discovery.

A MERRY combat has been raging around the subject of evolution since Sir Arthur Keith restated the case at the Leeds meeting of the British Association. Trumpets which have lain silent for years are blazing forth challenges to science, and weapons old and rusty with disuse are being burnished for the fray. We are not surprised, knowing something of the strength of fundamentalist feeling which lay dormant in Great Britain, hoping and waiting for the gradual overthrow of Darwinism. But what is surprising is the progress which the doctrine of evolution has made in the meantime even in the quarters which now challenge the sequel. Take the article on "Truth and Error in the Doctrine of Evolution" by Dr. J. A. Fleming, in the January issue of the *Nineteenth Century*. Dr. Fleming is a distinguished electrical engineer and, as a matter of course, knows a great

deal about recent developments in physical science. He is prepared, therefore, to accept the findings of the astronomers and physicists, and admits the evolutionary development of, say, the solar system. But he clearly knows a great deal less about the discoveries of biological science, and, perhaps as a consequence, is not prepared to accept the findings of the biologists. Yet when he reaches the greatest stumbling-block of all, the position of man, even he admits that "as regards bodily structure [the human race] is unquestionably closely allied to the animal races, and especially to the higher mammalia." His main difficulty in accepting evolution lies in the high qualities of man, which seem to cut him off as a being apart from the animal world, but here his misstatement of the facts is patent. All the existing races of mankind he regards as possessing the *same* marvellous qualities. Gradings, essential to the evolutionary view, are ignored, and the lowly Fuegans are (presumably) bracketed with the highest Caucasians. Had the author followed the course which he himself proposes, of endeavouring to trace the characteristics of finished humanity backwards to their simpler manifestations, he would have found a diminishing series through the Iron and Bronze Ages, to the neolithic and various palæolithic stages, which might have suggested that the series did not end there.

THESE are not the points to which Sir Arthur Keith has given prominence in his rejoinder, "Evolution and its Modern Critics" in the February issue of the *Nineteenth Century*. Both Dr. Fleming and another critic, Mr. G. H. Bonner, argue that the intelligent perception of orderliness and plan in Nature implies an intelligent planner. It is the old story of Paley's argument from design, the watch and the watchmaker, the contrivance which could not exist without a contriver; an argument which, seemingly invincible, "was yet in less than a generation replaced in classrooms, laboratories, and learned societies by that of Darwin." Paley forgot that even his watch had an evolution, and Darwin's argument succeeded because "he produced such a prodigious number of facts which could not be explained if special and instant creation was true, but which fell into place and assumed a rational order if the doctrine of evolution were valid in the world of living things." The human thighbone shows as clear evidence of architectural skill as Paley's watch, yet the internal struts carrying just the proper strains in the proper places are built by cells acting in response to the physical forces which play upon them. Architect and mason are one. "There is no duality of function in living matter." The critics are loth to surrender the uniqueness of the human 'soul': they say, a man is not his body; it is the soul, manifesting in a physical body in order to unfold, that is man. But the intricate manifestation "as we medical men know it, depends solely upon the brain"; the human soul is "the inward response and outward manifestation which is given by every living human brain."

THE Lewis Evans Collection at Oxford has recently received several very valuable gifts. One of these, the great silver microscope of George III., has already been referred to in our columns (Feb. 11, p. 226). Now the great Companies of the City of London have materially increased the fund for the collection, originally started with £1000 from the Goldsmiths' Company, on condition that the University devote to the collection the necessary accommodation in the Old Ashmolean Museum, and make such other arrangements for its future maintenance, care, and display as will enable the gift to be secured to Oxford, and available for study. In making these additions to the Lewis Evans Fund the subscribing Companies were greatly influenced by the very close relationship between the ancient museum of John Tradescant in Lambeth and the Old Ashmolean at Oxford. Both were science museums. Ashmole's museum was the child of *Museum Tradescantianum*, with a rich share of the parental qualities, and a richer endowment of the family heirlooms. Until the recent revival of the old Museum its scientific origin was forgotten, being obscured by the growth of the art and archæological side, while the original scientific treasures of the seventeenth century were relegated to the cellars of the University. Yet, as has been aptly said, "Tradescant's Museum was for the London of the 17th century what the British Museum plus the Imperial Institute plus Kew is for London of the 20th century."

THE Old Ashmolean was opened in 1683, wholly as a scientific institution. At present one-third only is available for scientific purposes, for its original laboratories are being used for the storage of Bodleian books, while a second third is used for completing Dr. Murray's "New English Dictionary." The plans for a great extension (or a great reduction) of the University Library give ground for hope that accommodation for both books and the dictionary staff may be found elsewhere than in a building which is now the oldest building in Britain that was specially built for the study and teaching of natural science. Contributions to the endowment fund, such as those from the City Companies, for which the University has recently recorded a decree of thanks, will materially aid objects which have the sympathy of all interested in the history of science in Great Britain.

THE announcement in the *Times* of Jan. 9 that Dr. Hans Merensky had found artesian water in the gneiss formation of Namaqualand is important, if borne out by experience. The vegetation of this region is mostly fed by the sea-mists that drift in, and is singularly beautiful. At dawn the rolling downs in the Sand Veld become white, yellow or blue in patches acres in extent, as the sun touches the buds of the flowers interspersed among the grass; while in the Harde Veld, where the rock appears at the surface, the Mesembrianthemums afford a rich pasture for sheep. The curse of the country, however, is the want of water, so that the whole region lies idle until the rare showers fill the water-holes and valleys. The recent discovery of diamond gravels along the coast has made the finding of water imperative, as it would be useless for the Government to proclaim the

fields open for prospecting if there is no water for the people who would flock in, in the hope of making their fortunes.

THE Namaqualand gneiss is banded, with occasional slips of schist, which are metamorphosed sediments caught in the folds. It is a possible theory that the gneiss itself is the mashed-up sediments that have become entirely altered under extreme metamorphism. In the rock-shaft at the Kimberley Mine at 2520 ft. there were the ordinary shales and grits; at 3520 ft. the schists were riddled with a network of dykes of pegmatite; it was hoped to see the transition into a continuous mass of gneiss at the next level, but unfortunately the Blue Ground came to the end, and it was never cut. If this has been the history of the vast area of gneiss as a whole, it is quite conceivable that certain beds were more resistant to metamorphism, such as bands of quartzite, which, in the folding, would form impervious layers, and so help to constitute artesian basins in which subterranean water could be stored.

WE are reminded in the seventh annual report of the (British) Electrical (and Allied Industries) Research Association, known as E.R.A., that the problem before Great Britain is to provide a means which will enable its population of nearly fifty million persons to live and prosper. For about four-fifths of their food and for a large fraction of the raw materials of industry, the inhabitants of these islands depend on supplies from overseas. These supplies can only be obtained if the manufacturing industries in the country are able to carry on export trade in future with greater efficiency than the rest of the world. This is not done by lowering wages or increasing working hours. Commercial skill and organisation alone cannot succeed. It can only be done by research. Every stage in the production of the finished article must be done as efficiently as possible. Physical researches of the greatest difficulty have continually to be made, and these make the greatest demands on our physical knowledge and our manual skill. It has been found necessary to modify some of the conclusions previously arrived at. The method of finding the temperature rise in buried electric cables needs modification; this is probably due to the fact that the thermal properties of the soil round the cable are not accurately known, and this subject is being investigated. Special attention is being given to high voltage and high frequency work, and satisfactory progress is being made. The researches conducted by Prof. Callender on the properties of steam have been most successful. They are not only of importance in connexion with the design of steam turbines and boilers, but are also of value to the scientific worker. The expenditure of E.R.A. has now been extended from £16,000 per annum to £24,000 per annum, and the Association looks forward confidently to manufacturers and electric supply companies for support. Sir John F. C. Snell, chairman of the Electricity Commission, has been elected president for the ensuing year.

SIR WILLIAM BRAGG delivered a further lecture "From Faraday's Notebooks" at the Royal Institution on Feb. 9. When water lies in a pool on a vibrating support, quivering motions often appear on its surface; and sometimes the extreme regularity of their arrangement produces an exceedingly beautiful effect. Faraday carried out a number of experiments on these 'crispations,' as he called them. They are found on the surface of the water in a finger bowl when the wet finger is rubbed round the edge; or, as Faraday observed, in the small quantities of rainwater that may lie on the objects in a cart which is rattling over the pavement. Their explanation brings in some interesting points of physical science, for their form depends on the properties of the liquid on which they occur, and they have been used as the basis of a method for measuring liquid surface-tensions. Faraday also observed, when on a visit to Hastings, the curious ridges that form on the water lying in thin layers on the wet sand when the wind blows over the beach, and he pointed out that the ridges are parallel to the direction of the wind; that is, at right angles to the ripples that a wind produces in the ordinary way. These, too, he tried to explain on the same principles that he applied to his crispations. He thought that he saw a similar effect in the ridges that appear upon a water surface when the end of a vibrating iron bar is just dipped into the water; the ridges radiate outwards in approximately straight lines from the end of the bar. Curiously enough, he tried to use this effect as an analogy which would help him to understand how a vibrating body in the ether would cause the emission of rays of light. He proved that the water ridges are due to oscillations of the water at right angles to the ridges, and suggested that there was a similarity to the transverse vibrations which Fresnel had considered to be characteristic of the propagation of light.

THE Post Office is to be congratulated on the completion of the long-deferred underground electric railway in London for the conveyance of letters and parcels. It will appreciably contribute to the reduction of surface street traffic. The tube connects the Paddington District Post Office with the Eastern District Post Office. The total length of the railway as at present constructed is 6½ miles. It is the first permanent 2-foot-gauge railway in Great Britain. The minimum diameter of the tunnel between the stations is seven feet, and it accommodates a single track. The operation of the driverless trains is entirely automatic. When a train is standing at a platform ready to be loaded an operator inserts a plug, and a panel which describes where the train is going is illuminated. When the train has been loaded, the foreman operates a switch which lights a green light in the control cabin and a red light on the platform indicator. The switchman then pulls the lever appropriate to the route, starting the train and extinguishing the other lights. The electrical power required for the trains is purchased from two London supply companies and is supplied at 11,000 volts three-phase. It is then converted down in two operations to 440 volts direct current. A train passing through a station does not require to be

watched by the switchman, as he can always see its exact position by looking at the illuminated diagram in the control cabin of the station. The trains consist of two or three steel motor wagons, each of which is capable of carrying half a ton. It is possible to dispatch a second train from one station before the arrival of the first train at the next station.

ON Thursday morning, Feb. 9, Mr. Baird succeeded in sending from his laboratory the first glimmerings of images of persons in London to a room in a suburb of New York. The transmission was sent by a telephone wire from London to the radio transmitter at Purley, and from there was broadcast to New York. The waves that produced the pictures were detected by the loud irregular humming noise they produced in a telephone. The pattern of a man's head moving in a human way was clearly seen, but it sometimes faded away. This fading was attributed to interference from short-wave stations in Paris and Mexico City. A picture of a woman's head moving in a natural way was also transmitted. The receiving apparatus used in this experiment was a comparatively simple device. It comprised only a system of rotating shutters controlled by a small electric motor, the source of light being a discharge tube. Mr. Baird attributes the imperfections of the images to atmospherics and fading, and says that they could have been very considerably improved by using a higher-powered transmitter at Purley. The experiment proves that the trans-Atlantic transmission of living pictures is possible, and it indicates some of the difficulties that have to be overcome.

SIDKY PASHA's proposal to the Chamber in Cairo that all royal mummies at present being exhibited in the Cairo Museum or elsewhere in Egypt should be returned to their tombs and reinterred in their sarcophagi, will no doubt commend itself to a certain section of Egyptian opinion for reasons which, perhaps, need not be too closely examined. His views, as explained to the *Times* correspondent and published in the issue of Feb. 8, are from certain points of view unexceptionable, if not entirely convincing. The analogy he draws from the fact that great men of more modern periods are not exposed to view though they were of less importance than the Pharaohs in their day, is somewhat irrelevant. In arguing that scientific requirements alone could justify the continued exposure of the bodies, and that these have long been satisfied, Sidky Pasha assumes that further discovery is no longer possible to future generations of anatomists and archæologists—an assumption as great as the statement that those who now look at these mummies in the Museum are inspired by nothing but a vulgar curiosity. If this were true, it would involve sad implications for those who seek to popularise our museums. The appeal to sentiment in the argument that this is an attempt to comply with the religious ideas of the ancient Egyptians and to meet the requirements of the dignity of Egypt, will add weight to a proposal which it might be difficult to take seriously if it were not a real danger to the future study of ancient Egypt, and if it had not already been applied in the case of Tutankhamen.

PRINCIPAL A. P. LAURIE, of the Heriot-Watt College, Edinburgh, and professor of chemistry at the Royal Academy of Arts, and Mr. Noel Heaton, have been elected honorary associates of the Royal Institute of British Architects.

IT is announced in *Chemistry and Industry* that the Perkin medal for 1927 has been presented to Dr. Irving Langmuir, assistant director of the research laboratory of the General Electric Company, Schenectady. The medal is awarded each year by the American Section of the Society of Chemical Industry to the chemist who, in the opinion of a committee representing the Section, the American Chemical Society, the Société de Chimie Industrielle, and the American Electrochemical Society, has rendered the greatest service to American chemistry.

THE following officers and new members of Council of the Royal Astronomical Society have been elected: *President:* Rev. T. E. R. Phillips; *Vice-Presidents:* Prof. A. S. Eddington, Prof. Alfred Fowler, Dr. J. W. L. Glaisher, Lieut.-Col. F. J. M. Stratton; *Treasurer:* Dr. E. B. Knobel; *Secretaries:* Dr. John Jackson, Dr. H. Knox-Shaw; *Foreign Secretary:* Prof. H. H. Turner; *New Members of Council:* Prof. S. Chapman, Sir Frank Dyson, Mr. W. M. H. Greaves, Dr. Gerald Merton, Prof. E. A. Milne.

AT the recent annual meeting of the Botanical Society of America, the following were elected corresponding members: Abbé G. Bresadola; Prof. S. Ikeno, professor of botany in the Imperial University, Tokyo; Prof. C. H. Ostenfeld, formerly Keeper of the Botanical Museum, Copenhagen; Prof. O. Rosenberg, professor of botany in the Högskola, Stockholm; Prof. R. von Wettstein, director of the Botanical Garden and Botanical Institute, Vienna. Officers of the Society were elected as follows: President, Prof. A. H. Reginald Buller, of the University of Manitoba; Vice-President, Prof. Irving W. Bailey, of Harvard University.

DR. J. PHILLIPS, whose important botanical work in connexion with the indigenous forest trees of South Africa, carried out at the Knysna Forest Research Station in South Africa, has been referred to from time to time in our columns, has accepted an appointment in the new Research Station to be inaugurated in Tanganyika. It is much to be hoped that the South African Government will find it possible to carry on the important and interesting work to which Dr. Phillips devoted so much energy and perseverance, and which is so fraught with interesting possibilities whilst being of considerable importance to the Forestry Department.

AN American expedition to Nicholas Land, north of Cape Chelyuskin, is announced in a *Daily Science News Bulletin*, issued by Science Service, Washington. This is the Arctic land discovered in 1913 by Com. B. A. Vilkitski and partially explored by him in the following year. Since then it has apparently not been

visited. The expedition is to sail in the *Morrissey* under Capt. R. A. Bartlett, and will be mainly concerned with the collection of material for the American Museum of Natural History. No indication is so far given of the date of sailing or the route to be taken.

THE title of the *Amateur Aquarist and Reptilian Review* is being changed to the *Aquarist and Pond Keeper*, for it is intended that, besides the usual inhabitants of aquaria and ponds, the journal shall also deal with the mammals and birds which affect these directly or indirectly, either as enemies or friends. The present number (Winter 1927), the last of the old series, includes many short articles of interest to aquarium owners. These are chiefly about fishes, but there are also notes on miscellaneous subjects, such as lizards, snails, and fresh-water plants.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A part-time demonstrator in chemistry at Birkbeck College—The Secretary, Birkbeck College, Breams Buildings, Fetter Lane, E.C.4 (Feb. 21). A technical assistant in the Department of Fisheries, Irish Free State—The Secretary, Civil Service Commission, 33 St. Stephen's Green, Dublin, C.2 (Feb. 24). A mycologist to the Department of Agriculture, Tasmania—The Agent-General for Tasmania, Australia House, Strand, W.C.2 (Feb. 29). A woman staff lecturer and demonstrator in the Department of Physics of Royal Holloway College—The Principal, Royal Holloway College, Englefield Green, Surrey (Mar. 14). A professor of biochemistry at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, South Kensington, S.W.7 (April 12). Male cartographers in the Hydrographic Department of the Admiralty—The Secretary, Civil Service Commission, Burlington Gardens, W.1 (return of application forms, May 24). A research worker with metallurgical training, in the Research Laboratories of the General Electric Company, Ltd.—The Director, Research Laboratories, G. E. Company, Ltd., Wembley. A junior veterinary surgeon in the Department of Agriculture, Southern Rhodesia—The Secretary, High Commissioner for Southern Rhodesia, Crown House, Aldwych, W.C.2. A director of agricultural research and of experiments and demonstrations in the application of fertilisers, and a director of fertilised propaganda, under the Chilean Nitrate Committee—The Chilean Nitrate Committee, Friars House, New Broad Street, E.C.2. A head of the Department of Biology of Huddersfield Technical College—The Director of Education, Education Offices, Huddersfield.

Our Astronomical Column.

FIXING THE DATE OF EASTER.—A new Bill, entitled the Stabilisation of Easter Bill, 1928, is being introduced as a private member's bill in the House of Commons by Capt. Bourne and is down for a second reading on Feb. 17. The Bill, which is to regulate the date of Easter Day and other days depending thereon, provides that "Easter-day shall, in the calendar year next but one after the commencement of this Act and in all subsequent years, be the first Sunday after the second Saturday in April."

THE TOTAL ECLIPSE OF AUGUST 31, 1932.—This is the only total eclipse in the next eight years that is visible in an easily accessible region. A recent *Daily Science News Bulletin*, issued by Science Service, Washington, gives the particulars about it that have been calculated by Dr. L. J. Comrie of the *Nautical Almanac* Office. The eclipse is total in eastern Canada and the north-eastern corner of the United States ; it occurs at 3.30 P.M., height of sun 30°, duration of totality 100 seconds, width of totality track 100 miles ; the central line runs from Pierreville, Quebec, to Biddeford, Maine. The southern limit of totality runs from Montreal to Salem, Mass. ; the northern limit from St. Jean des Chaillons, Quebec, to Richmond, Maine. The central line passes over the White Mountains. Three Rivers and Sherbrooke in Quebec, Portland in Maine, and Portsmouth in New Hampshire are all suggested as suitable stations. Montreal is too near the edge of the track, except perhaps for some investigations of a special character. Boston is very close to the track, but just outside it. It will be remembered what enthusiasm was excited in America by the eclipse of January 1925. That of 1932 crosses a region not much less populous ; it comes at a better time of the year and the sun is higher, so still more successful results may be hoped for.

This is a return after two Saroses of the eclipse of 1896, Norway, Novaya Zemlya, Japan ; and after one Saros of that of 1914 (Sweden and Russia) ; the eclipse is nearing its end in the Saros cycle, and 1932 is the last occasion on which it will be visible under favourable conditions in accessible regions.

THE SUN'S ROTATION AND THE RELATIVITY SHIFT OF SPECTRAL LINES.—A paper by Mr. J. Evershed dealing with "The Solar Rotation and the Einstein Displacement derived from Measures of the *H* and *K* Lines in Prominences" is published in *Mon. Not. Roy. Ast. Soc.*, Dec. 1927. It is well known that, at the photospheric level of sunspots, the sun's angular rate of rotation diminishes from the equator towards each pole. Spectroscopic observations of the Doppler effect made by Adams in 1908 indicated that the angular speed of rotation also increases from the photosphere outwards through the chromosphere. In 1925, Evershed published his results obtained from spectroscopic observations of prominences, which gave the unexpected value at the sun's equator of nearly 17° for the daily sidereal rotation as compared with $14\frac{1}{2}°$ at the level of the photosphere (visual observations of sunspots).

The present paper, which confirms and extends Mr. Evershed's earlier results, is based on data derived from 200 spectra of prominences photographed last year at Pitch Hill, Surrey. For purposes of measurement, a comparison spectrum of the iron arc was used instead of the spectrum of the centre of the sun's disc as employed earlier. From a discussion of class *A* of spectrograms (those in which the lines were narrow, well-defined, or otherwise undistorted by radial motions of eruptive prominences) a first approximation of the mean shift of the spectral lines, *H* and *K*, in prominences is given as + 0·0109 A., the predicted relativity shift at 28″ above the sun's surface being + 0·0081 A. The outstanding difference is discussed. The paper also contains an account of Mr. Evershed's apparatus which he has installed in his underground observatory at Pitch Hill.

Research Items.

THE EARLY RACES OF AMERICA.—Dr. Etienne B. Renaud has published in the *University of Colorado Studies*, vol. 16, pt. 1, the results of an examination of two small series of skulls, one from La Plata (Colorado) and one from Cañon del Muerto (Arizona), and a comparison with other skulls from the south-west United States and from South America. The skeletal material in question is of the highest importance, not only because examples are few, but also because of its relation to the results which are now emerging from the study of the archæology of the area on scientific lines. The skulls belong to the second of the three phases in culture into which archæologists are differentiating the Indian civilisation of the south-western area of North America. These are, first, the earliest nomadic population, of which practically nothing is known, representing a late palæolithic stage; secondly, the basket-makers, representing the mesolithic culture; and, thirdly, the pueblo cliff-dwellers, a full neolithic phase, whom the Spaniards disturbed in their normal development. Of the two latter, the basket-makers were a dolichocephalic people with undeformed head, the pueblos a brachycephalic people who deformed artificially the back of the head. The two series of skulls under review belong to the basket-makers, and, apart from certain local variations, agree sufficiently in their ten characteristics here examined to warrant their being regarded as of the same race—a race which further comparison with other skeletal material reveals as a common south-western type for which as an ethnical and cultural entity the name basket-maker is suggested provisionally. The significance of this conclusion is enhanced when it is shown that this type is sufficiently cognate to warrant inclusion with the Lagoa Santo group of South America, for which Dr. Rivet and others have suggested a kinship with Melanesia and Papua—a kinship for which Dr. Rivet has argued further on linguistic grounds.

A MAGDALENIAN SITE IN THE DORDOGNE.—Excavations in La Grotte Bâtie (Crozo-Bastido) at Saint-Sosy (Lot), on the right bank of the Dordogne, are described in *L'Anthropologie*, vol. 37, Nos. 5-6, by M. Armand Viré and l'Abbé Clement Teuliere, by whom the investigations were carried out. The cave or rock shelter is situated 10 metres above a path which runs precariously along a cornice on the cliff face at an altitude of 135 metres, the height of the Dordogne at this point being 105 metres. A low wall of unknown purpose has at some time been erected at the entrance. Hence the name. The remains here described were found in the lowest of four strata, which at the centre of the cave reached a minimum depth of 1·50 metres. They include teeth and bones of reindeer which had been used as food, and a number of objects made from the antler, including a series of harpoons, mostly fragmentary or incomplete, one of them, fairly flat, resembling an Azilian type without hole. A number of bone needles were found, of which six had eyes. There were also a few piercers, but none intact. Several engravings on bone were found, of which the finest was a well-engraved horse's head showing part of the neck and chest. A shaped object with an eye on each side may be a fish or serpent. The stone implements were exclusively of flint, of varied coloration, but only rarely patinated. Scrapers and burins predominated, with scraper-burins and flakes *à dos abattu* of all sizes. One implement in particular is interesting in its resemblance to Aurignacian or early Solutrean forms. The evidence of the remains in general, but especially the harpoons, points to an Upper Magdalenian date.

OCEANIC ANGLER-FISHES.—The British Museum (Natural History) has added to its collection of post-cards two sets, each of five cards, representing some of the oceanic angler fish, mostly collected by Dr. John Schmidt, and described by Mr. C. Tate Regan (Series 1 and 2, Set M3 and M4). These are printed from beautiful drawings made by W. P. C. Tenison and are extremely interesting. The first series depicts some of the remarkable free-swimming forms, all of which are females, the males, illustrated in the second series, being parasitic on the females. These oceanic anglers are some of the most wonderful of all fishes, having the first ray of the dorsal fin modified into a lure. They live near the bottom in the deep sea where there is little or no light, the body being a uniform black colour and the lure luminous to attract the fishes on which they feed. Most of them are quite small, the female of the Atlantic *Melanocetus Johnsoni* being only 3 in. long, but it is so extremely voracious that it is sometimes found extended with fishes many times its own size. *Photocorynus spiniceps* is 2½ in. long, the male, attached to the top of its head above the right eye, being only ⅜ in. On the other hand, we have *Ceratias holboelli* trawled off Iceland, 42 in. long, the two males attached to the abdomen being a little more than 3 in. The ceratioids are unique amongst vertebrates in having the dwarf males, which actually fuse with the skin of the females, and are unlike all other animals in having the male nourished by the female's blood system.

THE POLAR FILAMENT OF THE SPORE OF NOSEMA.—K. Ohshima (*Annot. Zool. Jap.*, vol. 11, No. 3, 1927) has investigated the polar filament of the spore of *Nosema bombycis*. The extrusion of the filament was brought about by placing the spore in hydrogen peroxide solution, but the action was too rapid to permit determination of the method of extrusion, *i.e.* whether by eversion of the filament (as in the case of nematocysts) or by shooting out the filament from the extremity of the spore. The addition of 5 per cent. to 10 per cent. salt solution decreased the rate of extrusion, and the author was able to observe that the contents of the filament issue from its tip as soon as extrusion is accomplished and form a spherical droplet 3μ to 6μ in diameter. The substance of the droplet is colloidal and strongly adhesive, so that it fixes the spore to the slide. The filament is a long, fine tube of even diameter, and the author concludes that its extrusion is not due to a process of eversion. Spores examined in the digestive fluid from silkworms discharged their viscous contents from their respective filaments. The viscous material no doubt serves to fix the filament to the digestive epithelium. The digestive fluid was found to dissolve the filament in from two to five seconds. A further account is promised of the nature of the enzyme in the digestive fluid and of the nature of the proventricular fluid of the silkworm moth which causes extrusion of the polar filament but does not dissolve it. The author suggests that the viscous material discharged from the spore weakens the digestive epithelial cells and produces a condition more favourable for infection.

A NEW PARASITIC GASTROPOD.—S. Hirase describes (*Annot. Zool. Jap.*, vol. 11, No. 2, 1927) a new parasitic gastropod—*Sacculus okai*, n. g., n. sp., found in

colonies imbedded in gall-like swellings of the test of tunicates in the north-western Pacific. 19 examples were found in one swelling in *Ascidia prunum* and 11 in *Boltenia ovifera*. Each of the gastropods is globular in form and about 3 mm. long and 2 mm. broad, and lies free in the lumen which communicates with the exterior by a small slit-like opening in the test. A brief account of the anatomy of Sacculus is given and the genus is placed in the Tænioglossa, though the presence of a well-developed proboscis and a bipectinate osphradium distinguish it from the other members of the sub-order. The radula is not reduced, and there is a monopectinate ctenidium with a well-developed osphradium.

NEW VARIETIES OF HOPS.—A large number of new varieties of hops have recently been raised in the Experimental Hop Garden at Wye College, and established at the East Malling Research Station. Some of the recent work, which was carried out under the auspices of the Institute of Brewing Research Scheme, is summarised by Prof. E. S. Salmon in the *Journal of the Institute of Brewing*, **33**, 488; 1927. The 112 varieties tested included new and commercial types, of which 74 cropped at the rate of at least 20 cwt. to the acre, whilst one of the former yielded 32¾ cwt. to the acre. Although in all the early, mid-season, and late classes certain new varieties had higher preservative properties than any of the commercial varieties tested, the panel of experts which judged the hops favoured certain of the latter in preference to any of the former. Comparison with the results of previous seasons, however, have shown that one new mid-season variety is gradually being regarded more favourably by the judges, and as it has high preservative properties, hopes are expressed that it will ultimately prove of value. Excellent results have been obtained in brewing trials with certain of the new varieties which have been under observation for from five to nine years. The paper also contains the scheme of manuring employed, together with notes on the diseases of the hop (cf. NATURE, **117**, 67; 1926).

SEASONAL CHANGES IN CONIFER LEAVES.—Several observers have recorded the disappearance of starch and the increase of sugars in leaves of evergreens during the winter season. The special interest of these changes lies in the possible protective action against frost. By increasing sugar concentration by 'feeding,' Lidforss succeeded in rendering glass-house plants resistant to a temperature of − 7° C., and claims that sugar prevents the precipitation of the proteins on freezing. He explains the well-known phenomenon of death from frost in spring of the leaves on the sun side of trees such as Abies, as due to earlier regeneration of starch, and the resulting lessening of the sugar content on the sun side. Prof. J. Doyle and Miss Phyllis Clinch have now taken the problem further and published (*Proc. Royal Irish Acad.*, vol. 37, B, No. 26) the results of some investigations on seasonal changes in conifer leaves with reference to enzymes and starch formation. Their observations on the autumnal disappearance and spring regeneration of starch lead them to conclude that these phenomena cannot be related to assimilation or environment changes, and that the starch-sugar equilibrium is determined in winter by protoplasmic change. They take exception to the claim of Chapman (see *Biochem. Jour.*, vol. 18, No. 6, p. 1388) that three enzymes at least—amylase, dextrinase, and maltase—must be present before starch formation can go on, and consider his experimental data insufficient to support his conclusions. Maltase seems absent from *Tsuga Albertiana*, which also lacks dextrinase and probably amylase in winter. Maltase seems also to be absent from *Pinus parviflora* in winter. The presence of amylase in winter is also doubtful in *Pinus larizio*. Yet in all these cases starch can be formed either naturally in summer or by artificially increasing the sugar concentration in winter.

TIME OF APPLICATION OF SPRAYS FOR FRUIT TREES.—Modern work on the control of pests and diseases of fruit trees lays emphasis on the importance of applying the spray fluids at a particular stage in the plant's development. A recommendation for 'spring' or 'winter' treatment is no longer considered a close enough definition. H. R. Briton-Jones and A. H. Lees, realising the inadequacy of verbal instructions for describing the necessary stages, have published a paper (*Jour. Min. Agric.*, **34**, p. 814) with numerous photographs of various types of commonly grown fruit trees in the condition when spraying will be most effective. The successive stages illustrated are roughly classified as dormant, swelling, bursting, green-flower, and pre-flowering respectively. Information concerning the various pests which may be successfully dealt with at the various stages depicted, and the most suitable type of spray for use in each case is given, and cautions are included where treatment at any stage may be useless or dangerous. Such work in achieving better standardised methods must ensure a greater degree of reliability in the employment of spray fluids, and consequently extend their use to the benefit of fruit growers.

MOVEMENTS OF THE NORTHUMBRIAN FAULT BLOCK.—The tectonic conceptions of Argand have been applied with conspicuous success to the structures of the Northumbrian fault block by Mr. H. C. Versey (*Proc. Yorkshire Geol. Soc.*, pp. 1-16, 1927). He considers the block to be a fractured *pli de fond* of Hercynian orogeny. The effect of the uplift was to develop a saddle-shaped structure in the rigid substratum, as a result of which the thin covering of carboniferous rocks was folded into small *plis de couverture*. The most northerly of these folds trends to the north-east across Teesdale and Weardale, and appears to be related genetically to the thickening of the Whin Sill. The latter is thus regarded by Mr. Versey as being locally phacolithic in its mode of emplacement. The fault block acted as a horst to the folds produced in the deposits of the Pendle trough to the south. Thus various types of virgations are exemplified in the fold-lines between the rigid areas of the Northumbrian and Midland blocks. The tectonic interpretation of the region is thought to be in good accord with the characters of the Permian rocks east and west of the block, but it should be pointed out that totally different views have recently been expressed by Mr. J. S. Turner (*Proc. Geol. Assoc.*, pp. 339-374, 1927). Both writers appeal to the composition and distribution of the Brockrams in support of their respective readings. Prof. Holmes's discovery of a pebble of Whin Sill rock in the upper Brockram near Appleby, recorded briefly in Gilligan's "Geology of Appleby," is, however, strongly in favour of the validity of Mr. Versey's conclusions.

MAGNETIC DETECTION OF MINERALS.—The economic applications of geophysical science are rapidly growing in importance, and recently led to the publication, for a time, of a *Zeitschrift für angewandte Geophysik*. An interesting account of magnetic methods of investigation of underlying minerals is contained in a lecture by Dr. L. Palazzo, published in the *Memoria d. Pont. Accad. d. Scienze—I nuovi Lincei*, Ser. 2, vol. 10, pp. 271-308, 1927. The various instruments

devised for such purposes are described and illustrated, with their mode of employment. A brief account is given of the theory of local magnetic disturbance by magnetic masses below ground, and various researches on actual disturbed regions, at Kursk in Siberia, and in certain parts of Italy, are described.

THE STEREOSCOPE IN AIR SURVEY.—The need for the use of the stereoscope in plotting surveys from air photographs is now recognised and makes the publication of a simple explanation of the process most opportune. "The Stereoscopic Examination of Air Photographs," by Lieut. M. Hotine, forms No. 4 of the Professional Papers of the Air Survey Committee (London: H.M. Stationery Office. 3*s*. 6*d*.). This small volume begins with an explanation of the principles underlying stereoscopic measurement, and goes on to explain machine plotting and to describe the topographical stereoscope. A final chapter on stereoscopic training and testing should also prove valuable.

ELECTRICAL RESISTANCE MEASUREMENTS.—When an electromotive force E applied to a circuit drives a current I through it and I is proportional to R, so that in the equation $E=RI$, the resistance R of the circuit is a constant, the quotients E/I and dE/dI have the same value R, while if R is not a constant but varies with I, the second quotient has the value $R+I(dR/dI)$, and has generally been called the 'differential resistance' of the circuit. In the December issue of the *Journal of the Franklin Institute*, Mr. H. Nakamoura, of the Research Laboratory of the Tokyo Electric Company, shows that some of the methods of measurement of resistance in common use determine the ordinary resistance and some the differential resistance.

THE CRITICAL POTENTIALS OF TUNGSTEN.—The erratic records usually obtained of the secondary emission of electrons from metals bombarded by cathode rays have been shown by H. E. Krefft to be connected with the presence of adsorbed films of gas. His experiments, which are described in the *Annalen der Physik* (vol. 84, p. 639), were made with a tube built entirely of metal and glass, in which a vacuum of 10^{-8} mm. mercury could be maintained, containing a tungsten target which could be heated to 1500° C. by radiation from an auxiliary filament. At the higher temperatures the breaks in the secondary emission curves were reproducible, and ratios of the secondary current to the primary current were obtained which were consistent to less than one per cent., under favourable conditions. At lower temperatures, and in general when gas was known to be present, new breaks appeared; and finally, when the gas-content became relatively large, the curves were smooth. The main critical potentials agree well with those found by Prof. O. W. Richardson and Dr. Chalklin from the study of soft X-rays, but one persistent break at about 16 volts has had to be attributed to ionisation of molecular oxygen, from which it appears impossible to free the metal, even above 1000° C.

A POLARISATION COLOUR SCHEME.—A useful miniature booklet for the waistcoat pocket has been issued by Messrs. James Swift and Son, Ltd., entitled "Polarisation Colour Scale." The contents have been drawn up as an aid to mineralogists by Drs. W. R. Jones and A. Brammall. On the inside of the cardboard cover is given a table of the birefringencies of seventy-eight mineral crystals, and two polarisation colour scales (in colour, a very good attempt at reproduction of the natural colours), one for crossed Nicols and the other for parallel Nicols, each for the first four orders of spectra. In the four little pages of text, explanations are given of the practical meaning of birefringence and of the numerical scale-values attached to the colours, and instructions are detailed for using the scale to determine the thickness of rock-sections and the birefringence of mineral crystals, either in rock-sections or in mounted grains. The method recommended for finding the thickness of a rock-slice is, first, to select some familiar colourless mineral of low birefringence, such as quartz (birefringence 0·009), represented in the slice by numerous sections; then, to evaluate in $\mu\mu$ the highest interference colour given by these sections, by reference to the scale; for thickness = (interference colour value)/(birefringence × 1000). The thickness thus given (in microns) can then be used to determine the birefringence of an unknown mineral; for the birefringence = (interference colour value)/(thickness × 1000). If the mineral be itself a naturally coloured one, allowance must obviously be made for the modification this causes in the polarisation colours.

MOLECULAR STRUCTURE IN SOLUTION.—Various physical properties of solutions of cobalt chloride with increasing hydrochloric acid content and of hydrochloric acid alone have been determined by O. R. Howell in an attempt to investigate the change of state of the cobalt atom with increasing concentration of acid. The November number of the *Journal of the Chemical Society* contains conductivity values for such solutions, and the conclusions drawn from these results are in agreement with those obtained from previous work on other properties. As acid is added to a cobalt chloride solution, the red colour changes to blue, owing to the cobalt atom being forced out of association with six molecules of water, $Co(H_2O)_6''$, in order to unite with four atoms of chlorine, $CoCl_4''$. Hill and Howell, in 1924, showed that in blue compounds the cobalt atom is surrounded by four other atoms or groups, whereas when it is surrounded by six atoms the compound is red. Howell points out that these facts can be utilised to predict, to a certain extent, the crystal structure not only of compounds containing cobalt but also of those in which a metallic atom can be replaced by cobalt. Several predictions made in this way (for example, with zinc and magnesium orthosilicates) have been verified by determination of the crystal structure.

IONISATION AND CHEMICAL CHANGE DURING SLOW COMBUSTION.—The work of Dixon and others has shown that before the main combustion of a gaseous mixture occurs, there is an induction period during which slow combustion proceeds. Bennett and Mardles, in the *Journal of the Chemical Society* for December, have attempted to investigate the nature of the changes occurring during this period. They found that in the case of a system containing liquid drops (*e.g.* *n*-hexane and air) more ionisation took place and a considerably lower temperature was required for spontaneous ignition than with the corresponding vapour mixture. It is questionable whether ionisation accompanies all gaseous reactions, but ionisation was detected with various systems, although it did not occur below the temperature of initial oxidation. During the period of slow combustion, the main changes appear to be due to thermionic emission followed by the formation of centres of chemical change around the liberated ions. The presence of various 'antiknocks' (*e.g.* lead tetraethyl, iron carbonyl) causes a decrease in electron emission and in the initial chemical change, thereby delaying spontaneous ignition and also lowering the temperature at which slow combustion begins.

Insulin and Carbohydrate Metabolism.

ALTHOUGH the main outline of the action of insulin on the metabolism of carbohydrate is now fairly clear, the actual details of the chemical transformations occurring in the synthesis and combustion of sugar in the body are still only known in part. The view that insulin transforms glucose into some reactive form, although still maintained by some investigators, has not been confirmed by others. Either there is a failure to find any change in the rotation of the glucose under the influence of muscle tissue and insulin (A. B. Anderson and A. Carruthers, *Biochem. Jour.*, vol. 20, p. 556; 1926), or discrepancies between the polarimetric and copper reduction values of the extracts examined are considered to be explicable rather on the basis of the presence of other optically active or reducing substances in addition to the glucose (H. F. Holden, *ibid.*, p. 263, and G. S. Lund and C. G. L. Wolf, *ibid.*, p. 259). Anderson and Carruthers have also found that the polarimetric value of dialysates or extracts of blood varies according to the reaction of the solution at the time of estimation.

It appears certain that phosphorus plays an essential part in the utilisation of glucose; and the formation of a hexosephosphate may be regarded as an essential link in the chain, probably both to synthesis and degradation. An exception, however, appears to be provided by blood, the corpuscles of which break down, *in vitro*, glucose into lactic acid, without the intervention of the phosphorus molecule (J. T. Irving, *ibid.*, p. 1320). The reduction in the blood-sugar under the action of insulin is always accompanied by a parallel reduction in the inorganic phosphorus, which, however, is later excreted from the body, any hexosephosphate formed not being stored but rapidly broken down again.

The development of convulsions when the blood-sugar has fallen to a low level, and their abolition by the administration of glucose, has provided a useful means of investigating further the details of carbohydrate metabolism by observing what compounds have the same favourable effect as glucose. The convulsions appear to be caused by disturbances in equilibrium, the symptoms being similar to those observed after unilateral labyrinth extirpation or other lesion to the vestibular apparatus (W. Russell Brain, *Quart. Jour. Exp. Physiol.*, vol. 16, p. 43; 1926). Thus the animal (rabbit) holds its head rotated to one side, and the whole body may be rotated on the pelvis. Later, rolling movements occur towards the side to which the head is rotated, sometimes also to the opposite side. On the other hand, the preliminary symptoms of apprehensiveness and shying at the movement of an observer suggest a heightened irritability of the whole of the central nervous system, which perhaps one might suggest to be correlated with the fall in the sugar of the blood.

The brain, and presumably also the rest of the nervous system, depends for its glucose upon that brought to it in the blood; although reducing substances are present in the brain tissue, they appear to consist chiefly of creatinine and pentoses (Barbara E. and E. G. Holmes, *Biochem. Jour.*, vol. 19, p. 492; 1925; and vol. 20, p. 595; 1926). These authors, in their investigations into the metabolism of the brain, have found that this tissue forms lactic acid from glucose in the absence of oxygen, and that the acid is removed if oxygen is afterwards admitted. Examination of rabbit's brains *post mortem* shows that they contain lactic acid, the amount of which does not increase on anaerobic incubation unless glucose is also present. From their series of experiments, the conclusion may be drawn that the amount of lactic acid found in the brain *post mortem* depends on the level of the blood-sugar at the time of death, and is roughly proportional to it: thus it is increased following the administration of an anæsthetic and decreased after an injection of insulin. It bears no relationship to the reducing substances in the brain, which, as we have seen, are not glucose, or apparently to the glycogen, which remains remarkably constant after a variety of experimental procedures, such as depancreatisation or the injection of a convulsive dose of insulin.

The formation of lactic acid from the blood glucose must be a highly active process, since it appears to be complete in the few minutes elapsing between death of the animal and removal and cooling of the brain: in the rabbit the amount found is of the order 0·1 gm. per cent. Insulin has no direct effect on the lactic acid metabolism of the brain, but influences it solely by producing hypoglycæmia: moreover, following depancreatisation, the brain can convert both blood and added glucose to lactic acid under anaerobic conditions and remove it again in the presence of oxygen, and to the same degree as a normal brain (*ibid.*, vol. 19, p. 492; 1925, and p. 836; vol. 20, p. 1196; 1926; and vol. 21, p. 412; 1927).

It appears, then, that insulin plays no part in the conversion of glucose to lactic acid and the subsequent removal of the latter in the brain as in skeletal muscle, but the work throws no light on why hypoglycæmia should produce convulsions: the lactic acid in the brain tissue itself is reduced when the blood-sugar falls, but, following the convulsions, the blood lactic acid increases, owing to the escape into the circulation of some of the acid set free during the violent muscular movements.

Since Herring, Irvine, and Macleod investigated the remedial effect of various sugars upon insulin convulsions (*Biochem. Jour.*, vol. 18, p. 1023; 1924), numerous other investigators have studied the same problem, using a variety of sugars or their possible metabolites in the hope of discovering some of the stages through which carbohydrates pass in their metabolism in the body. Recovery has been produced by the administration of glucal (Winter) and dihydroxyacetone (Kermack, Lambie and Slater, Laufberger, Hewitt and Reeves, Markowitz and Campbell, etc.), whilst the following compounds have been found to be inactive: glucosan and desoxyglucose (Winter), methyl glyoxal, lactic acid, glycerol, sodium citrate and pyruvate, and rhamnose (Lambie and co-workers), hexosedi- or mono-phosphate (Marks and Morgan), glyceric aldehyde (Hewitt and Reeves), and glucosone (Hynd) (L. B. Winter, *Biochem. Jour.*, vol. 20, p. 668; 1926; and vol. 21, p. 54; 1927; W. O. Kermack, C. G. Lambie, and R. H. Slater, *ibid.*, vol. 20, p. 486, and vol. 21, p. 40; Lambie and Frances A. Redhead, *ibid.*, vol. 21, p. 549; H. P. Marks and W. T. J. Morgan, *ibid.*, vol. 21, p. 530; V. Laufberger, *Publ. de la Faculté de Médecine*, Brno, Czechoslovakia, vol. 4, p. 1; 1926; J. A. Hewitt and H. G. Reeves, *Lancet*, vol. 2, p. 703; 1926; J. Markowitz and W. R. Campbell, *Am. J. Physiol.*, vol. 80, p. 548; 1927; A. Hynd, *Proc. Roy. Soc.*, vol. 101, B, p. 244; 1927).

Various points of interest emerge from this work. Glucal is presumably effective owing to the similarity of the molecule to that of glucose. More interest attaches to the place of dihydroxyacetone in carbohydrate metabolism. Laufberger has shown that its behaviour in the body is the same as that of glucose (*Pub. de la Faculté de Médecine*, Brno, Czechoslovakia,

vol. 2, p. 83; 1923–24), and Lambie and his co-workers have adduced evidence indicating that it acts by being directly oxidised and not by being converted into glucose first: in which case they suggest that the reaction which is facilitated in the organism by insulin, and fails to proceed satisfactorily in the diabetic, is the transformation of glucose into dihydroxyacetone. Thus they have found that in the decerebrate eviscerated preparation, the latter will not maintain the blood-glucose at a constant level when infused, nor does it accumulate in the blood, the inference being that it is immediately oxidised: in other experiments its administration has failed to give so marked a rise in the blood-sugar as that of glucose itself: it raises the respiratory quotient and increases the metabolism more quickly and to a greater extent than glucose: and the fall in the inorganic phosphate of the blood parallels the intensity of the metabolic change, so that it appears that dihydroxyacetone causes a more rapid formation of the phosphoric acid ester than glucose.

These authors suggest that the reactions which occur may be similar to those postulated, from theoretical considerations, by A. L. Raymond (*Proc. Nat. Acad. Sci.*, vol. 11, p. 622; 1925). Glucose reacts with phosphoric acid to form a hexosemonophosphoric ester, which then splits into a molecule of triose and one of triosephosphate: two molecules of the latter condense to form a hexose diphosphate, which is hydrolysed back to hexose and inorganic phosphate. The triose may be dihydroxyacetone itself or closely related to it. In a further discussion, Lambie points out that lævulose, like dihydroxyacetone, is both more easily oxidised and a better glycogen former than glucose, yet only glucose can be obtained from glycogen on hydrolysis: it is therefore possible that dihydroxyacetone may be a common intermediary between lævulose and glucose and glycogen. Lævulose, however, does not cause recovery from insulin hypoglycæmia so readily as glucose or dihydroxyacetone: possibly it may be converted into the latter without the aid of insulin, being more closely related to it than glucose. In insulin hypoglycæmia, however, the conversion of glucose into dihydroxyacetone under the influence of the excess of insulin might be even more rapid than the transformation of lævulose, so that glucose would be more effective in causing recovery than the latter.

This hypothesis of the mechanism of action of insulin and of the rôle of dihydroxyacetone in metabolism has, however, been controverted by Markovitz and Campbell, who maintain that this compound is not a normal metabolite of glucose, but must be converted into the latter by the liver before the body can make use of it, and adduce experimental evidence in support of this view. The ultimate decision between these two views must be withheld until further work, which will be awaited with interest, has been carried out on the rôle of dihydroxyacetone in carbohydrate metabolism.

In conclusion, attention may be directed to some interesting observations which may possibly lead to a satisfactory explanation of the cause of insulin convulsions. Mention has been made of the fact that methylglyoxal cannot produce recovery from them: Lambie and his co-workers have also noticed that after an injection of this compound, glucose or dihydroxyacetone may also be ineffective: in other words, methylglyoxal appears to exert some toxic action on the animal. Hynd has gone even further, and observed that an injection of glucosone (a body closely related to glucose from which methylglyoxal might possibly be derived) produces a condition similar to insulin hypoglycæmia, which, however, differs from the latter in that glucose cannot bring about recovery. He suggests that insulin may cause the production of glucosone from glucose in the body.

These observations suggest that the convulsions are caused by some intermediary metabolite in the combustion of glucose: it appears reasonable to suppose that this compound is always being formed in small quantities in the body, but is immediately further broken down. Following an injection of insulin, the amount produced is considerably increased and the oxidising mechanism fails to keep pace with this increased production, so that the compound set free in the body is enabled to exert its toxic effects. In this connexion the work of Dakin and Dudley may be recalled: they found that most tissues contained an enzyme, glyoxalase, which was capable of converting methylglyoxal into lactic acid. However, the relationship between the curative effect of an injection of glucose or dihydroxyacetone upon insulin convulsions, and the possible presence of glucosone or methylglyoxal in excess as their direct cause, appears to require further investigation before one of the different hypotheses outlined above can be considered definitely established.

Marine Biology in Ceylonese Waters.

DETAILS of the marine biological research carried out by the Ceylon Government are contained in the Administration Report of the Government Marine Biologist for 1926. (Part 4: Education, Science, and Art (F), by Dr. Joseph Pearson. Pp. F29. Colombo: Government Record Office. 65 cents.) In this report there is an account by Mr. A. H. Malpas, the assistant marine biologist, on the present state of the pearl oyster, the window-pane oyster, and the chank (a gastropod, *Turbinella pyrum*, Linn.) fisheries. It would appear that there is no likelihood of a large pearl oyster fishery for at least four years, whereas an experimental fishery on the lines advocated by Dr. J. Pearson, the marine biologist, may be held in 1928. The essence of the new system is the elimination of the sale of oysters to the public, by which means all the pearls would come into the hands of the Government.

The window-pane oyster fishery at Lake Tamblegam in 1926 was very successful. Although the Government received a revenue of only Rs.18,000.0 for two million oysters, it is stated that the lessee's returns from the fishery were between one and two lakhs of rupees, but the sum was more probably nearer Rs.50,000.0. There is a curious anomaly in the control of the chank fishery in the Palk Strait. On the Indian side the fishery is under the control of the Madras Fisheries Department, and hence the Government made a net profit of Rs.46,367.0.0 in 1922–23 on 466,540 chanks. On the Ceylon side chank fishing is open to all comers, and the only revenue that accrues to Government is that derived from the export duty. In 1923, the Ceylon Government made a profit of Rs.12,065.0 on 2,419,786 chanks. From these figures it is clear that although the Ceylon chank fishery is about five times as large as the Madras fishery, yet its value as a Ceylon Government asset is almost negligible.

A considerable amount of fisheries research has been carried out by Mr. A. H. Malpas and Mr. M. Gomez. It is very gratifying to note that, as a direct outcome of the trawling experiments carried out by the Government Marine Biology Department, a company has been registered in Colombo to modernise

the local fishing industry. There is every hope that this new enterprise for commercial exploitation of Ceylon waters will be successful. The part of the report that should interest every Ceylonese is that entitled 'Miscellaneous.' Under this heading, the author states that a sum of Rs.8,048,297.0 was collected in 1925 as import duty on dried fish goods. Hence any step that could be taken towards the organisation or the development of local curing should be encouraged. Towards this aim some useful experiments have been carried out, and so far with great success.

Work on fresh-water fishes has been mainly carried out by Mr. P. E. P. Deraniyagala, the second assistant marine biologist. He has commenced on an atlas of fresh-water fishes of Ceylon, which it is hoped will be useful to both laymen and naturalists. In addition to this he records that a fish, *Lutianus rivulatus*, locally known as *Baddau*, has an inshore migration lasting for a few weeks in May, and suggests that it spawns in deep water far from land.

The marine superintendent, Lieutenant-Commander E. L. Pawsey, is making some useful investigations to locate the exact position of the pearl banks, beacons, etc., as the existing charts are found to be almost useless.

The Marine Biology Department of the Ceylon Government should be congratulated on the amount of useful work it is carrying out towards the development of the resources of the country.

University and Educational Intelligence.

Oxford.—The honorary degree of Master of Arts has been conferred on Mrs. Florence Joy Weldon, widow of the late Dr. W. F. R. Weldon, professor of zoology, who had recently received the thanks of the University for her gifts of pictures.

Owing to need for further space in Dr. Lee's department of inorganic chemistry required by workers engaged on research in physical chemistry, a special research room is to be added at a cost not exceeding £2800 from the Government grant.

Preparations are being made for an expedition this year to the south-west coast of Greenland under the leadership of Dr. T. G. Longstaff, and a grant of £50 has been voted thereto by Congregation. The main purpose will be the study of the ecology of the Arctic fauna and flora in that region. Similar expeditions were undertaken by members of the University in 1921 to Spitsbergen, and in 1923 and 1924.

Mr. F. G. Tryhorn, lecturer in physical chemistry in the University of Sheffield, has been appointed professor of chemistry in University College, Hull.

Dr. R. K. Butchart, lecturer in mathematics in the University of St. Andrews (University College, Dundee), has been appointed to the chair of mathematics at Raffles College, Singapore.

The trustees of the Mary Ewart fund are offering a travelling scholarship, value £200, for one year, to past and present students of Somerville College, Oxford. Particulars may be obtained from Mrs. T. H. Green, 56 Woodstock Road, Oxford.

Applications for the Government Grant for scientific investigations, in connexion with the Royal Society, must be received on a prescribed form by the Clerk to the Government Grant Committee, Royal Society, Burlington House, W.1, by, at latest, Mar. 31.

An examination for the following scholarships offered by the Household and Social Science Department of King's College for Women, Campden Hill Road, W.8, will be held on May 10: the "Carl Meyer," value £80, and tenable for three years; the "Minor College," value £40, and tenable for three years. Particulars may be obtained from the Secretary of the College.

Examinations for the award of Tate and Morgan scholarships in engineering, science, domestic science, hygiene, and art, at Battersea Polytechnic for the session 1928–29, will be held on Tuesday, June 12, and succeeding days. The scholarships vary in value from £20 to £30 per annum with free tuition, and are tenable for two or three years. The latest day of entry is April 21.

An excursion for geographers and other workers in open-air sciences, starting on July 27, is being arranged for field-work in southern Spain and in the Rif. The party will stay first at Algeçiras, and then at Tangier. An attempt will be made at comparative regional surveys of the northern and southern boundary areas of the Straits of Gibraltar. Particulars may be obtained by sending a 2d. stamp to Mr. Valentine Davis, Cheshire County Training College, Crewe.

The Ella Sachs Platz Foundation for the Advancement of Scientific Investigation is inviting applications for grants in aid of research. Preference is given to research in medicine and surgery or branches of science bearing on these subjects, and particularly to work on any single problem. In previous years, the general subject of chronic nephritis has received support, and, in a lesser degree, internal secretion and injection. Last year, twenty-four grants were made, seventeen of them being to workers outside the United States. Applications must reach Dr. Joseph C. Aub, Massachusetts General Hospital, Boston 14, Massachusetts, before May 15.

"The Quality of the Educational Process" is the title of a comparative study of education in the United States, England, France, and Germany, undertaken by Dr. W. S. Learned for the Carnegie Foundation for the Advancement of Teaching and published in the Foundation's recent annual report. Dr. Learned is concerned to reveal the defects in his own country's systems and to show how they may be remedied by applying the lessons of the hard-won experience of European nations. In three important respects he finds the European systems superior to the American. The general foundation is laid compactly in a single sequence including nearly the entire adolescent period and, as a consequence of this thorough preparation, the student's general education continues inevitably after he has embarked on his more advanced and vocational studies. Secondly, the principle of continuity in the main threads of the educational material is respected, long periods of work being adjusted to clearly defined aims, the material being constantly revised from advancing points of view, and the student's attention being kept fixed upon the quality of his thinking rather than on merely getting through set tasks. Thirdly, the final, usually external, examination at the end of each considerable stretch of work invigorates the whole process, constituting not merely a satisfactory test of intellectual power but also an indispensable instrument wherewith to develop it. With these three merits—compact foundation, continuity of subject matter, and judicious use of examinations—are contrasted the corresponding defects of the American system. Specially noteworthy is the praise bestowed on the place assigned in Europe to examinations. This paper, and a previous paper by the same author on secondary education in the United States and in Europe, are published separately as *Bulletin* No. 20 of the Foundation.

Calendar of Customs and Festivals.

February 20.

COLLOP MONDAY: also, sometimes, Shrove Monday. The period of merrymaking and feasting before Shrove Tuesday and the beginning of Lent known as Shrove Tide or Carnival, as the latter name is intended to suggest, bade farewell to meat before the entry upon the Lenten or spring fast. In the north of England this survived in the custom of eating collops (slices of bacon or salted meat) with eggs as one of the dishes at dinner on the Monday before Ash Wednesday.

February 21.

SHROVE TUESDAY. The day for the confession of sins or shriving, also the day on which the merrymaking of carnival culminates. In England Shrove Tuesday was a holiday and occasion of merrymaking both before and after the Reformation. The summons to confession was by the ringing of a bell, which continued to be rung after the Reformation but was known as the Pancake Bell. In England the eating of pancakes and the tossing of the pancake in Westminster School are now practically the only survival of the Shrove Tuesday feast and its ritual.

As a holiday Shrove Tuesday was especially associated with the freedom of the apprentices and workers, who jealously guarded their privileges of "doing what they list." They also joined in the customary activity in searching out and carting women of ill fame and their male companions at this time. The licence permitted to the 'prentices may be compared with the privileges allowed school children in some parts of Scotland on this day, which are similar to those permitted at Candlemas. At Bromfield, in Cumberland, the scholars of the Free School used to bar out the schoolmaster for three days. The articles of capitulation specified the times of study and play in the coming year, and stipulated the immediate playing of certain games—a cock-fight and a football match.

Cock-fighting, one of the most popular of the amusements of Shrove Tuesday in England, was also practised in Scotland, especially by schoolboys. Cock-throwing or baiting (sometimes hen baiting) was also widely practised, when sticks were thrown at a cock tethered to the ground. Sometimes two metal cocks were used in a game in which missiles of lead were thrown at the cocks by opponents, each standing behind his own bird. Cock-throwing has been explained as an expression of the hostility of Saxon and Dane, or of our enmity with the French, but the cock is almost certainly a substitute for a human victim.

In Wales such hens as did not lay eggs before Shrove Tuesday were thrashed by a man with a flail, who received for his pains any hen which he killed.

Football was an important feature of the Shrovetide observance, and in nearly every town or village the streets were the scene of a vigorous and sometimes violent game. The contest was usually between two wards of the same town, or two towns or villages. In so far as it was a ritual observance, judged by analogy, it represents the struggle between winter and spring.

At Ludlow the contest took the form of a tug-of-war, attended by the Mayor and corporation. In other localities, matches at battledore and shuttlecock, especially between men and women, were played.

A curious and significant custom is recorded in the *Gentleman's Magazine* in February 1779. The writer saw in a Kentish village a figure called a Holly Boy being burnt by boys. This had been made by the girls but stolen from them. In another part of the village the girls were burning an Ivy Girl which they had stolen from the boys. The representation of the two sexes warrants the inference that the figures originally represented the male and female principle in Nature. Similar male and female figures appear in the processions which are found on the Continent at this and other times of the year. Sir James Frazer gives a number of instances. In the case of the processions on or about Shrove Tuesday, the significant feature is that the human figure, which is the central object of the celebration, is either torn to pieces or burnt. Sometimes in the latter case the fertility of the crops in the coming season is prognosticated by the height of the flames. In this custom of 'burying the Carnival,' it may be taken that the lay figure is the surrogate of a human victim who represented the god of vegetation. Similarly, the *bœuf gras* of the *Mardi Gras* celebrations in France is the spirit of fertility in flocks and herds.

In Roman Catholic countries the celebration of Carnival has generally survived with greater vigour than in the Protestant. Certain features are crucial. It is a period of freedom or licence. Disguise is worn which, like the skins worn by those who took part in the Lupercalia, may be either a protection against evil spirits, or an attempt at assimilation to the deity. Finally, there is usually some personification, human or animal, around which the festival centres.

February 22.

ASH WEDNESDAY. PULVER WEDNESDAY (*Dies Pulveris*). The opening day of the Lenten fast takes its name from the custom of marking each member of the congregation in church with the cross in ashes which have been blest by the priest. The ashes should be those of the palms used on Palm Sunday in the previous year. There is a reference to the practice in Anglo-Saxon times, but it was abandoned in England at the Reformation.

It is said that originally Lent did not begin until the following Sunday, but that Ash Wednesday and the succeeding days were incorporated in the observance to equalise it with the forty days' fast of Our Lord. It is, at least, true that after the solemn service of the day was over, the remainder was given up to merrymaking similar to that of Shrove Tuesday. Sometimes and in some places this included the procession, in which a figure was carried and afterwards destroyed. One such is recorded from Marseilles. Similarly, in England, Jack-a-Lent, a lay figure made from an old suit of clothes stuffed with straw, was carried in procession, pelted with sticks, and afterwards pulled to pieces.

In Germany it is said—the exact locality is not recorded—that the youths dragged the maidens, accompanied by a fiddler, in a cart until they reached some lake or river 'and there wash them favouredly.' Similarly, in England the Fool Plough, which formed part of the Ash Wednesday observances, and was drawn by youths while the girls sat on it, also ended its course in a pond—a piece of horse-play which had degenerated from a rain or fertility charm.

As usual on such occasions, children begged from door to door with an appropriate song, the custom being known as 'clacking,' from the fact that they carried pieces of wood which they clacked before the door, hoping to receive pieces of bacon for a feast. If they failed they stopped the keyhole with mud. It is also recorded that in the evening boys used to run along carrying firebrands and torches. In Dijon on the first Sunday in Lent, known as Firebrand Sunday, large bonfires were lit in the streets, a custom derived, it is said, from the practice of carrying lighted torches of straw to drive away 'badder' from the earth—in other words, evil spirits.

Societies and Academies.

LONDON.

Royal Society, Feb. 9.—**O. W. Richardson**: On the extraction of electrons from cold conductors in intense electric fields. The attraction of an electron by its mirror image in a conductor is treated as a Schrödinger wave problem. The sharpness of the photo-electric effect at a metal surface is accounted for. A formula is obtained for the field currents from cold conductors, which agrees well with the experimental data. The result implies that electrons are being generated at a rate proportional to $(\psi\bar{\psi})^{\frac{1}{2}}$.

R. H. Fowler: The restored electron theory of metals and thermionic formulæ. This note amplifies the recent work of Sommerfeld on the electronic theory of metals by applying his ideas to thermionic phenomena. The equilibrium state of an assembly consisting of a heated metal and an atmosphere of free electrons is calculated. It appears that the vapour pressure has twice the commonly accepted value owing to the two orientations of each electron. This result is then applied to the theory of thermionic emission, and gives values in excellent agreement with the best observations.

R. H. Fowler: The photo-electric threshold frequency and the thermionic work function. The old equation for the saturation current required assumptions for which there is no justification. Sommerfeld's theory of metals leads quite simply to the existence of a sharp photo-electric threshold frequency ν_0, and to the equality of this $h\nu_0$ with the thermionic work function χ. These points have been recently considered by O. W. Richardson, but in a more elaborate manner which appears capable of simplification.

P. A. M. Dirac: The quantum theory of the electron. In order to make the quantum theory, when applied to atomic structure, agree with observation, one has had to assign to each electron a spin and a magnetic moment. This is not necessary; agreement with observation can be obtained without arbitrary assumptions by a correct relativistic application of the general quantum theory to a point-charge electron. The Hamiltonian function on which the present theory is based is linear in the energy and momentum. The spinning electron model, applied in the previous non-relativistic way, is justifiable for many purposes. The motion of an electron in a central field of force is worked out, and the energy levels obtained are shown to be the same as those given by the model in the first approximation for a Coulomb law of force.

H. T. Flint and O. W. Richardson: On a minimum proper time, and its application to (1) the number of the chemical elements, (2) some uncertain relations. The existence of a minimum proper time h/m_0c^2 is deduced by a method which is independent of the assumptions about the metrics of space and time used previously. This leads to an upper limit $\left(\frac{n}{n+1}\right)^{\frac{1}{2}}c$, on the velocity of an electron in an atom in an orbit of total quantum number n. This involves an upper limit (97) on the atomic number of any chemical element and also an upper limit on the quantum number of an intranuclear orbit. This limit is a function of the atomic number of the nucleus.

H. Jeffreys: Some cases of instability of fluids. The problem of the instability in a liquid produced by heating below is rediscussed by a formally accurate method. Where the fluid is enclosed between two perfectly conducting solid boundaries, the honeycomb structure is not developed when the liquid is flowing, being replaced by a division into long strips. There is a formal analogy between this problem and G. I. Taylor's problem of the stability of liquid between two rotating cylinders. In atmospheric problems the earth's rotation will have a considerable effect in modifying the motions produced by excessive heating below; this will probably be in the direction of making the departures from the adiabatic gradient needed to cause instability greater than in the absence of rotation (though they will still be very small) and of confining the ascending currents to regions of smaller horizontal extent.

H. A. Wilson: The emission of light by flames containing sodium and the absorption of light by mercury vapour. It was shown by Gouy in 1879 that the intensity of the light from a sodium flame is proportional to the square root of the mass of sodium in the flame per square cm. of area, perpendicular to the direction of the light emitted. This result can be explained by assuming that the sodium atoms absorb and emit light like simple damped oscillators. The absorption of mercury resonance radiation by mercury vapour can be explained in the same way by assuming that the mercury atoms absorb the resonance radiation like simple damped oscillators.

C. N. Hinshelwood and H. W. Thompson: The kinetics of the combination of hydrogen and oxygen. An examination has been made by a static method of the combination of hydrogen and oxygen, at constant temperature and volume, from the region of purely catalytic surface reaction up as nearly as possible to the point of explosion. In the last fifty degrees of this range a reaction, approximately of the fourth order, comes into prominence; it is strongly autocatalysed by steam, and has a high temperature coefficient. The normal positive catalytic effect of the walls of the reaction chamber gives place to a negative effect, which may be due to the catalytic destruction of an autocatalyst for the main reaction, or the interruption of 'reaction-chains,' or to both causes. It is concluded that the reaction measured is the true gas reaction between hydrogen and oxygen.

E. T. Copson: On electrostatics in a gravitational field. Prof. Whittaker has recently discussed the effect, according to the general theory of relativity, of gravitation on electromagnetic phenomena. In particular, he has considered electrostatics in gravitational fields of two kinds, namely, those specified by the quasi-uniform metric and by Schwarzschild's metric. Algebraic expressions for the potential of an electron in these gravitational fields are now obtained by the use of Hadamard's theory of 'elementary solutions' of partial differential equations. The expression for the potential in the quasi-uniform field is the same as that obtained by Prof. Whittaker, who used entirely different methods.

W. R. Brode: The analysis of the absorption spectrum of cobalt chloride in concentrated hydrochloric acid. The principal absorption band, between 720 and 850 $\mu\mu$, consists of at least seven component bands. By different mathematical methods of analysis, the observed curve is resolved into seven similarly shaped components. There is a constant frequency difference between each of these components, and this frequency difference is the highest common factor of the frequencies of these component bands. There is apparently a definite relation between the odd and even numbered multiples or component bands and their relative intensities of absorption.

Society of Public Analysts, Jan. 11.—**J. R. Nicholls**: Determination of small quantities of benzoic acid and cinnamic acid, with some notes on the colorimetric determination of salicylic acid. The method of determining benzoic acid is based on its partial oxidation, in a constant proportion, to salicylic acid by means of hydrogen peroxide in the presence of ferric chloride,

and colorimetric determination of the salicylic acid under specified conditions. Cinnamic acid may be determined by first oxidising it quantitatively to benzoic acid.—**L. E. Campbell**: Report of the Preservatives Determination Committee of the Chemists of the Manufacturing Confectioners' Alliance and of the Food Manufacturers' Federation, on the determination of sulphur dioxide in foods. A normal procedure and an apparatus have been devised, and details of standard volumetric and gravimetric determinations are given, together with details of the treatment required in certain special cases, such as starch, gelatin, meats, dried fruits, etc.—**J. W. Black** and **B. J. W. Warren**: Notes on the effect of other reducing substances on the determination of SO_2. In some cases (*e.g.* glucose and gelatin) the interference of other reducing substances is negligible, but in others (nutmeg, mustard, ginger, etc.) it is considerable, and a time limit must therefore be set to the distillation period.—**H. R. Jensen**: (1) Rapid estimations of sulphites by alkaline liberation, or extraction, and titration. The sulphite content of certain products, such as glucose syrup and cornflour, may be satisfactorily determined by direct extraction followed by titration with iodine. (2) Barium sulphate losses in gravimetric estimations. Too low acid concentration favours adsorption of barium chloride; hence it is desirable to add the reagent in a very fine jet, and to have an excess to reduce the solubility of barium sulphate and the adsorption of alkaline sulphate.—**Osman Jones**: Determination of sulphur dioxide in sausages. On the addition of sulphite to sausages there is an immediate loss of sulphur dioxide, so that the amount found is invariably lower than that added. A method of vacuum distillation is described, which gives results agreeing well with those of the Committee's standard method.—**H. M. Mason** and **G. Walsh**: Note on the oxidation of sulphites by air. Carbon dioxide must be quite free from oxygen if used in a lengthy sulphite distillation. Removal of the adsorbed air from the foodstuff by the use of a vacuum before the heating will prevent oxidation losses, but good results are also obtained by extremely rapid heating and distillation.—**H. M. Mason**: Note on the titration of dilute sulphite solutions with standard iodine solutions. The low results obtained when sulphite solutions are titrated with iodine are due to oxidation and to the escape of sulphur dioxide set free by the hydriodic acid formed during the titration, the latter being responsible for 70 per cent. of the loss.—**A. W. Knapp** and **R. J. Phillips**: Determination of sulphur dioxide in fatty substances. In rancid fats free from sulphur dioxide, volumetric determinations show an apparent content of sulphur dioxide; hence only the gravimetric process should be used in such cases.

Royal Anthropological Institute, Jan. 17.—**R. Ruggles Gates**: A pedigree study of Amerindian crosses in Canada. Crosses between French and Indians began in Ontario about 1660. The present study concerns interrelated pedigrees extending through six generations from crosses involving Cree and Ojibway Indians on one hand and French, Scotch, and English on the other. Pedigrees and ancestry of many individuals of mixed blood were obtained, with photographs of persons having many different degrees of Indian blood. The inheritance of features was studied as well as eye-colour, skin colour, and hair characters. Individuals of three-sixteenths Indian ancestry were found having essentially blue eyes and at least one factor for skin pigmentation. It is concluded that the Indian probably has more than two factors for skin colour, and that certain of these factors are independent of certain factors for eye-colour. Independent segregation of genetic factors was found in several families. People with one-sixteenth Indian blood and distinct eye pigmentation showed the presence of an undilutable factor for skin colour. There is evidence that certain tribes probably have fewer factors for skin colour than others. This appears to be the first attempt to apply genetical pedigree methods to the study of the results of interracial crossing in man. There is abundant scope for the application of this method to anthropological crosses in many parts of the world.

Royal Meteorological Society, Jan. 18.—**Hugo Hergesell**: The observation of clouds, with special reference to the safety of aviation (*v.* NATURE, Jan. 28, p. 143).—**Sir Gilbert Walker**: World weather. Comparisons by graphical methods of variations of pressure, temperature, and rainfall have during the past half century brought to light a number of relationships between conditions at places separated by considerable distances; these have in recent years been studied systematically by taking 30 centres widely distributed over the earth and calculating by statistical methods the relationships between their seasonal values. It appears that there are three main oscillations or swayings: (1) the North Atlantic; (2) the North Pacific; and (3) the southern, affecting the Pacific and Indian Oceans. These relationships have obvious applications for seasonal forecasting.

Linnean Society, Jan. 19.—**C. V. B. Marquand**: The botanical collection made by Capt. F. Kingdon Ward in the Eastern Himalaya and Tibet in 1924–25. Capt. F. Kingdon Ward, travelling eastwards from Gyantse to Tsetang over unexplored ground, and crossing the Temo La to Tumbatse, entered the region in the neighbourhood of Lat. 29° 40′ N., Long. 95° E., where the most important part of the collection was made. A short distance east of Tumbatse a number of high passes over the eastern extremity of the Himalaya were traversed. On the highest of these passes, the Nam La, over a southern spur of the lofty Namcha Barwa at an altitude of 17,500 ft., a large number of alpines were collected. In Aug. 1924 an extensive collection was made around the Trasum Lake, and the Banda La, a pass over 18,800 ft., the most northerly point of the Expedition, was visited. Excluding the three genera Meconopsis, Rhododendron, and Primula, the collection comprises 446 species, including 54 new species as well as 26 new varieties. The genera most strongly represented, apart from the three above, are Saxifraga, Gentiana, and Pedicularis.—**F. W. Edwards**: Insect-collecting in the Southern Andes. The expedition described was a joint one arranged by the British Museum (Natural History) and the Bacteriological Institute of the National Department of Health of Argentina, its object being to make investigations regarding the mosquitoes and other bloodsucking flies of the Southern Andes, and to form a general collection of insects from the southern beech-forests. Two and a half months, October 1926 to January 1927, were devoted to collecting, most of the time being spent around Lake Nahuel Huapi, close to the western border of Argentina in latitude 41° S. From here the party worked their way across to the Chilean coast; the route taken was the regular one over the Perez Rosales Pass and across Lakes Nahuel Huapi, Frias, Todos los Santos, and Llanquihué, an ancient route which is now being increasingly used by tourists.

PARIS.

Academy of Sciences, Jan. 9.—**Pierre Termier**: The strata of the Aiguilles d'Arves between Lauteret

and Vallouise.—**Ch. Fabry**: A phenomenon which accompanies binocular vision when the two visual images are not combined into one.—**J. S. Townsend**: The theory of high-frequency currents through gases. —**B. Hostinsky**: The probabilities relative to repeated transformations.—**Hadamard**: Remarks on the preceding note.—**Julius Wolff**: On the series $\sum \frac{A_k}{z-a_k}$.—**P. Bessonoff**: Nearly periodic meromorph functions defined in the whole plane.—**P. Faton**: The movement of the perihelion of the planets.—**Wright**: A photograph of Jupiter, obtained at the Lick Observatory (California). The photographs were taken in approximately monochromatic light with the large 95 cm. Crossley reflector. In the first series the light had passed through a screen permitting the passage of only ultra-violet light of about λ3700: in the second series the screen is transparent only for rays about λ7600 in the extreme red. The photographs show great differences, the causes of which are discussed.—**L. Décombe**: The electrified spherical pellicules and the fine structure of the spectral lines.—**Paul Woog**: The extension of lubricants over solid surfaces.—**P. Schwartz**: A method of radioelectric direction finding applicable to geodesy. The radiogoniometric method described gives the position of emitting stations with a precision comparable with that obtained by optical methods.—**G. Colange**: The electrocapillary properties of mercury in contact with air. The capillary constant of mercury increases when it is electrified negatively and diminishes when it is positively electrified. There is a maximum capillary constant for mercury, which under the experimental conditions described corresponds to a negative potential of 15,000 to 20,000 volts.—**Marcel Dufour**: The refraction of a parallel light beam normal to a cylindrical lens.—**Pierre Brun** and **Jean Granier**: The dielectric properties of aqueous-alcoholic mixtures. Measurements of the dielectric capacity (high-frequency current, wave-length 50 metres) of isobutyl alcohol—ethyl alcohol—water and isoamyl alcohol—ethyl alcohol—water mixtures. The results are shown graphically. It is concluded that the Maxwell formula relating dielectric capacity and refractive index of organic liquids ($K=n^2$) should be replaced by $K=n^2+k_2$, in which k_2 is a variable, a function of the number of free hydroxyl ions in the solution.—**Mlle. Suzanne Veil**: The evolution of nickel sulphide and cobalt sulphide in the presence of water. The changes in the sulphides are followed by means of the changes in the magnetisation coefficient.—**F. Bourion** and **E. Rouyer**: Ebullioscopic determination of the molecular equilibria of resorcinol in aqueous solutions of calcium chloride.—**M. Tiffeneau** and **Mlle. Jeanne Lévy**: The comparative migratory aptitudes of acyclic radicals in the semipinacolic transposition of the phenyldialkylglycols. Their relations with the affinity capacities.—**Georges Brus**: The crystallised dihalogen derivatives of pinene.—**Paul Fallot**: The western termination of the Sierra de Cazorla (Andalusia).—**Henri Schoeller**: The stratigraphical characters of the Embrunais layer and of the outer edge of the Briançonnais layer to the north of the Pelvoux region.—**G. Mangenot**: The signification of the red crystals appearing, under the influence of cresyl blue, in the cells of certain algæ. The red crystals are the iodide of the oxonium derivative of cresyl blue, and indicate the presence of iodides. The distribution of iodides in algæ can be determined by means of this reagent.—**Bogdan Varitchak**: The nuclear evolution in *Ascoidea rubescens*.—**M. Bridel** and **P. Picard**: The primeveroside of salicylic acid.—**Maurice Fontaine**: The analogies existing between the effects of a tetanisation and those of a compression.—**M. Raymond-Hamet**: The action of chloralose on the sympathetic and parasympathetic. —**Jean Timon-David**: Contribution to the knowledge of the fats of insects: the butter from the insects parasitic on *Pistacia Terebinthus*. The aphides *Pemphigus utricularius* and other species of Pemphigus give about 20 per cent of their weight as a fat soluble in ether. The chemical constants of the fat are given.—**G. Lavier**: The prebasal vacuole of trypanosomes.—**Ch. Pérard**: A disease of the mackerel (*Scomber Scomber*) due to a myxosporidium, *Chloromyxum histolyticum*.—**Marage**: The nature of the deafness of Beethoven.

SYDNEY.

Linnean Society of New South Wales, Nov. 30.—**A. H. S. Lucas**: Notes on Australian marine algæ (No. 5). This paper contains (1) a list of the algæ collected at Michaelmas Cay, near Cairns, Qld., (2) Chlorophyceæ from Bowen, including records new for Australia, (3) a description of a new species of Codium, (4) notes on Caulerpa with a description of *C. Hedleyi*, (5) distributional notes on Fucoideæ, and (6) descriptions of two new species of Chondria.—**B. Bertram**: Mosquito control in the municipality of Lane Cove, New South Wales. The problem was to deal with *Culex fatigans*, breeding in natural waters polluted by house drainage. Oiling gave useful results, but channelling was equally satisfactory, more permanent, and likely to be less expensive. The widespread benefit felt from the treatment of certain creeks suggests that the range of flight of *C. fatigans* is greater than is usually supposed.—**Rev. H. M. R. Rupp**: A new Dendrobium from New South Wales and Queensland. The new species is allied to *D. Beckleri* and *D. Mortii* and occurs throughout the brushes among the foothills of Barrington Tops, N.S. Wales, and also at Tambourine Mt., S. Queensland.

VIENNA.

Academy of Sciences, Dec. 1.—**A. Müller** and **A. Sauerwald**: The behaviour of aluminium-triethyl under the influence of nickel catalyser at higher temperatures.

Dec. 9.—**K. Przibram**: The theory of the coloration of rock-salt by Becquerel rays; also remarks on the natural blue rock-salt. Pressure is supposed to be part cause of the colouring.—**E. Steinach, M. Dohrn, W. Schöller,** and **W. Hohlweg**: The biological actions of the female sexual hormone in aqueous form. A hormone oil containing extract of placenta has been prepared with a strength of 50,000 mouse-units per gram. The active substance is soluble in water to a solution of 500 mouse-units per cubic centimetre. Experiments have been made with albino guinea-pigs, making it easy to observe the reddening or hyperæmia of the mammæ. Marked effects have been produced in the early maturity of the mammæ and uterus in females which had been castrated when young. The effects of injecting water-soluble hormone are similar to the action of physiological hormone obtained by transplantation of ovary.—**E. Steinach**: Reactivation of the ovary and the whole female organism by the hormone method. Senile females of the rat are rejuvenated by the water-soluble hormone.

Dec. 15.—**K. Fritsch**: Observations on flower visiting insects in Styria, 1906.—**F. Frankl**: Topological relations of compact portions of Euclidean space to their components and application to the theory of prime ends. The results of Alexander's work on the Jordan-Brower theorem are extended.

Official Publications Received.

BRITISH.

Canterbury College (University of New Zealand). Records of the Canterbury Museum. Vol. 3, No. 2, 14th December. Pp. 88-149+plates 18-23. (Christchurch, N.Z.)

Publications of the South African Institute for Medical Research. No. 22: A Mosquito Survey of certain Parts of South Africa, with special reference to the Carriers of Malaria and their Control. (Part 1.) By Dr. Alexander Ingram and Botha de Meillon. Pp. 81+15 plates. (Johannesburg.)

Nyasaland Protectorate. Annual Report of the Department of Agriculture, 1926. Pp. 26. (Zomba: Government Printer.)

The Empire Marketing Board and the Home Producer. Pp. 12. (London: Empire Marketing Board.)

The Journal of the Quekett Microscopical Club. Edited by W. S. Warton. Ser. 2, Vol. 15, No. 93, November. Pp. x+289-374+xxx+xii. (London: Williams and Norgate, Ltd.) 8s. 6d. net.

The Scientific Proceedings of the Royal Dublin Society. Vol. 18, N.S., Nos. 43-47. 43: Comment on an Article by James Wilson on "The Maintenance Requirements of Cattle on different Rations and at different Rates of Production," with a Note on "Dynamic Action," by E. B. Forbes; 44: The Maintenance Requirements of Cattle, a reply to E. B. Forbes' Criticism, by James Wilson; 45: *Catenaria anguillulae* as a Parasite of the Ova of *Fasciola hepatica*, by Prof. J. Bayley Butler and J. J. C. Buckley; 46: Some Experiments on feeding Rats with Soya Beans and other Materials, by D. T. Barry and J. Freud; 47: The Formation of Vortices behind a Cylinder moving through a Fluid, by E. T. S. Walton. Pp. 495-584+plates 23-27. (Dublin: Royal Dublin Society; London: Williams and Norgate, Ltd.) 4s.

British Guiana: Combined Court, Annual Session, 1927. Report on the Preliminary Geological Survey of the Potaro-Ireng District of British Guiana. By Smith Bracewell. Pp. iii+60. (Georgetown, Demerara: Department of Lands and Mines.)

FOREIGN.

Annual Report of the Director, United States Coast and Geodetic Survey, to the Secretary of Commerce for the Fiscal Year ended June 30, 1927. Pp. iv+47+15 maps. (Washington, D.C.: Government Printing Office.) 50 cents.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 394: Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory at Cheltenham, Md., in 1923 and 1924. By Daniel L. Hazard. Pp. ii+111+10 charts. (Washington, D.C.: Government Printing Office.) 20 cents.

Report of the Acting Secretary of the Smithsonian Institution for the Year ending June 30, 1927. (Publication 2923.) Pp. vi+131. (Washington, D.C.: Government Printing Office.)

Fifteenth Annual Report of the Secretary of Commerce, 1927. Pp. xlii+310. (Washington, D.C.: Government Printing Office.) 30 cents.

Treasury Department, United States Public Health Service. Studies on Oxidation-Reduction. 11: Potentiometric and Spectrophotometric Studies of Bindschedler's Green and Toluylene Blue. By Max Phillips, W. Mansfield Clark and Barnett Cohen. Pp. iii+36. 10 cents. 12: A Note on the Schardinger Reaction (in reply to Kodama). By W. Mansfield Clark, Barnett Cohen and M. X. Sullivan. Pp. ii+10. 5 cents. (Washington, D.C.: Government Printing Office.)

State of Connecticut. Public Document No. 24: Fiftieth Report of the Connecticut Agricultural Experiment Station, New Haven, Conn., for the Year 1926. Pp. xvii+590+18 plates+58T+3 plates+11. (New Haven, Conn.)

CATALOGUES.

Training Electrical Engineers. Pp. 32. (London: The Electrical Standardizing, Testing and Training Institution, Ltd.)

Catalogue of Botanical Books. (No. 157.) Pp. 56. (London: Dulau and Co., Ltd.)

Catalogue of Books and Journals bearing on the Mathematical, Physical and Chemical Sciences. (No. 301.) Pp. 74. (Cambridge: W. Heffer and Sons, Ltd.)

Diary of Societies.

SATURDAY, FEBRUARY 18.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Newcastle-upon-Tyne), at 2.30.—W. Maurice: Electric Mine Lamps and Better Lighting.—Prof. W. M. Thornton: A New Gas Detecting Miners' Electric Lamp.—High Candle-power Lamps will be exhibited and explained by H. Staples on behalf of Prof. R. V. Wheeler.—*Papers open for further discussion*:—Impressions of the Canadian Empire Mining Congress, by W. C. Carr.—Further Modifications of the Correlation of the Coal-seams of the Northumberland and Durham Coalfield, by Dr. W. Hopkins.

PHYSIOLOGICAL SOCIETY (in Department of Physiology, University, Manchester), at 8.—E. Boyland and A. D. Ritchie: The Adductor Muscles of Pecten.—Prof. A. V. Hill: Recent Myothermic Experiments.—F. W. Lamb and J. V. A. Simpson: Assessment of Schoolboys by Air Force Tests.—F. W. Lamb, E. D. Portman, and G. J. Woolham: Posture Deviations of the Arm and their Reversal.—A. N. Birkett and F. W. Lamb: Balance of Ocular Muscles in Normal Subjects.—C. E. Brunton: Respiratory Responses to Interruption of Breathing and to Inflation.—Dr. J. C. Bramwell and R. Ellis: (a) The Tidal Wave; (b) Some Observations on the Action of Amyl Nitrite.—J. G. Woolham: On Correlations between Pulse and Respiratory Tests.—Dr. G. A. Clark: Pituitrin and Blood-Sugar.—H. E. Magee and B. A. Southgate: A Method for Determining the Effect of Electrolytes in the Lumen of the Surviving Gut on its Movements. (Preliminary Communication.)—B. Finkleman: Vagus Inhibition in its Relation to Ions.—Dr. A. D. Macdonald and E. D. Portman: The Diuretic Principle of Pituitary Extracts.—E. D. McCrea and Dr. A. D. Macdonald: The Action of Drugs on Entogastric Pressure.—Dr. E. C. Eaves: Calcium, Iron, and Phosphorus in Normal and Some Abnormal Brains.—M. M. Croll: Alteration in Weight of the Brain and Some Other Tissues during Formalin Fixation.—H. D. Kay: The Organic Phosphorus of the Erythrocyte.—Prof. R. J. S. McDowall: Class Experiments in Leucocytosis.—I. Berembloom and Dr. B. A. McSwiney: Reaction of Adrenaline with Relation to the H-ion Concentration.—Demonstrations:—Light Production in a Marine Animal (Cypridina), by W. R. Amberson; Apparatus for the Observation and Photography of the Skin Capillaries in Man, by G. L. Brown and F. W. Lamb; An Optical Sphygmograph, by Dr. J. C. Bramwell; Records of Sounds, by Dr. J. C. Bramwell and F. W. Lamb; The Action of Pituitary Extracts on Isolated Blood-Vessels, by E. D. Portman and Dr. A. D. Macdonald; Calcium and Vagus Threshold, by B. Finkleman; Histological Preparations showing the Innervation of Different Parts of the Human and Rabbit's Pituitary, by M. M. Croll; A New Drop-Recorder, by O. Inchley.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—H. C. Colles: Musical London from the Restoration to Handel (1660-1759) (III.).

SOCIETY OF SUPERINTENDENTS OF TUBERCULOSIS INSTITUTIONS (at 122 Harley Street), at 3.—Dr. A. N. Robertson: Open-air Treatment and Meteorological Conditions.

OXFORD UNIVERSITY JUNIOR SCIENTIFIC CLUB (in Departments of Electricity and Comparative Anatomy, Oxford University), at 8.15.—Annual Exhibition.

MONDAY, FEBRUARY 20.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—E. B. Bailey: Schist Geology: Braemar, Glen Cluny, and Glen Shee.—Dr. H. H. Read: Highland Schists of Middle Deeside.—C. N. Kemp: The X-ray Examination of Coal Sections (Preliminary Note).—*To be read by title only*:—Dr. E. Henderson: An X-ray Examination of Saturated Dicarboxylic Acids and Amides of the Fatty Acid Series.—W. L. Ferrar: General Derivatives and Integrals.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Prof. T. G. Pinches: The Influence of the Mythology and Heathen Practices of the Canaanites upon the Hebrews.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—C. E. Shattock: Pathological Specimens in the Museum.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 6.30.—Informal Discussion on The Relative Importance of Sales, Design, and Works Organisation in Engineering.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—L. Emanuell and others: Discussion on 132,000-volt Cables.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.30.—Dr. S. Z. de Ferranti: Electricity in the Service of Man (Faraday Lecture).

RAILWAY CLUB (25 Tothill Street, S.W.1), at 7.30.—Annual General Meeting.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Prof. A. P. Laurie: Stone Preservation and Decay.

ROYAL SOCIETY OF ARTS, at 8.—Dr. H. Gough: Fatigue Phenomena, with special reference to Single Crystals (Cantor Lectures) (2).

CHEMICAL INDUSTRY CLUB, at 8.—Dr. F. C. Shrubsall: Mental Deficiency.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—G. Watkins: The Cambridge Expedition to Edge Island.

SOCIETY OF CHEMICAL INDUSTRY (Yorkshire Section).—Dr. F. L. Usher and others: Discussion on The Phenomenon of Wetting and its Industrial Significance.

TUESDAY, FEBRUARY 21.

ROYAL DUBLIN SOCIETY (in Science Room, Ball's Bridge, Dublin), at 4.15.—Rev. H. C. Browne: Stereoscopic Notes.—Dr. J. H. J. Poole: The Measurement of the Current flowing through a Photo-electric Cell by means of a Neon Lamp.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: The Behaviour of Animals (1).

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—Dr. T. H. C. Stevenson: The Vital Statistics of Wealth and Poverty.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Hon. Ivor Montague: Exhibition of Photographs of the Moscow Zoological Gardens.—G. C. Robson: Observations on the Oviposition of Octopus.—Prof. D. M. S. Watson: On Some Points in the Structure of Palæoniscid and Allied Fish.—Oldfield Thomas: The Delacour Exploration of French Indo-China Mammals. II. On Mammals collected during the Winter of 1926-27.—S. Maulik: New Chrysomelid Beetles from India, with a Note on the Scales of Coleoptera.

INSTITUTION OF CIVIL ENGINEERS, at 6.

LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.), at 6.30.—L. W. Chubb: Our Common Lands: The Story of their Preservation.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—A. Page: Address.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at College of Technology, Manchester), at 7. Dr. S. Z. de Ferranti: Electricity in the Service of Man (Faraday Lecture).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—C. E. Kayser: A Comparison of the Norman Doorways of Yorkshire, Norfolk, and Gloucestershire.

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Engineering and Scientific Club, Wolverhampton), at 7.30.—C. R. F. Engelbach: Works Re-organisation to Increase Production.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (jointly with Institution of Post Office Electrical Engineers—Scottish East Centre) (at Freemasons' Hall, Edinburgh), at 7.30—E. H. Shaughnessy: The Rugby Radio Station.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—Dr. R. M. Brown: Fatigue of Metals: Some Effects of Cold Drawing on the Strength and Endurance of Mild Steel.

WEDNESDAY, FEBRUARY 22.

ROYAL SOCIETY OF MEDICINE (Comparative Medicine Section), at 5.—Dr. H. P. Bayon: The Pathology of Certain Avian Diseases compared with that of Analogous Morbid Conditions in Man and Animals.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—C. P. G. Wakeley: Investigations into the Surgical Diseases of the Salivary Glands, including their Pathology and Treatment.
GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. C. A. Matley: The Pre-Cambrian Complex and Associated Rocks of South-Western Lleyn (Carnarvonshire).
BIRKBECK COLLEGE PHYSICAL SOCIETY, at 6.—Prof. E. V. Appleton: The Influence of the Earth's Magnetic Field on Wireless Transmission (Distinguished Visitors' Address).
SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (jointly with Institute of Chemistry) (at 39 Elmbank Crescent, Glasgow), at 7.—J. H. Hawley: Some Aspects of Toxicology.
SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section), at 7.30.—F. H. Carr: The Methods Employed in the Preparation of Unstable Substances.
INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—A. Page: Address.
GLASGOW UNIVERSITY ALCHEMISTS' CLUB (at Glasgow University), at 7.30.—Prof. R. A. Berry: Chemistry in Relation to the Science and Practice of Agriculture.
SOCIETY OF CHEMICAL INDUSTRY (Edinburgh and East of Scotland Section) (at 36 York Place, Edinburgh), at 7.30.—Annual Meeting.
ROYAL SOCIETY OF ARTS, at 8.—Dr. H. R. Hall: The Excavations at Ur from 1919 to 1926.
EUGENICS SOCIETY (at Linnean Society), at 8.—Dr. C. P. Blacker and Mrs. Marjorie Farrer: Birth Control: When is it Justified?
FOLK-LORE SOCIETY (at University College), at 8.—Annual Meeting.
BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Medical Society of London, 11 Chandos Street, W.1), at 8.30.—Dr. G. V. Anrep: Conditioned Reflexes and Experimental Neuroses.

THURSDAY, FEBRUARY 23.

ROYAL SOCIETY, at 4.30.—Sir Leonard Rogers: The Yearly Variations in Plague in India in Relation to Climate: Forecasting Epidemics.—Dr. W. S. Patton and E. Hindle: The North Chinese Species of the Genus Phlebotomus.—H. Eltringham: On the Production of Silk by Species of the Genus Hilara, Meig. (Diptera), with an Appendix.—A. H. Hamm: On the Epigamic Behaviour of *Hilara Maura*, Fab., and two Allied Species.—Dr. H. M. Leake: Agricultural Value of Rainfall in the Tropics.
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. F. Ll. Griffith: Nubia in Antiquity and in the Middle Ages (1).
INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.
CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Mrs. Stella Churchill: Sunlight in its Effect upon the Development and Growth of Children.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—T. N. Riley and T. R. Scott: Insulating Oils for High-Voltage Cables.
INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre, Dublin) (at Trinity College, Dublin), at 7.45.—T. J. Monaghan: A Review of the Present Position of Wireless Telegraphy.
CHEMICAL SOCIETY, at 8.—Prof. A. Fowler: Spectra and Atoms (Lecture).

FRIDAY, FEBRUARY 24.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—W. H. J. Childs: Some Methods of Estimating the Intensities of Spectral Lines.—Prof. P. W. Burbidge and N. S. Alexander: On Electrical Methods of Hygrometry.—L. Hartshorn: On Constants of Thermionic Valves.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—W. D. Newcomb: The Relationship between Peptic Ulceration and Gastric Carcinoma.
INSTITUTION OF PROFESSIONAL CIVIL SERVANTS (at Central Hall, Westminster), at 5.30.—S. V. Goodall: Admiralty Floating Docks.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in Mining Institute, Newcastle-upon-Tyne), at 6.—G. U. L. Sartoris and K. Watson: The Michell Crankless Engine.
INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section) (jointly with Students' Sections of Institutions of Civil and Mechanical Engineers) (at Institution of Electrical Engineers), at 6.15.—F. C. Dain: Salesmanship and its Application to Engineering.
MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section), at 7.
INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Exhibition of Industrial Kinematograph Films.
JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—C. H. Faris: The Applications of Electro-chemical Deposits of Metals to Engineering.
ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Dr. R. Miller: Some Public Health Aspects of Juvenile Rheumatism.—Dr. J. T. Clarke: The Pathogenesis of Rheumatic Fever in its Climatological Relationship to a Possible Insect Carrier.
OXFORD UNIVERSITY JUNIOR SCIENTIFIC CLUB (in Department of Biochemistry and Physiology, Oxford), at 8.15.—Dr. A. E. Dunstan: Lecture.
ROYAL SOCIETY OF MEDICINE (Disease in Children and Surgery Sections), at 8.30.—Special Discussion on Chronic Appendicitis in Children. Dr. Robert Hutchison (Children); A. J. Walton (Surgery).
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. G. Gordon: The Lives of Authors.
SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Thomas' Café, Swansea).—N. H. Hartshorne: The Electronic Theory of Chemical Combination.
CHEMICAL INDUSTRY CLUB.

SATURDAY, FEBRUARY 25.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students' Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—Dr. R. J. Perring: Miners' Nystagmus.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—C. Dodgson: The Life and Work of Albrecht Dürer (1).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 18.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Amulets and Magical Figures of the Ancient Egyptians.

MONDAY, FEBRUARY 20.

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—A. Bridges: Sugar Beet Costs.
GRESHAM COLLEGE, at 7.30.—G. P. Bailey: Modern Science and Daily Life: Chemistry in Industry.
LEEDS UNIVERSITY, at 8.—Dr. Ll. Wynn Jones: Recent Advances in Experimental Psychology: Analysis of Typical Results with special reference to Experiments on Cognition.

TUESDAY, FEBRUARY 21.

GRESHAM COLLEGE, at 6.—A. R. Hinks: The Foundations of Astronomy. (Succeeding Lectures on Feb. 22, 23, and 24.)
THEOSOPHICAL WORLD UNIVERSITY CENTRE (153 Brompton Road, S.W.3), at 6.—Prof. E. Marcault: Principles of Race-Psychology. (Succeeding Lectures on Feb. 28, Mar. 6, 13, and 20.)

WEDNESDAY, FEBRUARY 22.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.30—Dr. J. E. W. Macfall: Some Aspects of Legal Live Birth.

THURSDAY, FEBRUARY 23.

BRITISH MEDICAL ASSOCIATION (Tavistock Square, W.C.1), at 5.15.—Sir W. Heaton Hamer: Epidemiology in England during the last Hundred Years. Part 2. The Return to the Hippocratic Method (Chadwick Lecture).
LEEDS UNIVERSITY, at 8—Dr. D. R. Fox: The Development of Public Education in the United States.

FRIDAY, FEBRUARY 24.

KING'S COLLEGE, at 5.30.—C. J. Gadd: Ur in the Time of Abraham.
THEOSOPHICAL WORLD UNIVERSITY (at Friends' House, Euston Road), at 5.30.—Prof. E. Marcault: Psychology of Man's Evolution. (Succeeding Lectures on Mar. 2, 9, and 16.)
EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—Dr. W. F. Bewley: The Cultivation of the Tomato.

SATURDAY, FEBRUARY 25.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. Edith Durham: Primitive Life in South-East Europe.

CONFERENCES.

FEBRUARY 21-24.

CARBONISATION CONFERENCE (in Birmingham and Midland Institute and Queen's College, Birmingham).
Tuesday, February 21 (in Birmingham and Midland Institute).
At 10.30 A.M.—
W. J. A. Butterfield: The General Scope of the Gas Industry.
T. Hardie: Some Phases of Modern Practice in Gas Manufacture.
T. Hardie: Presidential Address to the Southern Association of Gas Engineers and Managers.
M. Barash and T. C. Finlayson: Continuous Vertical Retorts.
N. J. Bowater: Vertical Intermittent Chamber Ovens for Gas Manufacture.
R. H. Ruthven: Intermittent Vertical Chambers.
Wednesday, February 22 (in Birmingham and Midland Institute).
At 10 A.M.—
C. P. Finn and R. Ray: The General Scope of the Coke Oven Industry.
G. J. Greenfield and G. H. Harrison: Modern Coke Oven Practice.
E. C. Evans: Coke Research and the Steel Industry.
Thursday, February 23 (in Birmingham and Midland Institute).
At 2.30—
T. F. E. Rhead: Steaming in Vertical Retorts.
A. T. Green: Gas Works Refractories.
Dr. A. Parker: Gas Works Effluents.
Friday, February 24 (in Queen's College).
At 10 A.M.—
Sir Arthur Duckham: The Handling, Preparation, and Utilisation of Gas Works Coke.
J. Roberts: Blending in the Gas and Coke Oven Industries.
At 2.15—
F. S. Sinnatt: A General Review of Low Temperature Carbonisation.

FEBRUARY 24 AND 25.

ASSOCIATION OF TECHNICAL INSTITUTIONS (Annual Meeting) (at Stationers' Hall).
Principal G. H. Austin: Commercial Education.
Principal S. Carter: Suitable Courses in Commerce for Small Institutions.
T. P. Bennett: The Technical Training of the Architect.
Principal F. E. Drury: Technical Education for the Building Trades.
F. W. Roberts: Technical Education for the Boot and Shoe Industry.

SATURDAY, FEBRUARY 25, 1928.

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The Range of the Scientific Faculty.

"*How can we harness opinion to knowledge and steady the emotions of the multitude with experience and science? This, it seems to me, is the master problem of our time.*"
J. A. SPENDER.

IN a recent address[1] on "Contacts of Science and Literature," which he delivered as president of the Science Masters' Association, Sir Richard Gregory has once more directed attention to the urgent need of a closer approach of letters and science. Sir Richard, as all know, is both broad and fair in his outlook; no one is less likely to present a prejudiced view of the situation; also he is ever an optimist. Any statement that he may make upon such a subject is not to be put lightly aside. In suggesting, as he does, that indifference to science among teachers of English is more general than neglect of literature by students of science, he is upon sure ground—almost that of platitude. What are we to say of his subsequent contention?

"We are not likely ourselves to forget that science and the humanities are the warp and woof of the fabric of modern life any more than we overlook the human factor in industry; but while these relationships are frequently presented to scientific assemblies, we miss the same friendly gestures to science from our literary colleagues. Men of letters tell us that men of science are the only people who have something to say and are unable to say it and we accept the rebuke, even though we know the difficulty of making the intricate processes of Nature intelligible in the vocabulary of ordinary life. Our retort, however, may very well be that men of letters should be expected in these days to know a little of Nature and science and to be able, therefore, to exercise their literary art in displaying the wonder and value of the rare treasures which the argosies of scientific explorers are continually bringing into our havens from uncharted seas. Science does not want a divorce from literature but closer union with it and a common understanding of the distinctive qualities by which each can contribute to the fullness of life. It would be easier to mention leaders of science who have enriched literature by their writings than to select men of letters who have exercised their imagination and art upon scientific knowledge and achievement; and we ask those who have the gift of radiant expression to remain no longer outside our temples but to enter and be moved to testify to the revelation which will then be given them."

Is the invitation thus given one that is likely to be accepted? Can men of letters ever enter into the Temple of Scientific Endeavour and do what is here asked of them? Have we not too long followed Adam and Eve?

"Thus they in mutual accusation spent
The fruitless hours but neither self-condemning
And of their vain content appeared no end."

[1] Published in the *School Science Review* for February.

Nothing can be gained by the one party always gibing at the other. Should we not rather consider the office of each, what is really within the power and province of each ?

Man is to be distinguished from the rest of animate creation by three, if not four, faculties—that of speech, the use of hands, commercial ability and the use of fire. The art of scientific inquiry is but a modern discovery—a modern superstition, may we not say, something foreign to man's ordinary nature—superadded to it and necessarily the prerogative of the few ? Carlyle has claimed that he is the tool-using animal, strangely forgetting that man, especially woman, is a literary creature almost from birth. The highest literary artist is but a biped in whom the chief art of his being is developed to the utmost—writing, after all, is nothing but the cultivated art of speech recording. It is no particular credit to us to write and speak well; rather are we to be blamed for the very partial and imperfect manner in which we are accustomed to develop and exercise our chief natural, inborn faculty.

Have we, then, not the right to rate the literary as an intellectually inferior class ? Have they not mere ordinary brains, however highly developed ? Hazlitt has painted them to the life, particularly in his essay " On the Ignorance of the Learned," in saying :

" All that men really understand is confined to a very small compass : to their daily affairs and experience ; to what they have an opportunity to know and motives to study or practise. The rest is affectation and imposture."

Can we expect the literary as a class, ever to be scientific ? It is absurd to suppose that, if the power were latent in them, men of the seeming intelligence of say Oxford dons should be proof against all persuasion to take an interest in the work of scientific discovery and be unable to do more than use more or less ordinary words in dealing with the ordinary events of common life and continually to depict only the obvious—glory in being masters of inextensible subjects. In truth, there is a factor of intelligence missing from their minds—let us call it factor X.

Sir Richard rightly had much to say in praise of poetry—he quoted examples to show that the poet is able to seize upon and portray the findings of scientific observers, Tennyson's felicitous lines, in particular. Yet the poet of old, we have to remember, was but the singer, the speaker of music : he is only to-day the writer and put into print ; he is but the highest form of speechmaker, no modern development or new discovery. Poetry, in fact, is more or less akin to our nature. Music also is a barbaric trait—it is in us all to some extent, especially in Germans ; there are few who do not hate noise, if they do not react to harmonious sounds.

Again, no special claim can be made on behalf of commercial ability—it is necessarily more or less born in us all. From his earliest days, man has been obliged to barter, buy and sell, in order to live : at least, up to the time of the discovery of the dole, the acceptance of which may but connote a superior form of commercial ability.

As to the use of fire, this is so ancient a custom that it is now an instinctive practice. Clearly it is not a sign of intelligence but rather the reverse—in its modern development, the sign of a desire for occupation and of its irrational satisfaction. The woman who knits, not only satisfies the desire of her being to be busy but also does something useful. The smoker but deadens the same desire in destruction and dirt ; it is true he occupies himself : the brute is tamed, usually *after* being fed—but wastefully and selfishly.

As to our use of hands, we could (we were allowed to) use these in the distant past to greater advantage than we do to-day : Egyptian tombs tell us this story. Only on Dec. 31 last, a picture was given in NATURE of a machine able to make a million bottles a week, which is to be worked by a single man ! Formerly, hundreds were needed to make any such number. None the less, *bottled* beer is dearer than it ever was. Who gains the advantage the hundreds formerly had from blowing bottles—what is behind the machine ? Is it not the execrable modern discovery we call scientific activity ? The effective activity of knowledge used systematically and by the very few, of set purpose, to a foreseen end ?

The systematic use of scientific method, the method of using knowledge not merely to do this or that but also to extend and verify knowledge—through reasoned observation and experiment : the existence of men gifted with the factor X, this is the paramount discovery of modern times, scarce centuries old. Let this not be confused with mere science—which is but exact knowledge. The faculty of using knowledge is a rare one, almost a modern discovery. The scientific, therefore, may claim to be a superior people, a people who can advisedly, of set purpose, find things out and do things, whilst the literary can at most talk about them. Natural science, the work of this new class, may claim to stand alone as the music of the future : either its priesthood will be the leaders of the people—the givers and guardians of their necessary

morality—or the people will perish, if not from want of knowledge, from lack of the power to use it.

The literary write themselves up everywhere—each goose as it comes to market is made into a swan in the reviews of to-day and the virtues in the classics are ever impressed upon us. Yet who shall say that the sciencers are behind: certainly not the physikers; the others at least write one another down. The scientific after all are much as other men, human in their foibles and vanities; yet they are gifted with a power—the mysterious factor X—which definitely divides them from the mass: however much they may be appreciated by society, they will never be really understood. In fact, they are very fine fellows and it is unfortunate that Mr. Bernard Shaw has not been induced to sketch their psychology for us—but they are a class of supermen which must ever be beyond such writers as he.

If our argument be sound, the literary will never do what Sir Richard Gregory suggests they should do. Factor X will never stir within them; they are mentally unresponsive. The work will only be within the power of those sciencers who are also competent as writers. As speaking is a common human attribute, there is no reason why such should not be forthcoming, provided the schools do their duty. These have yet to show that they can teach the use of words, let alone science. French men of science are able to write well, because training in rhetoric *is* given in their schools: in ours it is not.

To-day, the schools do not do their duty. They simply do not know what their duty is. They are controlled by people who only know the old knowledge and are without understanding of scientific method. Thring, the schoolmaster, told his colleagues long ago—to break down the knowledge idol. Sanderson, at Oundle, made an abortive attempt. Our universities are all engaged in its fervent worship. Education, like sport, is fallen a victim to professionalism: the system pursued is akin to that of the electric hare in coursing—its practical equivalent.

Being a nation of shopkeepers, willy nilly we are engaged in commercialising education in all its forms, including research. School is carried on mainly in the interests of the machine, not in the interest of scholars. Education is in the control of two of my inferior classes—the literary and the commercial. The writing upon the wall is very clear—needing no Daniel to interpret it. Who will read it out in the market places, so that it may be understood by all and my text be fulfilled? The first duty of scientific workers to-day is to the public. Having put such vast powers of exploitation in selfish hands, we at least must endeavour to inform the masses how best to use the opportunities before them—never to think of chalk as fuel.

To make university education of avail we must appoint teachers competent to teach, first the things of yesterday. Let the research workers be a class apart. The schools are not producing the men for whom the world is asking. We are moving to-day in a closed vicious circle—the schools say they are in the hands of the universities, whilst these retaliate that they are subject to the schools. Examinations pay everybody except the learner—the poor guinea-pig.

The teaching of science in our schools is a failure, because it is parrot work, not scientific; because it is confined to special subjects—chiefly chemistry and physics—geology, botany and biology being all but neglected; because it is so far beyond the common intelligence and the teacher's. No attempt is made in the schools to teach the simplest elements of scientific method, as applied to ordinary life and to ourselves. We must mend or end the system. The Science Masters' Association has neglected great opportunities in the past half-dozen years of discussing the problems, when at Oxford and Cambridge, with the authorities.

The public cannot allow the subject to be trifled with much longer; the two parties must meet and debate the situation, so that each may put its house in order without any further delay. H. E. A.

University College Centenary.

University of London: University College. Centenary Addresses. Bound together in one volume. With a Preface by Dr. R. W. Chambers. Pp. viii + 33 + 36 + 42 + 28 + 31 + 35 + 19 + 30 + 25 + 28 + 28 + 20. (London: University of London Press, Ltd., 1927.) 12*s*. 6*d*. net.

THE re-issue of these addresses in the form of a bound volume will be welcomed by an even wider public than the members and friends of University College, London. Anniversaries have been celebrated from the dawn of civilisation and correspond to something real and significant in human life. The 'majority'—the twenty-first anniversary—when a man comes to his estate and arrives at 'years of discretion,' was based presumably on some *pseudo*-physiological facts decocted by lawyers. It corresponds to nothing in the life of an institution, for an institution is born adult, at any rate in such matters as the privilege

of paying income-tax. Jubilee, the year following the Jewish seven Sabbaths of years, when liberty was proclaimed and every man returned to his family, had originally a religious and racial meaning. A centenary, representing an arbitrary period of time based on our decimal notation, offers some advantages from the viewpoint of institutional celebration. In the course of Nature, the founders of a college are not privileged to be present at its centenary; and for that reason their memory and achievements may more appropriately be revived and revered. Further, a college which has survived for a century has passed the audits of time and can look forward with equanimity to its future.

There may be risks attending the foundation of new universities, said Mr. H. A. L. Fisher in his Foundation Oration reprinted in this volume, expressing the accustomed Oxford view on this question—risks which we venture to suggest are usually over-estimated—but those risks, he added, do not apply to an institution which has weathered one hundred years. In an eloquent tribute to the ideals for which University College was founded, he said:

"Your college has given ample pledges. It has been served by a long line of distinguished teachers who have left their mark upon the intellectual life of the country. It has always stood for free and fearless inquiry. It has never receded from the large and undifferentiating hospitality which now, for one hundred years, it has extended to all who desire to learn."

Who was the founder of University College and of the University of London—for it is fair to acknowledge that the founder of University College was in one important sense the founder of the University? Thomas Campbell's letter to the *Times*, published in February 1825, urging the establishment of a great University of London, is well known. The letter was addressed to his dear friend Brougham, a somewhat sinister figure in the political life of his times, a man who was not a hero even to his biographer. Aspinall, in his book "Lord Brougham and the Whig Party," animadverts on his "faithlessness and egoism"—characteristics not to be looked for in a pious founder—but he pays tribute to the "influence, energy, and capacity" which "did most" to carry Campbell's scheme to execution. To Brougham, therefore, honour is rightly accorded in this centenary volume. But the authorities of the College have shown a wise discrimination in selecting Jeremy Bentham for special praise and thanksgiving as a founder of the College.

"I do not suppose," said the Bishop of Manchester, in the sermon preached at the special service in Westminster Abbey, "that it would be extravagant to say that no man in English history has accomplished so much definite good that can be plainly traced to his work and influence as Jeremy Bentham": and this high praise is endorsed by Prof. J. E. G. de Montmorency in his notable address on "A Century of Jurisprudence," who accords to Bentham the proud title of spiritual founder of University College "a utilitarian if you like, but a utilitarian who, being dead, has slowly brought the Platonic heaven to earth."

From the founders of University College we may pass to its teachers and students. Once a year the members of the College come together "to pay a tribute to the memory of our founders and to some of the distinguished men and women who have done so much to make the name of this College famous." Two of these commemorations are recorded in this volume, the first, on March 25, 1926, when the Provost (Sir Gregory Foster) delivered the Foundation Oration, and the second, a year later, when the delegates from 208 universities and colleges assembled to honour the centenary of the College, the orator on this occasion being Mr. H. A. L. Fisher, to whose address reference has already been made. Two lists of names selected for special honour are therefore published in the book. We do not claim to discern the principles on which the names are selected, for if the lists include some distinguished names, others not less distinguished are excluded—de Morgan, Lister, and Walter Bagehot, for example. Lister, one of the greatest benefactors of the human race, was a true son of the College, graduating both in arts and medicine, and receiving later in his life the rare distinction of an honorary degree from the University. Walter Bagehot, described by Morley as a "striking genius," had a deep and pervasive influence on political and economic thought, an influence not dissipated by the catastrophic events of recent years. He was elected a fellow of the College in 1849, and was induced to offer himself as a candidate for the original representation of the University of London in Parliament. Surely also, among former professors, Augustus de Morgan, the brilliant mathematician, should be considered worthy of inclusion among the teachers who built up the fame of the College; and might not the name of a representative of those students who fell in the War—William Howard Lister, for example—have been included in one of the lists, or even in both lists, to which are appended the memorable words:

"All these were honoured in their generations,

and were a glory in their days. Their glory shall not be blotted out."

The only name accorded the honour of inclusion in both lists is that of a benefactor, Sir William Bartlett, Bart.

Sir Gregory Foster selected an avowedly historical subject for his Foundation Oration—" These Hundred Years." This was, as to date of delivery, the first of the addresses included in this volume, and might well have been placed at the beginning of the book as furnishing an introduction to the other addresses. The address is full of interest to the student of educational history. If there is one subject for criticism, it is that the question of the relation of the College to the University of London might have been examined in more detail and with greater care. Reference is made to the 'evil' results to the London Colleges of " the severance in 1858 of the University from the affiliated Colleges." The word 'severance' is inappropriate to describe what took place at this time. Affiliation of colleges had become in course of time practically meaningless, and the affiliation of further colleges was therefore discontinued, the examinations (except in medicine) being thrown open to all comers. The relation of University College to the University remained, however, much as before. According to official evidence presented to one of the numerous Royal Commissions which have investigated the university question in London, both the University and University College received their original charters on the same day in 1836, and the College was always tacitly regarded as the teaching department of the University.

The union, it is true, was not organic; and the word 'severance' cannot therefore be used either as implying the pre-1858 relation or as defining the post-1858 relation of College to University. " Reform came in 1900," we are told, " but that reform was a tentative step." A tentative step, forsooth! The drab old gentleman of Burlington Gardens, busy exclusively with his written and practical examinations, was metamorphosed by this reform into an Apollo to whom the College at once proposed matrimony—'incorporation' is the technical word—a complete fusion of interests! " As you know," the Provost continued, " only the day before yesterday, a new plan of 'evolutionary' development was issued by the Departmental Committee appointed by Mr. Trevelyan." Is this a worthy reference to the culmination of twenty-six years of anxious thought and discussion, in which the Provost's views have always been listened to with strained and respectful attention? Great praise is accorded by the Provost to the " Education Acts of 1901 and 1902 "—the reference must be to the Acts of 1902 and 1903—and to their inspirer, Sir Robert Morant. " Owing to those great Acts, the growth in this College and in other university institutions throughout the country has been remarkable." Has the College, the wayfaring man will ask, gained nothing from the closer association with the University and the other London Colleges secured by the " tentative " reform of 1900? By a slight extension of the title of his address, the Provost might well have attempted to limn the vision of the new University of London, with its libraries, research institutes, and special schools, growing in beauty and harmony alongside its greatest college—

> " Yet ever and anon a trumpet sounds
> From the hid battlements of Eternity:
> Those shaken mists a space unsettle, then
> Round the half-glimpsed turrets slowly wash again."

Interesting as the history of the College undoubtedly is *per se* and in relation to the development of our educational system, the addresses here reprinted on the progress of science during the century will appeal more directly to scientific readers—physiology by the late Prof. E. H. Starling, physics by Sir Oliver Lodge, a brilliant and characteristic *causerie*, medicine by Sir John Rose Bradford, electrical engineering by Prof. J. A. Fleming, and chemistry by Prof. J. Norman Collie. " At the date of the foundation of this College," said Prof. Starling, " science as an academic study was practically non-existent in this country." The College suffered abuse in its early days not only for its 'godless' character, but also on account of its enthusiasm for scientific teaching and research. 'Stinkomalee' was one of the epithets specially coined for the purpose of this abuse; and the noble motto *Patens omnibus Scientia* was converted into a nickname—Brougham's Patent Omnibus. An abridged list of names will suffice to establish the claims of the College in this respect. In physiology, the College can point to Sharpey and to his brilliant pupils Burdon-Sanderson, Michael Foster, and Schafer, of whom the first two bore the torch to Oxford and Cambridge; to Bayliss, Horsley, and Starling. In physics and chemistry, the list is not less distinguished, including the names of Graham, Williamson, and Ramsay. And may we not add that many of those who are still living and working in the College are worthily maintaining the high tradition of scientific research set by these honoured names?

"It is one of the glories of University College," said Mr. Fisher, "that it has contributed not to education only, but to the advancement of learning, and that its alumni and professors are taking their full share in that great movement of human curiosity, which is transforming our conceptions of the physical constitution of the universe, as well as in the many laboratory experiments which in the last one hundred years have lessened the physical sufferings of mankind." T. LL. H.

The Oldest of the Arts and the Youngest of the Sciences.

Animal Ecology: with especial reference to Insects. By Royal N. Chapman. Second edition. Pp. ix + 187 + 183. (Minneapolis, Minn.: Burgess-Roseberry Co., 1927.) n.p.

PRESIDENT LOWELL was assuredly wrong when he gave to *business* the title of "the oldest of the arts and the youngest of the sciences." The art by which, for example, the naked Australian black extracts the means to live from country where a white man would starve—this art of food-getting—is surely older still. It depends on an extraordinarily detailed empirical knowledge of the habits, inter-relations, and distribution of animals and plants; in other words, on the subject matter of that newest of the sciences which clamours for the attention of every thinker under names as varied as the philosophic outlook of its numerous exponents.

Prof. W. M. Wheeler, so long ago as 1902 (*Science*, N.S., vol. 15, pp. 971-976), exposed the abundant synonymy to which its wide appeal has led. The first attempts to codify this knowedge took the form of such natural histories as that of Pliny. From this general, diffuse, and impractical subject split off specialised fragments like taxonomy and its ungrateful children, morphology and physiology. By these were organisms more or less satisfactorily named, their parts and the functions of those parts described. There remained that which was the *fons et origo* of man's primitive interest in animals and plants—their relations with other organisms including himself—in other words, what they do. This residual biological science was first distinguished by Saint-Hilaire in 1859 as *ethology*—a term which we may agree with Wheeler is etymologically more appropriate and all-embracing than any of its proposed successors. These latter were Haeckel's *Oekologie* (1866) (English *œcology* or *ecology*), Ray Lankester's (1889) *bionomics*, and Whitman's, Lloyd Morgan's, and Watson's *behaviour*, to which may be added the French *comportement* and the restricted German *Biologie*.

In man's dealings with organic Nature, the life and death practical necessities of this knowledge have been hitherto met almost solely by crudely empirical or traditional means. His conquest of the inorganic world by the application of the more exact physical sciences has now brought him to the position that he must either bring increasingly the biological sciences into his relations with other organisms, or lose that civilisation which physics and chemistry have built up but cannot unaided maintain. This is essentially a matter for applied ethology. Whatever else his specialised studies have made him—agriculturist, medical man, entomologist—the grower of man's crops and his and their protector against diseases and pests must be in increasing measure an ethologist.

So long ago as 1784, Bernardin de Saint-Pierre, whose ethological viewpoint is strikingly modern, envisaged that application of the qualitative data of entomological ethology now exciting considerable and well-deserved interest in the principle of biological control, or the suppression of insect pests by means of their natural enemies. He writes:

"It is important for us to be acquainted with at least such insects as destroy those offensive to man. We might take advantage of their hostility, and convert it into the means of our own repose. The spider catches flies by a net; the ant-lion surprises ants in a tunnel of sand; and the four-winged ichneumon seizes butterflies on the wing. There is another ichneumon so small and so cunning that it lays an egg in the anus of the vine-fretter. Man has it in his power to multiply, at pleasure, the families of insects which are useful to him, and he may find the means of diminishing such as commit depredations on his agricultural possessions."

In spite of the fact that the qualitative data on insect ethology are now extraordinarily voluminous—and commensurately difficult to codify and to synthesise—they are still fundamentally and appallingly incomplete. There is probably not a single injurious insect which could be at present economically controlled on the basis of data already accumulated and without the acquirement of further merely qualitative information. We therefore regret to see that Dr. Chapman, in the work under review, scorns *qualitative* data. He has, however, performed a service of inestimable value in bringing together references to or examples of almost all the *quantitative* work which has been accomplished on the ecology of insects. He has produced a book which Oliver Wendell Holmes' specialist in the Scarabæidæ might well have regarded with dismay, but it undoubtedly indicates the type of knowledge which must form part of the equipment of the applied entomologist of the future.

The entomologist of the old school was—and is —too prone to regard the place and time of capture and the movements of the insect in view, as more or less accidental; or if the latter looked purposeful or intelligent, to ascribe them to the workings of an inscrutable 'instinct' which stood like a wall against further inquiry. This reproach applies as much to the morphologist as to the taxonomist. The specificity of insect behaviour is so great that taxonomy must inevitably form the foundation of all entomological research and the basis of all intelligent ethological work; but the economic entomologist should above all remember that it is what the insect *does* which matters. Dr. Chapman has assembled a vast amount of useful data to show what it tends to *do* under the influence of all those extremely numerous stimuli which are exerted by the inorganic and the organic environment.

It is only fair to suppose that when this mimeographed book is finally printed such slips as "voluminious," "vestigal," "stimulæ," "calabrate," "resperation," and "canabilistic" will disappear. It may also be noticed that the leafhopper which threatened the Hawaiian cane-fields was not *Pyrilla aberrans* but *Perkinsiella saccharicida* Kirk., a very different insect. J. G. MYERS.

Early Man in East Anglia.

The Antiquity of Man in East Anglia. By J. Reid Moir. Pp. xiv+172+25 plates. (Cambridge: At the University Press, 1927.) 12s. net.

MR. REID MOIR'S researches into the evidence for the antiquity of man in East Anglia have excited such widespread interest that he has done good service by summarising the results in a single convenient volume. He has provided for the specialist by giving copious references to the original papers by himself and others, in which the facts and observations were first published. He has also attempted to interest the general reader by enlivening his narrative with some popular interludes and elementary explanations. His numerous beautiful drawings and photographs add greatly to the attractiveness of the book.

Most of the work naturally deals with the Eolithic and Palæolithic divisions of the Stone Age, with which Mr. Reid Moir has been specially occupied. The evidence is chiefly that of flint implements, and as he admits that "it is very difficult, if not impossible, to tell in every case if any single flaked flint of a primitive, simple type is the result of human intention or natural fracturing, such as is caused by pressure or percussion," he begins by explaining the criteria on which he relies. He is satisfied that the 'eoliths' first found by the late Mr. Benjamin Harrison on the North Downs are "the earliest flint implements known to science, which were made by a race of ape-like people living in Kent, perhaps a million years ago." His explanation of the Eolithic plateau in Kent, however, is marred by a crude diagrammatic section across the Weald, which represents strange unconformities that do not exist. He considers that the occurrence of similar 'eoliths' in the detritus bed below the Red Crag in Suffolk fixes the geological age of this plateau, which he regards as early Pleistocene rather than late Pliocene. Both the Red and Norwich Crags are referred to the Pleistocene. All the 'eoliths,' however, are rolled and waterworn, and thus belong to an earlier period than the deposits in which they occur.

The large 'rostro-carinate' flint implements which Mr. Reid Moir was the first to recognise at the base of the Crag, are regarded as being of later date than the 'eoliths' and as forming "a connecting link between these primitive artifacts and the later palæoliths." He gives good figures of 'rostro-carinates' and various other chipped flints found associated with them, and thinks that some of the pieces of fossilised bone of the same age show traces of shaping by man.

Several early Palæolithic flint implements of the Chellean type, including one large specimen weighing 7 lb., are described as obtained from the Cromer Forest Bed. A fragment of wood, apparently yew, and a piece of fossilised bone, are supposed to have been shaped by man; and three bones discovered by Mr. A. C. Savin in the upper part of the Forest Bed at West Runton, are said to show "clearly defined cuts" which "can only have been produced by flint knives in removing the flesh."

Numerous Acheulean and later Palæolithic implements are known from several localities, of which interesting descriptions and illustrations are given. In some cases there are associated remains which afford scope for speculation. On one of the upper Palæolithic floors at Ipswich, fragments of human bones "exhibit cuts and marks of scraping and gnawing," from which it is "evident that the occupants indulged occasionally in cannibalism." On the same level were found some planks of wood and stakes, which are supposed to have been part of a wind-screen like that still constructed by the primitive Australians. Among surface finds which have also been regarded as probably of Palæolithic age, may be specially mentioned the natural cast

of a chamber of ammonite from the chalk, which Mr. Reid Moir still thinks has been touched up by man to give it the semblance of a mammoth.

To complete his account of the Old Stone Age, Mr. Reid Moir adds a short chapter on the known human remains from other localities, and concludes with some reference to East Anglian discoveries. It is difficult to believe that the very modern type of human lower jaw from Foxhall dates back to the period of the Red Crag in which it was found. The claims of the so-called Ipswich man to Palæolithic antiquity are also somewhat doubtful.

One chapter is devoted to the Neolithic period in East Anglia, with beautiful illustrations especially of the discoveries at Grime's Graves. Mr. Reid Moir suggests that these flint mines may have been begun in Palæolithic times, and includes a good photograph of the flint incised with the outline of an elk, which was discovered by Mr. Leslie Armstrong.

The men of the Bronze Age and later times in East Anglia are known chiefly from remains in burial mounds and cemeteries. There are still flint implements in some of the mounds of the Bronze Age, and a flint implement was found in each hand of a skeleton in one of the Roman cemeteries. In the latter case the implements were well patinated and clearly much older than the Roman period.

In a concluding chapter, Mr. Reid Moir discusses the place of origin and the progress of man. He thinks that England is just as likely as central Asia to have been his original home, and he pleads for a more intensive examination of the later geological deposits in Britain. He himself has long pursued the research with indefatigable zeal and with "well ordered imagination" (as he terms it), and his new book should stimulate others to follow his example. A. S. W.

Our Bookshelf.

A Graphic Table combining Logarithms and Anti-Logarithms: giving directly without Interpolation the Logarithms to Five Places of all Five-place Numbers and the Numbers to Five Places corresponding to all Five-place Logarithms; also a Graphic Table as above reading to Four Places. By Adrien Lacroix and Charles L. Ragot. Pp. xi+46. (New York: The Macmillan Co., 1926.) 6*s*.

THIS volume presents a 5-figure logarithmic and a 5-figure anti-logarithmic table in graphical form. A typical page is that providing the logarithms of the numbers 40,000 to 43,000. Twenty-five horizontal lines are divided on their upper side into 3000 parts, each about one mm. long. Every tenth division is numbered, thus forming a linear scale from 40,000 to 43,000. The lower side of each line is graduated logarithmically, these graduations extending from 0·60206 to 0·63347. Hence the logarithm of a number may be found to five decimals without interpolation by locating the point in the upper scale corresponding to the number, and then reading the lower scale at this point. The reverse process serves for the finding of a number from a given logarithm.

Although suggestive of the slide rule, the graphical table is merely one of logarithms and anti-logarithms. The advantages claimed are the elimination of interpolation, and compactness, for the table occupies only 40 pages as against 380 for a fully printed 5-figure table. The authors do not seem to be aware that such a table actually exists in Scott's "Tables of Logarithms and Anti-Logarithms to Five Places," which, incidentally, is sold at exactly the same price as their table. The choice between the two tables is entirely a matter of temperament. One computer will find the graphical table easy to use, while another will find the reading of scales irksome, as it calls into play faculties which he does not usually exercise in his profession, and so will prefer the extra labour of turning over more pages, with its compensation of the fully printed result opposite a fully printed argument.

At the end of the volume is a similar 6-page graphical table giving directly 4-figure logarithms and anti-logarithms, which would meet the needs of most workers in engineering, the field in which graphical methods are most in vogue. L. J. C.

Memoirs of the Geological Survey, Scotland. The Oil-Shales of the Lothians. Third edition. Part 1: *The Geology of the Oil Shales Fields.* By R. G. Carruthers, based on the work of H. M. Cadell and J. S. Grant Wilson. Part 2: *Methods of Working the Oil-Shales.* By H. Caldwell. Part 3: *Chemistry and Technology of the Oil-Shales.* By E. M. Bailey. Part 4: *History of the Scottish Oil-Shale Industry.* By H. R. J. Conacher. Pp. x+274+12 plates. (Edinburgh and London: His Majesty's Stationery Office; Southampton: Ordnance Survey Office.) 5*s*. 6*d*. net.

THIS memoir was first published in 1906, revised in 1912, and is now in its third edition. It deals fundamentally with the geology and technology of the Scottish oil-shales, and now, as hitherto, constitutes the standard authority on the subject, especially concerning Scottish retorting practice. Much of the section on the chemistry and technology of the shales has been rewritten by Mr. E. M. Bailey, while the methods of working the raw material have been revised by Mr. W. Caldwell. An interesting part has been added by Mr. H. R. J. Conacher on the history of the industry since its beginning in 1858 up to the present day. In other respects the volume is not greatly changed, except for the addition of several excellent illustrations and a decidedly improved version of the geological map. A sheet

of comparative vertical sections depicting stratal sequences in different areas is included and helps considerably in the visualisation of underground conditions. Considering the size and comprehensive nature of this volume, the price is remarkably modest, and a wide circulation should ensue.

Ethnographical Studies in Celebes. By Dr. Walter Kaudern. Results of the Author's Expedition to Celebes, 1917–1920. Vol. 3: *Musical Instruments in Celebes.* Pp. xiii + 322. (The Hague: Martinus Nijhoff, 1927.) 20*s.* net.

The third instalment of Dr. Kaudern's reports on his ethnographical expedition to Celebes in 1917–1920 deals with the musical instruments of the island as a whole, although the original intention was to deal with those of the Toradja. As so frequently happens, however, he found that the study of distribution of the instruments used by these tribes only lacked completeness without a study of all the groups. His own collection of instruments was large—the list given here runs to several pages—but it was in itself insufficient for his purpose. In drawing upon the material in several museums, the data of provenance, etc., were at times inadequate, and to this extent, as he himself confesses, from the absence of his own personal observation, there is necessarily sometimes a lack of precision in the information available.

The musical instruments are classified according to construction into idiophones, some of which are not truly instruments at all, being merely devices for producing a rattling sound devoid of rhythm, membranophones, cordophones, and ausphones. Several of the instruments have been introduced from outside; the bamboo flute of the schoolboy band mentioned by the author, for example, is of the common transverse form, which is not a native type. At one time there was a rule that certain instruments could be played only by certain people at certain times, but this has now died out. Dr. Kaudern's valuable study of a little known subject is very fully illustrated—a matter of the greatest importance in any work on musical instruments.

Mathematical Geography. By Prof. A. H. Jameson and Prof. M. T. M. Ormsby. Vol. 1: *Elementary Surveying and Map Projection.* Pp. ix + 154. (London: Sir Isaac Pitman and Sons, Ltd., 1927.) 5*s.* net.

Although the subjects of field-work, surveying, and map projections are intimately associated, books have been devoted previously to one or two of these sections only. The study of map projections has aroused considerable interest recently, and now we are given a book which covers the whole of this work in broad outline.

The book is in two portions, which relate respectively to surveying and projections. In the former part, the three methods, chain, plane-table, and compass, together with relevant matters, are treated with clearness. One noteworthy feature which strikes the reader is the detailed description of the apparatus and of the method of its use. In the second part the small space is utilised fully. Although all the cases, equatorial, polar, and oblique, of the projections could not be treated separately, the commonly used projections are described, their uses are considered with examples, and the student is introduced to their constructions.

The authors have wisely, though perhaps a trifle harshly, warned students against imagining projections by means of a spot of light (p. 99). Thus errors due to facile conceptions will be avoided.

The work will be welcomed by geographers for its scope and clarity, and, moreover, with the exercises appended, will prove useful to all who are interested or concerned with this subject.

J. Eling Colclough.

Problems in Psychopathology. By Dr. T. W. Mitchell. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. v + 190. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1927.) 9*s.* net.

The editor of the *British Journal of Medical Psychology* is a whole-hearted Freudian and does Freud justice. He shows how the study of hypnotism and hysteria in the late nineteenth century resulted in the development by Freud of his theory of psycho-analysis. He discusses very clearly the theory of the libido and Freud's conception of the Ego, the Super Ego, and the Id. Freud's views on the instincts are of course more or less unique, and the author, although critical, treats him fairly. In the chapter on the neuroses, he presents us with Freud's view that the repressed libido finds outlet through condensation and displacement, distortion, and disguise in neurotic symptoms. In his concluding chapter he points out in no uncertain manner that neither Jung nor Adler can be in any way considered as psychoanalysts. When Dr. Mitchell writes anything we expect a brilliant effort, and we are not disappointed in this series of lectures.

American Game Shooting. By Capt. Paul A. Curtis. Pp. xvi + 279 + 15 plates. (New York: E. P. Dutton and Co., 1927.) n.p.

Captain Curtis writes with twenty years' experience of game shooting in the United States and Canada. He admits that he is not a naturalist, but all the same he has studied closely the habits of various animals. Many naturalists might read his chapters with interest if every study of the ways of the animals were not an introduction to the best means of killing it. He deplores the decrease in wild life in America, and believes that big-game hunting in the United States is practically over; he estimates that, outside zoological gardens and the Yellowstone Park, there are only 250 grizzly bears in the United States. The author disparages indiscriminate slaughter, but the destruction of the game is surely in some measure due to the sport of hunting, of which he is so keen an advocate. He cannot expect every hunter to be so careful as he is not to overdo the sport. His own enthusiasm must contribute to the end which he deplores.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Liquid Stars.

IN NATURE of Feb. 4 (p. 173), Dr. Jeans has given an attractive exposition of his new theory of stellar evolution involving 'liquid' stars. With all goodwill towards innovations which might help to remove present difficulties of the evolutionary theory, I cannot follow Dr. Jeans's lead because I find myself in disagreement with him on two preliminary and essential points. These points, discussed separately below, have already been the subject of careful investigation, and even in Dr. Jeans's fuller papers on his theory I find no new considerations which would modify the conclusions formed.

(1) STATE OF HIGHLY IONISED MATERIAL.—The theory put forward in 1924 that stellar material is a nearly perfect gas up to densities exceeding those of terrestrial solids met with surprisingly little opposition at the time; but opposition has now come in the form of Jeans's liquid stars. Fortunately, he and I are agreed as to the extent of the ionisation. In the upper half of the main series the ions are chiefly nuclei attended by two K electrons—a structure having a radius of about 10^{-10} cm. The average distance between neighbouring ions is at least 100 times greater. Jeans assumes heavier ions than I do, but that only augments the disparity between size and separation. The hypothesis of liquid stars postulates that in this condition the ions are jammed; that is to say, their effective volumes are 100,000 times greater than the volume covered by the electron system, and the space apparently so empty is in reality packed full. The defence is (*Mon. Not. R.A.S.*, **88**, p. 736): "Even with neutral helium the effective diameter of the atoms in the liquid state is 7·4 times that of the electron orbits as calculated from Bohr's theory. No one can say what it would be if the temperature were raised from two or three degrees absolute to ten or a hundred million degrees absolute, and we might, in any case, expect atoms surrounded by a powerful electric field to have relatively larger effective diameters than neutral atoms such as that of helium." The last defence is certainly wrong. The effect of the electric fields has been investigated by Debye and Hückel, Kramers, and (with more specific reference to stellar conditions) by Rosseland, Fowler, and myself. It is not necessary to read far into these investigations to see that the electric fields make the gas superperfect and have the opposite effect to that which Jeans expects. His first defence is an *ad hoc* postulate that at high temperatures something unknown to present-day physics intervenes to give the ions what is apparently an impossibly large volume. All the evidence is that the volume diminishes with increasing temperature. Moreover, I understand that atomic volume is now generally regarded as conditioned by Pauli's exclusion principle, and I cannot think that physicists will easily be persuaded to admit the enormously extended sphere of exclusion demanded by Jeans.

Dr. Jeans's reference to atomic volume is so brief and perfunctory that I think I am not misrepresenting him in saying that he adopts liquid stars, not on grounds of physical plausibility, but for reasons somewhat as follows. He has persuaded himself that a gaseous star is necessarily unstable. Therefore a star in any one of the long-enduring stages cannot be gaseous; and if present-day atomic physics declares it to be gaseous, then so much the worse the present-day atomic physics. This is logical enough if we grant his premises—which I do not.

(2) THERMODYNAMIC INSTABILITY.—Any inclination I may have had to discuss Dr. Jeans's earlier theories of evolution was arrested at the start by disagreement as to stability; he made out to be stable the stars which I (following Russell) found unstable, and vice versa. He has now come into line with Russell and myself in agreeing that if the rate of liberation of subatomic energy E decreases as a consequence of compression the star is unstable. In the other direction agreement is still not complete. I have maintained that if E increases moderately with compression the star is stable, but too rapid a rate of increase will throw it into pulsation. Jeans does not disagree with this for the smaller stars, but he claims to have shown that for stars of mass greater than $2 \times$ sun the range of stability disappears. The cause of this divergence is pointed out by H. Vogt in the current issue of the *Astronomische Nachrichten* (No. 5545), who shows that Jeans has omitted a term in his equations, and when the term is included the range of stability does not disappear. The range of stability is, however, rather narrow, and I have long urged the consequent difficulties (NATURE, Mar. 21, 1925; May 1, 1926) which seemed to be passed over too lightly in Jeans's earlier theories of stellar evolution. I have pointed out that the range is widened indefinitely if the liberation of energy is a two-stage process with a time-lag between the formation of the active substances and their spontaneous disintegration. At present this seems the most plausible way out of the difficulty. In any case it scarcely calls for the desperate remedy of liquid stars.

With regard to the evolutionary part of his theory, I am puzzled to find these 'liquid' stars behaving very differently from the way we supposed them to do when last I (like others) believed in them five years ago. Then the effect of loss of energy and contraction was that the liquid core increased in size and diminished in temperature. This still seems to be the correct deduction. But it would rule out the increase of central temperature, with consequent jumps to states of higher ionisation, on which Jeans relies.

In refusing to follow Jeans into the fire, I do not wish to give the impression that the situation is entirely comfortable in the frying-pan. Besides numerous difficulties associated with sub-atomic energy, there is the discrepancy of a factor 10 or more which I found between the stellar absorption coefficient and the value derivable from Kramers' theory of electron capture. Although Jeans alludes to this as one of the difficulties of the gas theory, I am not sure from his discussion whether the liquidity of the stars is supposed to cure it or whether he adheres to his former view that the discrepancy is removed by assuming very heavy elements in the stellar interior. The latter possibility was examined when the discordance was discovered, and it appeared that there was little or no advantage in substituting heavy elements (*Monthly Notices*, **84**, p. 110; "The Internal Constitution of the Stars," § 168). If, on the other hand, he explains the discrepancy by liquidity, so that the perfect gas curves for giants run 2½ magnitudes above those shown in his diagram, I can only feel the more amazed at the prodigious size of his ions which in M type stars must be supposed to jam at densities ... that of air.

A. S. EDDINGTON.
Observatory, Cambridge,
Feb. 12.

I AM very glad to have seen Prof. Eddington's critical comments on the theory of liquid stars.

The difficulty as to atomic diameters, which he places in the forefront, and also in the tail, of his letter, seems to me also to be the most serious difficulty in the way of the theory. But Prof. Eddington overestimates its amount, though arguing as though I maintained that the stars were liquid throughout, from centre to surface. If a star such as Betelgeuse breaks up by fission, it probably forms a binary system with the dimensions of V Puppis. If so, considerations of angular momentum show that before fission the greater part of its mass must have resided within about a twentieth part of its radius from the centre. For this reason I imagine Betelgeuse to consist of a liquid core having a radius perhaps only five per cent. of that of the star, while the other 95 per cent. of the radius is occupied by very tenuous gas. The small core determines the dynamical behaviour of the star, because it contains most of the mass; the rest is a mere obscuring veil. In more ordinary stars the liquid core may extend over perhaps a third or a fifth of the radius.

This consideration reduces the diameters which Eddington assigns to my ions by a factor of from 3 to 20, and the ionic volumes by a factor of from 27 to 8000; for example, the concluding words of his letter should not be "densities $\frac{1}{10}$ that of air," but "densities 80 times that of air," which makes a difference.

All the same, the hypothesis admittedly requires effective diameters many times larger than the orbital diameters of the Bohr atom. What Eddington describes as my "defence" of this was only meant as a suggestion. It may be wrong, but I am surprised at Eddington describing it as "certainly wrong"; it had never occurred to me that modern quantum-dynamics was quite so sure of itself as this, especially in dealing with states of matter of which we have no experience. Meanwhile the atom, like the stars, is dissolving into radiation, and the wave-mechanics may throw new light on the matter before long. But I frankly admit the difficulty as a bit perplexing, although not in the least as fatal or insuperable.

I cannot follow either Eddington's arguments or his statements about instability, and I have not yet studied Vogt's paper in detail. I ought, however, to say that my own mathematical analysis did not confirm Eddington's conjecture as to the efficacy of a time-lag in promoting stability. With a long enough time-lag all matter is obviously reduced to the purely radioactive condition in which the liberation of energy is uninfluenced by changes of temperature and density, and I think Eddington agrees with me that gaseous stars of this type are unstable all along the line and in every conceivable configuration in which the gas laws are obeyed. I would also remark that, even if I were to concede all of Eddington's statements and arguments, the validity of the theory of liquid stars would remain absolutely untouched; his arguments are not directed against the tenability or accuracy of the theory, but only against its inevitability.

On this question, may I point out that there are only two possibilities open—in the central regions of stars, either the gas laws are obeyed or they are not. The former is the hypothesis of gaseous stars, and the latter of liquid stars. I still consider that stability considerations rule out the former, and so make the latter inevitable. But, apart from this, the theories admit of almost direct observational test, by comparing their predictions with the observed Russell diagram, which is observationally indisputable.

For the configurations possible for stars of given mass, the theory of gaseous stars predicts a system of parallel, slant, approximately straight lines. The theory of liquid stars predicts the wavy curves I showed in my article in NATURE. Seares (*Astrophys. Jour.*, 55, p. 195; 1922) has drawn the lines indicated by observation and gives a set of curves which are very wavy indeed, and show the same general characteristics as the curves requisite for liquid stars; they show no resemblance at all to the straight lines of gaseous theory.

The two opposing theories can also be tested in terms of the areas of the Russell diagram which are tenanted by stars. The theory of liquid stars predicts a diagram shaped like a hand with white dwarfs lying along the thumb. Observation shows a diagram shaped like a hand, with white dwarfs lying along the thumb, the only complication being that observation cannot reach down to where the thumb joins the hand. The theory of gaseous stars predicts merely a flat, featureless diagram, into which features can only be introduced by extraneous *ad hoc* assumptions. Yet the observed features of the Russell diagram represent the outstanding facts of physical astronomy. Consider, for example, the almost sensational fact that no star of solar mass is known with a density intermediate between 1·4 (the sun) and 50,000 (Sirius B). The atomic nuclei are 15 times as widely spaced in one star as the other, and no intermediate spacing is known to astronomy. What does it mean? Apart from liquid stars, I know of only one suggested explanation, and this is purely *ad hoc*. All stability considerations being thrown to the winds, the stars are supposed to radiate by the same mechanism as an explosive at its flash-point. The flash-points of the sun and Sirius B are supposed to be so different that one is reached at a density of 1·4, and the other only at a density of 50,000; and it is assumed that no type of stellar matter exists with a flash-point intermediate between these two extremes. Does Prof. Eddington really prefer to accept this medley of *ad hoc* assumptions rather than concede the effective diameters demanded by the theory of liquid stars? Of course, he may say he prefers neither, thereby laying himself open to the charge he brings against me of waiting for something unknown to present-day physics to turn up.

I obviously cannot occupy more space, but I think all the other points raised by Prof. Eddington are dealt with in my papers in the *Monthly Notices*.

J. H. JEANS.

The Nature and Function of Golgi Bodies.

As he attributes to me the fallacy "that things which look alike are necessarily the same," it would appear that Dr. Ludford had forgotten parts of my letter to NATURE, Jan. 21, and corresponding parts of my paper (*Proc. Roy. Soc.*, B, vol. 101, 1927), before he wrote (NATURE, Feb. 4). These parts are very important, and show that, whether right or wrong, my arguments are not based upon the fallacy that Dr. Ludford sets up, and then proceeds to knock down.

All cells contain lipins. If acetic acid is used in fixing fresh material, the appearances known as 'Golgi bodies' are absent. If no acetic acid is used in the fixative, they appear after suitable treatment. My mixtures containing lipins behave in exactly the same way. The Golgi bodies appear or are absent, under the same conditions as they appear or are absent, in fixed cells.

If the Golgi bodies are really cell structures and not the products of the treatment to which the cells are subjected, then there should be two sets of Golgi bodies in each cell, for lipins are present in the cells

in the same order of proportions as in my mixtures. I consider as untenable the comparison between the structures described by me and the manufactured nuclei and other artefacts known to "Every elementary student of physiology." The nucleus can be seen in the living cell; it appears whatever fixative be used; and though possibly distorted, it is demonstrable and recognisable whatever the treatment to which the material be subjected, short of practical disintegration.

Dr. Ludford gives "the reasons why most cytologists have come to regard the Golgi apparatus as a definite cytoplasmic structure." Many workers have done little else than describe 'Golgi bodies and apparatus'; these doubtless believe, and their faith is founded, on such reasons as those given by Dr. Ludford. But there are others who have claim to be classed as cytologists who do not, and never have, agreed with them.

I will deal with Dr. Ludford's reasons under the numbers which he attaches to them.

(1) The 'Golgi apparatus' seen in the living spermatocytes of Helix (Platner, Murray, no reference given), apart from almost certain *ante-mortem* changes taking place in the detached cells, may well be the archoplasmic vesicles which appear in the various stages of the meiotic phase, and are destined to form the cap of the sperm. They have been described as occurring in every animal specially investigated. Their destiny was known long before the invention of the 'Golgi apparatus' in anything but nerve cells, and they can be demonstrated with or without acetic acid in the fixative, presenting much the same appearance in both cases. It is claimed by the supporters of the 'Golgi apparatus' that it is present at any rate in all animal cells. These vesicles, so far as I know, have been described only in cells involved in the meiotic phase. I see no valid reason for connecting them with what Dr. Ludford and others understand by the term 'Golgi apparatus.'

(2) We are not dealing with mitochondria, and whether or not I agree with Dr. Ludford's statements regarding them, I am not attracted by this particular red herring. The rest of the paragraph is too indefinite to deal with categorically. It is to be expected that some of the appearances claimed by Dr. Ludford and others as 'Golgi apparatus' may be structures that are really present in the cell (for example, the archoplasmic vesicles already referred to), and these would be demonstrable by both what he calls 'positive' and 'negative' methods. No doubt, also, anything that saturated the unsaturated fatty acid of the lipins would, under certain conditions, give a negative picture.

(3 and 4) These reasons were dealt with very fully in my paper (*loc. cit.*, *supra*). Suffice it to say here that it has been shown that the lipin content varies enormously in the cells of different tissues, and to a less extent in the cells of the same or similar tissues, according to their physiological condition. In cells where the lipin content is large, so is the 'Golgi apparatus.' Not only does the amount of lipin vary, but the relative proportion of saturated to unsaturated lipins varies with the physiological condition of the cell, and with the tissue. In my mixtures the 'Golgi apparatus' varies according to the lipin content. In some it forms a "net-work," in others a "compact cluster round the sphere," besides assuming many other forms and positions described and figured by workers on 'Golgi bodies and apparatus.' By saturating the fatty acids one should be able to produce entirely 'negative' pictures. The 'positive' depend upon the degree of unsaturation of the lipins.

(5) I do not see why anyone should accept Dr. Ludford's statement that the "secretion granules of gland cells arise in relationship with the Golgi apparatus." Some quite competent cytologists believe, and a great number have believed during the past thirty years, that many of these granules are simply the result of the methods of fixation. Nor can I accept a statement as to the position of the 'Golgi apparatus' in relation to these granules as a valid argument in favour of its reality, when its very existence is the point in dispute.

If my interpretation of these various observations be correct, then the nature, function, and destiny of the Golgi bodies are less obscure, and we may be a little nearer to the solutions of the problems of fat transference and metabolism. Otherwise, excepting the archoplasmic vesicles of the meiotic cells, which can have, as I have tried to show, no relation to what 'most cytologists' regard as 'Golgi bodies,' there is no evidence, scarcely even a suggestion, as to the function, nature, or destiny of these structures, which are supposed to be present in all animal and many vegetable cells.

CHARLES WALKER.

The University,
Liverpool, Feb. 7.

The Luminescence of the Dogfish *Spinax niger* Cloquet.

THE arrangement and the structure of the luminous organs of *Spinax niger* Cloquet have been thoroughly described by Johann.[1] Though these organs are present on the upper surface of the head and along the back (being distributed there mainly in association with the slime canals) they are enormously more abundant on the ventral surface of the body, and also on the flanks above the pelvic region, the black pigment, with which they are everywhere associated, forming a characteristic pattern on the skin of the fish.

I have very frequently handled Spinax at sea, and watched the luminescence of specimens taken from the trawl catch. When newly caught and vigorously alive, Spinax often shows no luminescence, nor are dead specimens luminescent. But while moribund, Spinax may show a greenish-blue light very distinctly visible to the dark-adapted eye.

Spots and streaks of light appear on the back of the fish, but their effect is very feeble compared with that of the belly, which appears as a steadily-glowing sheet of light, with brighter areas about the mouth, on the pectoral fin-bases, in the pelvic region, and on the tail fin. Th. Beer, who adds a note to Johann's paper, describing his observations on an injured specimen in the Naples Aquarium, says that the intensity of luminescence varied at short intervals, and was visible at a distance of 3-4 metres.

When a luminescent specimen is held so that one's line of vision is perpendicular to the ventral surface of the fish, the luminescence is plainly visible. When the fish is then rotated slightly to left or right about its long axis, the light disappears. This observation seems to offer some explanation of the function of the luminescence of Spinax.

Johann's description and figures of the luminous organs show that each organ has a complex structure, complete with reflector, lenses, and iris-diaphragm of melanophores. Moreover, he shows that, while the organs in the middle line of the belly have their axes perpendicular to the surface of the skin, those situated on the flanks are also arranged with their axes parallel to the median vertical axis of the fish, and therefore make a considerable angle with the

[1] L. Johann, "Über eigentümliche epitheliale Gebilde u.s.w. bei *Spinax niger*," *Zeitschrift f. wiss. Zool.*, 66, pp. 136-260; 1899.

surface of the skin. This is carried to an extreme in the row of organs present on each side of the laterally compressed upturned tail. Here the organs lie with their axes almost parallel to the surface of the skin.

The complex lantern-like structure of each individual organ seems designed to throw out a parallel beam of light, and to prevent scattering of the rays; the arrangement of the axes of all the organs parallel to the median vertical axis of the fish, seems to aim at precisely the effect described above, namely, that the luminescence will only shine upon objects immediately beneath the ventral surface.

The mouth of Spinax is situated remarkably far behind the tip of the snout, so that Spinax can obviously only seize objects immediately beneath (in the relative sense) its mouth. But it is only when an object is immediately below the ventral surface of the fish that the light from the luminous organs flashes fully upon it. One may therefore suggest that the sudden flash of light, at the moment of attack, may cause the prey of Spinax to hesitate for just that fraction of a second in which the mouth can make a successful snatch.

C. F. HICKLING.

Fisheries Laboratory,
Lowestoft, Jan. 27.

An Optical Paradox.

A PARADOX propounded at a meeting of the *Physical Society may be of interest to a wider* scientific circle.

Suppose that we have two lamp sockets, connected to perfectly steady electric supplies, clamped in fixed positions on an optical bench; exactly midway between these sockets is a photometer, also clamped. The photometer field, we will say, is divided by a fine vertical line into two parts, that on the left of the line receiving light only from a lamp placed in the socket on the left side of the observer, the part on the right of the dividing line receiving light only from a lamp placed in the socket on his right. Assume also that we have a series of lamps *A*, *B*, *C*, *D* . . . *Z* proceeding in finite steps from a lamp *A*, which emits at a definite rate light of a certain quality, to a lamp *Z*, which gives at some other rate light of some other quality.

We shall not be concerned with the ways in which the output of these lamps is to be measured quantitatively or qualitatively. Fechner's law applies to visual sensations, and we can therefore construct our finite sequence of lamps connecting any two given lamps *A* and *Z* in such a way that any two consecutive lamps of the series, if placed in the two sockets on our bench, will so illuminate their respective halves of the photometer field that the most critical observer can detect no difference between them. In other words, the visual sensations corresponding to the two halves of the field are identical. To say that the sensations differ by an amount so small that the observer is unconscious of the difference is to quibble.

Let us now suppose the lamps compared by an observer who is not subject to fatigue or other disturbing factor. We start with lamp *A* in the left socket and lamp *B* on the right. Each gives rise to the same sensation, which we will call *S*. Without in any way disturbing the system to the right of the photometer, we replace lamp *A* by lamp *C*. The sensations derived from the two lamps *B* and *C* are again identical, and since the system on the right is not in any way altered the new sensations are again exactly represented by *S*. We now leave the left-hand system alone and replace *B* by *D*; the previous argument applies without change, and the sensations are still *S*. The procedure indicated can evidently be carried as far as we like, and leads to the conclusion that any two lamps, *A* and *Z*, placed at the same distance from the photometer give rise to exactly the same sensation *S*. In other words, their candle power and their colour are the same, a conclusion which is absurd.

The significance of the paradox lies in the fact that the error in the argument arises from the neglect of a consideration widely ignored in scientific work. It should be observed that the experimental principles adopted, the use of a null indication and of simple substitution, are those most approved for precise measurements.

T. SMITH.

The National Physical Laboratory,
Teddington, Middlesex,
Jan. 28.

A Simple Form of Photo-electric Photometer.

DR. N. R. CAMPBELL (*Phil. Mag.*, **111**, pp. 945, 1041; 1927) has described a new method of using a gas-filled photo-electric cell by which small illuminations can be measured by the use of a telephone only. This method is, however, only applicable to gas-filled, and not to vacuum, cells; and for accurate measurements of strong illumination the latter are much more trustworthy. It is possible by using the well-known phenomenon of the intermittent discharge through a neon lamp to employ a somewhat similar method in the case of a vacuum cell. The circuit necessary is very simple. The photo-electric cell and the neon lamp are connected in series with a high tension battery of suitable voltage, and the neon lamp is shunted with a condenser. Under these conditions intermittent flashing will occur in the lamp when the photo-electric cell is illuminated, and the frequency of the flashes will increase with the illumination. It is accordingly only necessary to time this frequency to obtain a measure of the illumination. To do this it has been found more convenient to insert a telephone in series with the shunting condenser, and to count the clicks heard in it.

Some preliminary tests of the arrangement have been carried out, and they have shown that while the method is decidedly hopeful, it will need careful investigation before it can be considered reliable. The leakage current through the neon lamp before flashing occurs evidently limits the lowest illumination that can be detected. In the commercial Osglim lamp I have employed, this current appears to be unduly large, possibly due to insufficient insulation in the cap of the lamp. To obtain the best results it will probably be necessary to use special neon tubes. Leakage in the shunting condenser may also be troublesome. The sensitivity of the apparatus can easily be altered by using a variable condenser, and hence lights of very different intensities measured. It has been found, however, that the condenser should not be made too small, as then the flash discharge tends to become irregular.

If the method proves itself capable of yielding consistent and trustworthy results, it will undoubtedly be very useful for what we might call field measurements of daylight illumination with photo-electric cells. In these cases it is always inconvenient, and sometimes impossible, to use either a sensitive galvanometer or electrometer, and the only alternative is to employ some telephonic method such as has been developed by my brother, Dr. H. H. Poole (*Scientific Proc. Royal Dublin Society*, vol. 18, No. 9; 1925), in connexion with the measurements of

submarine illumination. The new neon lamp method would be simpler, more portable, and much cheaper than this arrangement, and probably less liable to go out of order as it contains no moving parts. It remains to be seen, however, whether it can be made to give as good results.

J. H. J. POOLE.

Physical Laboratory,
Trinity College, Dublin.

The Excitation of Spectra by High Frequency Oscillations.

WITH reference to M. Ponte's letter in NATURE of Feb. 18, p. 243, may I say that my letter in the issue of Nov. 19, 1927, p. 727, did not pretend to be a full account of the development of the spectrum of mercury by the method of the electrodeless discharge, nor was it my intention to give the impression that I thought the phenomena observed were necessarily dependent on the short wave-length of the exciting oscillations. It was stated in that letter that the spectrum of mercury was examined as a preliminary to work on other substances; one of the advantages of this procedure was that mercury had already been studied by MM. E. and L. Bloch, using a similar method.

My results, however, differ from those obtained by these investigators in what I regard as an important particular. Apparently all the spectra which they photographed consisted of a large number of lines; the 'arc' lines appeared first, then the 'first spark' lines, and so on. On the other hand, I was able to develop the 'arc' spectrum in stages, first the triplet series, then the singlet series. This may have been due to the better control over the exciting conditions which is given by the valve method of generating the oscillations in the exciting coil. MM. Bloch themselves point out, in the paper to which M. Ponte (*J. de Physique*, 4, 333; 1923) refers, that they could not keep the potential constant during an exposure. The method I used permits of this being done over a long period. This has the additional advantage that a steady temperature and pressure can be realised, with the coil activated, before an exposure is made.

The account which M. Balasse gives of his work with undamped oscillations is very brief; he says that he obtained the glow spectra of mercury, cæsium, and potassium, "which only showed arc lines." He does not mention any stages in the development of these arc spectra, and I look forward to a fuller account of this work.

M. Ponte attributes the absence of the p series "to the kind of discharge employed"; I suggested that it might be due to insufficiently high potentials applied to the exciting coil. Perhaps we may mean the same thing, for I observe that many of the lines recorded by MM. Bloch as 'spark lines' are members of this series. These spark lines were excited by increasing the length of the spark used in the production of the condensed discharge passed through the coil, and this lengthening of the spark involves a higher initial discharge voltage.

I would assure Prof. Bloch and his colleagues that I know and value their work. Nevertheless, the possibility of developing spectra series by series, not merely by stages of arc, spark, and so on, was new to me. It is the use of undamped oscillations at constant voltage which renders this possible because it facilitates control of the discharge, and it is this series by series development which I regard as full of promise.

J. R. CLARKE.

Physics Department,
University of Sheffield.

The Exit of *Leishmania tropica* through the Proboscis of *Phlebotomus papatasii.*

IT has been shown (*Ann. Trop. Med. and Parasitol.*, vol. 19, No. 3, and vol. 20, No. 2) that human beings can be infected with *Leishmania tropica* by inoculation with Herpetomonas from naturally infected sandflies. It has also been shown that sandflies (*P. papatasii*) both wild and laboratory bred can be infected with *L. tropica* by feeding on oriental sores, and further, that after a certain period of development the artificially infected sandflies contain flagellates which on inoculation into man produce cutaneous leishmaniasis. The development of *L. tropica* in *P. papatasii* suggests very strongly that infection in Nature is through the bite of a sandfly, but actual experimental proof of the exit of the flagellates via the proboscis of sandflies has been hitherto lacking.

The following experiment proves beyond all shadow of doubt that *L. tropica* can be expelled from the sandfly via the proboscis.

19/1/28.—Seven specimens of *P. papatasii* ♀♀ (hatched in laboratory 17-19/1/28) fed through a membrane of rabbit skin on an emulsion of culture of *L. tropica* in inactivated rabbit blood (3000 per c.mm.).

23/1/28.—All the sandflies re-fed on a human being.

27/1/28.—One sandfly died, and on dissection was found to be heavily infected with *L. tropica.*

27/1/28.—Three sandflies re-fed through a membrane on inactivated rabbit blood. The experiment was performed at 37° C.

After the sandflies had fed, some of the inactivated rabbit blood was sown on a tube of Shortt's N.N.N. The remainder was examined microscopically. In nine coverslip preparations not a single flagellate was found.

2/2/28.—The inoculated tube was examined and found positive, that is, *L. tropica* had passed via the proboscis into the fluid above the membrane. The number of flagellates which had passed through must have been very small, because no flagellates were found in the coverslip preparations.

Further, under the conditions of the experiment, all possibility of fæcal contamination from the rectum of the sandflies was completely excluded.

The method of infecting sandflies by feeding through membranes has been described (*Ann. Trop. Med. and Parasitol.*, vol. 21, No. 2).

Further details will be given elsewhere.

S. ADLER.
O. THEODOR.

Microbiological Institute,
Hebrew University,
Jerusalem, Feb. 3.

Segmental Interchange and Crossing-over.

IN October last I published a working hypothesis for segmental interchange between homologous chromosomes (*Proc. Nat. Acad. of Sciences*, U.S.A., vol. 13, pp. 717, 718). Since that date, further work with liliaceous plants has led to an addition to this hypothesis.

It is presumed that the two strands of each homologue have breaks in the chain of genes at the leptotene stage (leptophase). These breaks are presumed to be at random in each of the two strands making up each homologue. The breaks are supposed to be only in the chain of genes, and not in the visible thread itself. They are to be regarded as places where the genes have separated far enough to be out of the sphere of mutual attraction.

In this case, if $1/x$ represents the probability of

two breaks in any particular two of the four strands present at the zygotene stage (zygophase) coinciding, then the chance for such coincidence in any two of all four strands is $6/x$. One-third of these cases of coincidence will be between sister strands of the same chromosome. Hence the chance for coincidence between two breaks at a particular point in the twin halves of opposed homologous chromosomes is $4/x$. (The chance for coincidence between four such breaks, one in each of the four strands at pachyphase, is only $1/x^3$ at any particular point.)

In any coincidence of two breaks in strands of different homologues, for which the chance at any particular point is $4/x$, we may suppose that in half the cases the ends of the same threads are reunited, and in the other half of the cases ends of different threads unite, thus forming a chiasma. Hence the chance of a chiasma, or point of segmental interchange, between homologues at any one point in the bivalent is $2/x$. Since there is no chiasma between the other two strands, $1/x$ represents the chance of segmental interchange at any one point in the chromosomes resulting from the maturation division. (The occurrence of a second, or even a third, chiasma is to be allowed for.)

Hence $1/x = c/100$, where c is the observed percentage number of cross-overs between two adjacent genes.

JOHN BELLING.

Dept. of Genetics,
Carnegie Institution of Washington,
Cold Spring Harbor,
Long Island, N.Y., Jan. 21.

Optically Excited Iodine Bands with Alternate Missing Lines.

WE have recently been studying, under improved conditions, the fluorescent bands which develop around the 'fundamental' doublets when iodine is excited, in the presence of helium, by the green mercury line. The use of a battery of four mercury arc lamps surrounding the iodine tube excites such a brilliant fluorescence that it is possible to photograph it in 24 hours in the second order of a 9-foot grating. On the plates so obtained it is apparent that only alternate lines of the corresponding absorption bands occur, namely, those for which m' is even. Now the fluorescent bands are known to be developed by collisions of the second kind between excited iodine molecules and helium atoms, wherein m' is changed from 34, the value originally excited, to various neighbouring values. The new data, then, show that the rotational quantum number of the excited iodine molecules can change only by even numbers during these collisions of the second kind.

This result, while incomprehensible on the classical Bohr-Lenz theory, is entirely in accord with the conclusions of the wave mechanics. According to the theory of Hund, successive rotational states of a symmetrical molecule, such as I_2, have, alternately, eigen-functions symmetric and antisymmetric in the two nuclei. Moreover, since the symmetric and antisymmetric eigen-functions correspond to different orientations of the spins of the two nuclei, and since these spins are presumably very loosely coupled, it is to be expected that transitions between symmetric and antisymmetric states will be very infrequent. In fact, Dennison has recently solved the long-outstanding problem of the specific heat of hydrogen by assuming that transitions between symmetric and antisymmetric states do not occur in appreciable numbers, even during the time it takes to make a measurement of specific heats.

The absence of the alternate lines in the optically excited iodine bands affords direct evidence in support of the theories of Hund and Dennison.

R. W. WOOD.
F. W. LOOMIS.
Johns Hopkins University,
New York University.

Absorption of X-Rays in Various Elements.

PROF. RICHTMYER, in a letter published in NATURE of Dec. 24, 1927, p. 915, states that he has formerly tried the formula

$$\delta_K = \frac{E_K}{E_{L_1}} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

for the ratio δ_K of the absorption cœfficients at the K-discontinuity. In the paper cited by Prof. Richtmyer (*Phys. Rev.*, **23**, p. 292, Feb. 1924) he says: "This ratio is of the same order of magnitude as, but somewhat smaller than, the ratio of the energies required to remove a single K and a single L electron from an atom of the absorber." But the formula which contains the empirical facts, and given in my letter to NATURE of Nov. 12, 1927, p. 695, is not this one but

$$\delta_K = \frac{E_K}{E_{L_3}} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Numerically, this formula (2) differs considerably from (1).

As the notations may easily cause confusion, I wish to point out the different meanings of the two equations.

There exists three energy-levels in the L-group which have been designed by L_1, L_2, and L_3, where L_1 is much more marked than the two others. In the system of notation introduced by Bohr these levels were designated by L_{III}, L_{II}, and L_I respectively; that is, L_1 corresponds to L_{III} and L_3 to L_I. The fact that L_1 (or L_{III}) is the most prominent level in the L-group might explain why the true formula (2) containing the less prominent level L_3 or L_I has up to this time escaped observation.

As will be seen from my doctorate dissertation, the experimental results found by Prof. Richtmyer also fit very well with the two laws described in my former letter.

EDVIN JÖNSSON.
Physical Laboratory,
University, Upsala, Sweden,
Jan. 9.

Inflammable Gas from Plants.

IN Prof. Findlay's letter in NATURE of Jan. 14, he refers to Black's statement that "the *Dictamnus Fraxinella* emits" marsh gas "from its flowers," and asks for information on the topic.

Black undoubtedly alluded to *Dictamnus albus*, the fraxinella or dittany of southern Europe and central Asia, an old inhabitant of country gardens, which has showy, varicoloured, fragrant flowers. The plant is covered with glands that secrete a volatile oil, and in hot weather the air about the plant sometimes becomes inflammable therefrom.

According to Schimmel and Company (*Geschäftsber*, Oct. 1906) oil of white dittany contains 85 per cent. of pulegone, of which it smells strongly. Pulegone, or pulegenone, has been described by Semmler (*Ber.*, **35**, 1022; 1902), and by Wallach (*Ann.*, **329**, 125; 1903).

W. A. HAMOR.
(Assistant Director.)
Mellon Institute of Industrial Research,
Pittsburgh, Pa.,
Jan. 30.

Engines.[1]

By Prof. E. N. DA C. ANDRADE.

THERE is a certain appropriateness in 'Engines' as a subject for Christmas lectures at the Royal Institution. Most engines are machines for converting heat into work, and the first man to show experimentally the connexion between heat and work was Count Rumford, who founded the Institution in 1799. The original purpose of the Institution was "for diffusing the knowledge, and facilitating the general introduction of useful mechanical inventions and improvements; and for teaching by courses of philosophical lectures and experiments the applications of science to the common purposes of life." A course of lectures on engines certainly complies closely with this plan. While if it be urged that a physicist trained to occupy himself with vibrations and atoms should not meddle with things outside the usual scope of his studies, the physicist may, perhaps, without exposing himself to the absurd charge of arrogantly claiming kinship with so great a philosopher, point out that Thomas Young lectured at the Royal Institution on architecture and carpentry, on machinery, on hydraulics, and on what he called pneumatic machines, which included Newcomen's and Watt's engines, and the locomotive. In more recent times the present distinguished Fullerian professor of chemistry has lectured on trades. Precedent, then, is not lacking for the choice of so mechanic (using the word in the Shakespearian sense) a subject by a physicist.

Anything about engines has a claim on the attention of a juvenile auditory, but naturally with so vast a subject it is particularly necessary to have a very definite plan if the lectures are to be coherent. It was decided to make the course an illustrative commentary on the first two laws of thermodynamics, pointing out with a variety of examples how these laws operated, but carefully refraining from mentioning them by name, for fear of creating alarm and despondency in the juvenile ranks. The second law of thermodynamics may be held to be tough meat for the young, but it is perfectly easy to make boys and girls understand that you must have two different temperatures if heat is to be turned into work; to point out the two different temperatures in the case of each particular engine; and to show how there is always a striving on the part of the engineer to make the difference between these two temperatures as large as possible, because that enables us to turn the greatest fraction of our heat into work. The two laws were condensed in the phrases "Heat is work and work is heat" and "Lost temperature is lost opportunity," forms open, maybe, to criticism, but which proved convenient reminders of the substance of the rules. The last lecture was devoted to refrigerating engines, with the particular object of bringing home the essential character of the heat engine by showing what happens when it is driven backwards.

The chief difficulty in a course of Royal Institution lectures on engines is clearly the question of experiments and demonstrations. Some two hundred and fifty slides were prepared or borrowed, which helped to provide the necessary something-to-look-at. There is a certain number of simple experiments on mechanics and heat—on vapour pressure and steam, on explosions and on refrigeration—which can be conveniently shown to a large audience. Something more is needed, however, to give the lectures an engineering character, and that something was supplied by a large assortment of actual component parts of engines, and of models of engines and mechanisms, which the lecturer was fortunate enough to obtain on loan. Foremost among the lenders were the Science Museum, the director of which, Sir Henry Lyons, gave the most generous aid, and Mr. George Cussons, of Manchester, whose firm makes excellent working section models of all the chief types of engines and mechanisms, which proved admirably adapted for exhibition to a large audience. Loans from these sources were in evidence at nearly every lecture. Many other gentlemen[2] lent models of the products of their particular firms, models which proved a source of great interest.

In the first lecture, "The Rules which all Engines must obey," it was pointed out that, if there were no friction, the work done by any mechanism of pulleys, screws, or levers would be equal to the work done on the mechanism, but that, owing to friction, it was actually always less. A model hydraulic accumulator was used to emphasise the conservation of energy, and the meaning of power: a little pump slowly forced in the water which raised the accumulator piston, and then the energy so stored was quickly released to crush a cylinder of plasticine in a press. Talk of friction led to ball and roller bearing, and the Michell thrust block. A heavy wheel mounted on Skefko ball bearings (which, although it weighed some hundreds of pounds, turned to a silk handkerchief thrown on the spokes), and an air-lubricated model on the Michell principle provided practical illustrations. From the fact that diminished friction means diminished heat at bearings, passage was made to examples of great friction producing great heat, illustrated by the stock experiment of boiling ether in a rotating copper tube by friction against a wooden holder, the vapour blowing out a cork. Foucault's disc was used to show that, no matter how the resistance to motion arises, work done is turned into heat if no other effect is produced. Simple analogies of money changing were invoked to make clear the first law of thermodynamics. The fact that to convert heat into work special

[1] Summary of the one hundred and second course of Juvenile Christmas Lectures delivered at the Royal Institution on Dec. 29, 31, 1927, and Jan. 3, 5, 7, 10, 1928.

[2] Whose services will be acknowledged in the book which the writer is now preparing, to be published by Messrs. G. Bell and Sons.

conditions are necessary was then simply discussed, and the second law presented from the point of view already mentioned.

In the second lecture, "Learning about Steam," the meaning of vapour pressure and the simple properties of steam — such as the variation of boiling point with pressure, and the difference between saturated and superheated steam—were explained. The experiments on this point included lighting a cigarette at a jet of superheated steam. It was pointed out that steam is only an intermediary in the conversion of heat into work, and has no magical virtues of its own, and, to emphasise this, model engines were made to work with alcohol vapour, hot air, and liquid air. The creation of a partial vacuum by condensation of steam was discussed, with special reference to condensers.

The elementary properties of steam having been exposed, it was possible to run rapidly through the early history of the steam engine. A model working on Savery's principle, and the Science Museum model of Newcomen's atmospheric engine, were shown. Attention was directed to the experiments and inventions of Watt, in particular the separate condenser, the closed-in cylinder, the double-acting engine and the governor. It was mentioned incidentally that Watt did not invent the steam engine. This has caused abundant comment, and has made it clear that the belief that Watt did invent the steam engine is much more widely spread than the lecturer supposed.

The third lecture dealt with the reciprocating engine. First of all, methods of changing reciprocating into rotary and rotary into reciprocating motion were discussed—crank, eccentric, cam, and swash-plate, or slant. This last, an invention of Watt's, is now applied in the so-called crankless engine. A few words were said on valves and valve gear, in connexion with which models built of Meccano strips were demonstrated. The consequences of the modern use of high-pressure steam, the main advance since Watt's time, were mentioned, and the meaning and advantages of compounding briefly explained. The marine reciprocating engine was illustrated by a very fine model lent by Mr. Scott, of Michell Bearings, Ltd., a model which roused enthusiasm and envy among the juveniles. The merits and demerits of the steam locomotive were then discussed, the flexibility on one hand, and the waste consequent on the lack of a condenser on the other hand, being among the points mentioned. The locomotives built for different purposes nowadays differ widely in design, a great contrast being, for example, provided by the enormous American articulated goods locomotives and the elegant high-speed 'crack' English passenger locomotives. The lecturer ventured to put in a word on the beauty of the modern locomotive, in which the English practical genius finds artistic expression, and encouraged boys to continue to admire such engines as the *King George V.*, the *Royal Scot*, and the *Lord Nelson*.

The fourth lecture dealt with turbines. The simplest principle of converting the energy of a moving fluid into energy of rotary motion was illustrated by the windmill, in connexion with which the question of best speed of running was raised. The de Laval turbine led from this to the principle of velocity compounding and pressure compounding. The difference between an impulse and a reaction turbine was illustrated by a model consisting of two bicycle wheels, to the rim of one of which small rockets could be fastened obliquely. When the rockets were lit, the wheel to which they were attached rotated rapidly by the reaction principle if it was free. If, however, this wheel was held, and the other wheel, provided with oblique cup-like projections, brought near to it, then the rockets blew the second wheel round by the impulse principle.

The services of Sir Charles Parsons, who was called the Watt of the turbine, were then outlined, and a large number of slides of different turbines and components were shown, in particular of the Chicago 50,000 kilowatt installation. The special problems of the marine turbine—reversing and gearing—were then indicated. Finally, the turbine locomotive was mentioned, with a special word on the condenser which is fundamental for such a machine.

The subject of the fifth lecture was the internal combustion engine, where the heat is generated in the cylinder itself. Some explosions of gaseous mixtures in long tubes served to illustrate certain fundamental points of the gaseous explosion, such as finite velocity of travel and the effect of confinement. The fundamental importance of the compression stroke was emphasised, and the question of 'knock' consequent upon excessive compression and of anti-knock substances briefly handled. After gas engine and petrol engine followed the Diesel engine, simple physical experiments being shown to demonstrate the heating of air by compression. Two beautiful working sectioned models, some seven feet high, lent by Messrs. Burmeister and Wain, helped to make the action of the Diesel clear. The lecture closed with a word about the Still engine and the new Kitson-Still locomotive.

In the last lecture the principles of refrigeration were discussed, both the absorption and the vapour-compression plan. Water was very rapidly frozen on the Carré principle, by the use of a modern fast-sucking pump. The important part played by mechanical refrigeration in modern life was stressed, examples ranging from mining to food preserving and from ice-making to oxygen-making being cited. After the principles of the vapour compression machine had been demonstrated, the two laws of thermodynamics were restated and now mentioned by name. A simple illustration was provided by the help of a step ladder and a pile of flat wooden blocks, painted 'heat' on one side and 'work' on the other. Starting with the pile at the top of the ladder, it was explained that one unit could be turned from heat to work for every step of temperature through which the pile descended, and the conversion was effected by lifting a block and turning it round. When the heat was at atmospheric level, refrigeration was produced, the heat being made to go up a step by turning a unit of work into heat, and adding it to the pile.

In conclusion, the lecturer put in a plea for the recognition of the importance of a sound foundation of physics for engineering students, and ventured to ask if, perhaps, a little too much stress was not sometimes laid on workshop experience and the 'start at the bottom and sweep up the shavings' precepts. He suggested that workshop experience could always be acquired, but that unless physics was learnt early in life, it was never learnt properly. He therefore told his young listeners that if they wanted to be engineers—good engineers—they must study the working of the few simple rules of mechanics and physics of the operation of which they had seen so many examples in the course of the lectures.

Voices Across the Sea.

A JOINT meeting of the Institute of Electrical Engineers in New York and the Institution of Electrical Engineers in London was held on Feb. 16, between 10.30 and 11 A.M. New York time, and 3.30 and 4 P.M. London time. The occasion was the discussion of a paper on trans-Atlantic telephony at New York. For this purpose the telephone system connecting Great Britain with the United States was employed. Loud speakers were used, so that everyone in the Council Room and Lecture Room of the London Institution heard with perfect distinctness everything that was said by the speakers. Similarly, everyone in New York, at both the principal meeting and the overflow meeting, heard the speeches with perfect clearness, the disturbance from atmospherics being quite negligible.

Mr. Gherardi, the president of the American Institute, moved that Mr. Page, the president of the English Institution, take the chair at the joint meeting. This was agreed to unanimously. Mr. Page then invited Mr. Gherardi to address the meeting. Mr. Gherardi said that in the auditorium from which he was speaking there were present about a thousand electrical engineers, who came from all parts of the New World. He said that, as the result of the accumulated work of the scientific worker, the inventor, and the electrical engineer, this joint meeting had been made possible. In particular he mentioned Faraday, Maxwell, and Kelvin as having laid the foundations on which their art was built. Starting in 1876 with instruments and lines which with difficulty permitted communication over a few miles, telephone conversation now spanned the Atlantic. It had added yet another tie to the many uniting the two electrical institutions.

Mr. Page in his reply said that he represented the thirteen thousand members of the English Institution. He spoke feelingly of the boon that Graham Bell gave to the world by the invention of the telephone. His memory, along with that of Franklin and Henry, will ever be cherished as benefactors of mankind. He paid tribute to the great American Institution which has contributed so largely to the progress of electrical science, and has proved over and over again that the benefits conferred by engineering are truly international.

Colonel Purves, the engineer-in-chief to the Post Office, said it was a privilege to participate in a pioneer demonstration of a wider use of telephony which would tend to bring nations into closer relationship. It was a great thing that two large assemblies, separated by a wide expanse of ocean, could join together in interchanging their thoughts and ideas by the simple and natural medium of direct speech. It will conduce to a better mutual understanding. As we sit and talk to each other our speech is launched into the air by the radio transmitting stations at Rugby and at Rocky Point with an electromagnetic wave energy of more than 80 horse-power. By various refinements and special devices the speech-carrying efficiency of each unit is many thousands of times greater than that of an equivalent amount of power radiated by an ordinary broadcasting station. General Carty, of the American Telephone and Telegraph Company, brought forward a motion to the joint meeting that it express feelings of deep satisfaction that recent advances in radio communication have made it possible to have international assemblies, which should prove to be powerful agencies in the increase of goodwill and understanding among the nations.

In seconding the motion, Sir Oliver Lodge pointed out the various causes that have contributed to the success of radio communication. In the first place, there was the invention of the telephone. Next, in order to transmit speech by ether waves it was necessary to harness electrons by a thermionic valve. That ether waves are constrained by the atmosphere to follow the curvature of the earth's surface is an unexpected bonus on the part of Providence, such as is sometimes vouchsafed on behalf of human effort. The actual achievement of to-day is due to the scientific and engineering skill of many workers, both those in the background and those whose names are familiar to the public. The motion was then put by the chairman and carried unanimously. The meeting was then adjourned, the chairman adding 'good-bye.'

Before the joint meeting a film entitled 'Voices across the Sea' was shown, illustrating the processes that have to be gone through before a person in San Francisco can get into oral communication with a person in Plymouth. The path of the waves by the wires and over the ocean was indicated by luminous lines in motion. The delays at the various stations were also indicated, the whole operation before the lines were complete for speech taking only two or three minutes. From San Francisco to New York is by land line. The next link is to the transmitting station at Rocky Point, Long Island, then by radio to Cupar, and thence to Plymouth by land lines. The first link of the return journey is to Rugby, then by radio to Houlton, Maine, and so to San Francisco. The length of the radio link is about 3000 miles.

Obituary.

Prof. H. A. Lorentz, For. Mem. R.S.

HENDRIK ANTOON LORENTZ, whose death on Feb. 4 has already been recorded in our columns, was the subject of an article by Sir Joseph Larmor in NATURE of Jan. 6, 1923, when we had the privilege of reproducing his portrait in our Scientific Worthies series. Reference must be made to this article for a complete account of his scientific work and its significance in the progress of physics. It will suffice to state here that Lorentz was born at Arnheim, Holland, on July 18, 1853, and received his early training at the University of Leyden, where he became professor of theoretical physics in 1878. In 1902 he received the Nobel Prize for Physics; in 1905 he was elected a foreign member of the Royal Society; three years later he received its Rumford Medal, and in 1918 the Copley Medal. Such was his record; his personal qualities are described in the following brief messages with which we have been favoured.

EVERY student of the physical sciences knows the magnificent work of Lorentz: and his contributions have already been warmly and ably explained to the world. It may be justifiable to write a few words concerning the part that he played as a leader in international science, for that is less well known.

For many years Lorentz naturally and by general consent took the leading place in every European conference of physicists. He had won the affection and respect of men from all countries. He could use several languages fluently and accurately. He could grasp quickly the meaning of a speaker, and immediately on the termination of an address he could repeat its arguments and conclusions in such other languages as might be desirable, so that all present were kept in touch with one another. He never allowed a discussion to stray.

Nevertheless, even his great abilities and his sound judgment would not alone have made Lorentz the perfect president that he was. His success was due also to a wonderful and most attractive courtliness, to a humour that could express itself in not one language alone, and not least to the charm of a kindly and affectionate disposition. He was really beloved by all who sat under him. In his own field, and that no insignificant one, he was one of the forces that drew together men of different nations and brought them to a mutual understanding. W. H. BRAGG.

IN thinking of Prof. Lorentz one calls to mind, before all scientific achievements, his charming personality. A familiar figure at international and other conferences, speaking fluently several languages, he delighted everyone with his happy speeches and engaging simplicity of manner. There was no eccentricity of genius about him; he was just one of the simplest and most likeable of men. He must have wielded an immense influence, for he had come to occupy a unique place in the esteem of scientific men of all nations. Meeting him last autumn at the Conference at Como, I could see no sign of any failure of activity; and his mind was always young and able to enter with zest into the latest and most difficult advances of physics. In his long career he produced much work of the highest rank. The older work is now part of the commonplace matter of physics which we learn without thinking very much as to who originated it, and it is not easy to recollect at short notice the numerous developments that we owe to him. But his name recalls especially the Lorentz transformation, the culminating point of one phase of electrodynamic theory and the foundation stone of the next—relativity. I think it would be from about 1895 to 1902 that Lorentz and Larmor between them created a new chapter in electrodynamics. This development had two sides, one concerned with the effect of motion on all kinds of phenomena, and the other with the transition from Maxwell's continuous theory to the theory of electrons. I can well remember (as a student about 1905) how exciting was the escape from the old elastic solid ethers with their specific inductive capacities and other conventionalised conceptions to this new world of electrons. Lorentz's "Versuch einer Theorie" (the abbreviation is so familiar that one forgets there must have been some more of the title) alongside Larmor's "Æther and Matter" was the opening to the new physics; and what an opening it has proved! A. S. EDDINGTON.

MY own connexion with Lorentz, or rather with his works, goes back into a somewhat distant past. I took my degree at Cambridge in 1876, a few months after he had graduated at Leyden. A conversation with Stokes directed me to optics, Fresnel's wave surface, and the laws of double refraction as a first subject of investigation, and made me acquainted with Lorentz's dissertation on the reflection and refraction of light. From that time on I learnt to admire his work, and as the years passed on to recognise in him a master of physical science. Only some few weeks since I became possessed of the first volume of his lectures just published, and read again with increased feelings of regard and admiration some of that earlier work.

But to pass on. Lodge's paper on aberration problems aroused afresh the interest in the Michelson and Morley experiment of 1887; I think it was in June of 1893, when Fitzgerald was examining in the Natural Sciences Tripos along with J. J. Thomson, that he told us one evening in Thomson's rooms of his explanation of the difficulty—the brilliant baseless guess of an Irish genius we thought it at the time—he had given it in his lectures, he said, and then rather later we learnt of Lorentz's work and his paper in the *Transactions of the Amsterdam Academy of Sciences*. Little did we realise at that time all that was involved in the Lorentz transformation and his brilliant investigations into the laws of electromagnetism applied to moving media.

For me, however, much personal contact with Lorentz did not come until later; administrative work at the National Physical Laboratory severed in great measure my connexion with theoretical physics, but in 1922 I met him again at a meeting of the International Research Council at Brussels. The Council had been formed in 1919 to consist of allies and neutral nations replacing the former Association of Academies. Holland became a member at an early date, and Lorentz realised that, in many directions for the advancement of natural knowledge, the co-operation of the Central Powers was a matter of necessity. To this end he worked, feeling, as he wrote in 1925, that "the time had come to give as soon as possible to scientific effort that character of universality which, as a consequence of the nature of science, it ought to possess, believing that the action which he desired the Assembly to take would show a confidence in the future which could not fail to call forth a reciprocal feeling and assist in scattering the shadows darkening the life of nations."

Those of us who, in 1926, after the president, M. Emile Picard, had declared the proposal to invite Germany, Austria, Hungary, and Bulgaria to join the Council, to be carried by the unanimous votes of the 25 countries present, listened to his speech of thanks realised, if we had not known it before, that Lorentz was a great man, not only an eminent man of science, but also one who for his efforts in the cause of peace in science had fitly earned the gratitude of all who hold that on the growth of scientific knowledge depends the future welfare of mankind.

The International Research Council meets again in Brussels this summer. Is it a vain hope that at that meeting all nations may unite in doing honour to the memory of a man whose devotion to the cause of science has been so great, and whose work has proved a starting-point of one of the most marked advances of our time?

Richard Glazebrook.

In 1879, Maxwell was taken away in the prime of life, leaving behind him a mass of unfinished problems which seemed to call for the special genius of a Maxwell for their solution. It soon became clear that his mantle had fallen in a very special degree on the young Dutch mathematician who had just been appointed, at the early age of twenty-five, to the chair of theoretical physics at Leyden.

Lorentz took up in turn almost all the unfinished threads of Maxwell's work and carried them at least to the stage which Maxwell might have hoped to reach in a normal span of life, and often far beyond. He examined the effects of fine-grainedness of structure of media which Maxwell had treated as continuous; he took account of the mass of electrical charges which Maxwell had been content to neglect. These last investigations assumed great importance after the electron had been unearthed experimentally and established in its proper place in physics. Indeed, Lorentz's name is very specially associated with the mathematical theory of electrons, and his immediate explanation of the newly discovered Zeeman effect was one of his most sensational, although perhaps not one of his greatest, achievements. Whereas Maxwell had generally disregarded the effects of motion through the ether, Lorentz set to work to correlate the phenomena observable in systems at rest with those of systems in motion. He got so far as to show that the two sets of phenomena would be the same except for slight differences, imperceptible in practice, such as might be attributed to small (second-order) differences in clocks and measuring-rods. But this edifice needed for its consolidation a theory which ultimately came from other hands.

The aims of the two men were the same, but not their methods. Maxwell's science was an enchanted fairyland in which no one knew what magic would happen next. Lorentz's science was a workshop, in which tools of exquisite precision were fashioned with infinite care in view of all the world, and turned to their prearranged purposes; one almost seemed to see science growing according to plan.

Lorentz was beloved by all who had the honour of knowing him; the present writer can pay special tribute to his unfailing kindness and patience in discussing problems with men of a younger generation who had no conceivable claims on his time. Our admiration for his achievements is unbounded, but we will remember him mainly as our genial, kindly, and very human friend.

J. H. Jeans.

There is a remarkable unity, for the most part, in the work of Lorentz, converging as it does on the great purpose, to frame if possible a consistent theory of electricity and light and their mutual relations, and to clear up the obscurities inherent in these subjects, which are scarcely yet entirely dissipated. His studies on thermodynamics and radiation and gas theory may be recognised as all ancillary to the main purpose. To survey the titles alone of his published papers, in anything like a chronological sequence, is to recall the successive stages in a long endeavour which culminated in the theory of electrons and (in a restricted sense) of relativity. It is unfortunate from this point of view that the issue of his collected papers, begun in 1907, has not been continued. It was characteristic of the writer, though perhaps to be regretted on historical grounds, that he could not resist the very natural temptation, in a progressive subject, to revise and even to rewrite many of these by the light of further knowledge and reflection. It is to be hoped, in the interests of scientific history, that the publication will before long be continued and completed, as a fitting memorial of a great and effective genius.

The contents of the volume already published show that his interests were not wholly restricted to the speculations referred to, absorbing as these were. We find, for example, a paper on the turbulent flow of water in pipes. The theoretical work of Reynolds is here presented in a simplified form, and a novel attempt is made to find, on theoretical grounds, a limiting value of the 'critical

velocity.' The paper was probably the first introduction of the matter to continental readers. We find, again, an elegant mathematical paper on viscous motion of fluids, in which a certain 'reciprocal theorem' is used to extend somewhat the range of soluble problems. There is also an interesting discussion of the Hertzian dynamics, which was attractive, no doubt, for the 'geodesic' principle on which it is based. Finally, we may mention an elegant article on the classification of crystal forms.

To British investigators, Lorentz was ever a most sympathetic figure. This was due partly to his mastery of our language, which made personal relations easy, partly to his keen admiration of the work of the great English leaders of his time (notably Maxwell), and above all to the transparent kindliness and charm of his character, with its strict integrity, and the engaging candour with which he always admitted and even emphasised such difficulties as he had not been able to surmount.

H. LAMB.

THE unexpected death of Prof. Lorentz, premature not in years but in intellect, removes from the world a gracious figure, that will stand in the range of succession of other past leaders—Volta, Davy, Ampère, Faraday, Hamilton, Stokes, Helmholtz, Kelvin, Kirchhoff, Maxwell, Rayleigh, Boltzmann, Willard Gibbs, Hertz, Poincaré—in the development of physical ideas, especially on the side of the consolidation of theory. The main characteristic which he exhibited, most prominently in recent years, has been great rapidity of assimilation, resulting in conciseness and clarity of exposition, over all the field of mathematical physics. This has always been a welcome feature to his colleagues in Great Britain, brought up, from the mode of their education, towards width of outlook. He was the ideal leader for an international congress, for he was the most learned and rapid of contemporary physicists. Of necessity, therefore, he took his knowledge from where he could most readily find it; and perhaps the work of the great originating minds of the British school was not so fully before him historically as it has been to their own countrymen—as indeed on occasion he has been the first to admit. When one considers his fifty years of scientific activity, absolutely in the front rank, the zest and power with which in recent years he has thrown himself into new phases of physical development, such as relativity and *quanta*, often problematical and perplexing to older modes of thought, have been most remarkable. He has been an outstanding ornament of the Dutch school, and of their historic university of Leyden: and when one looks around for his peers the name of Huygens is apt to rise to mind.

JOSEPH LARMOR.

THE concentrated power of the human mind is illustrated by the achievements of mathematical physicists more decisively than by any other pursuit. The miracle does not lie in the working out of equations, but in the dissection and recognition of the essential operations of natural law with such completeness and clarity that the construction of equations to represent the intrinsic forces at work becomes possible. The deduction of consequences then naturally follows, or can be left to time.

In addition to analytical power, H. A. Lorentz had an exceptionally clear perception of the essentials of a physical process, and was able to state them with novel precision. He had thus the rare and enviable power of dealing with elementary and familiar facts in such a way as to interest advanced experts; for he could display unexpected connexions, and disentangle unforeseen contradictions, even in subjects which have long been taught superficially to first-year students. In this illuminating and clarifying power he has been likened to the late Lord Rayleigh, and the comparison is just. The difference was that Lorentz was a professor with worshipful students who took down and published some of his lectures, whereas Rayleigh had for the most part to range over the field of physical science by himself. Both clarified everything they touched. The way in which Lorentz's work dovetailed into, and often heralded, some of the modern developments—a search for invariants and the like,—his thorough grasp of the knowledge of his time, and his many steps over the border into new territory, have been dealt with in NATURE of Jan. 6, 1923, by a master mind: the only defect being that Larmor's own precursory or simultaneous contributions, which enabled him to appreciate so quickly the work of Lorentz, have been slurred over or ignored in that appreciative article.

In the past, too much of Lorentz's work has been partially buried in the *Archives Néerlandaises*, or has been made known only through lecture notes. A collection of his papers for English-speaking countries would be a great help; they might serve to recall attention to the physical bearing of some of the recondite speculations and revolutionary methods of treatment now in vogue, and help to re-establish connexion with much that has gone before.

Where so much has been done, it may seem trivial to pick out a single instance of Lorentz's scientific insight, but I was personally concerned in verifying the Zeeman dissection of spectrum lines by a magnetic field, at an early stage ("Yearbook of the Royal Society for 1897," **98**, p. 119), and could appreciate the almost contemporaneous electron-orbit precessional theory of Lorentz. It is well known that he anticipated or predicted a number of subsidiary details, about polarisation and the like, which were forthwith abundantly verified by observation.

I had the pleasure of entertaining Prof. and Mme. Lorentz at Edgbaston on the occasion of the conferment of an honorary degree, and they became our valued friends. With his scientific or philosophic outlook I found myself in close sympathy.

OLIVER LODGE.

I CANNOT pretend to write any appreciation of Lorentz's scientific work. I have only known him as chairman of a small international body of which I am a member, the committee set up by the League of Nations to provide the machinery

of international co-operation, when required, in questions of science, arts, and letters. It is generally known as the C.I.C. or Committee of Intellectual Co-operation.

The first chairman was the philosopher Bergson, a swift and subtle thinker, a man of infinite accomplishments, accustomed to the great world, and a speaker of distinguished eloquence, equally at home in French and English. When Bergson retired, it seemed almost impossible to fill his place, until someone—I have been told it was his pupil Einstein—suggested the name of Lorentz. He was not at the time a member of the committee, but as soon as he came among us he impressed all his colleagues as the right man. He had not the brilliance or the diplomatic power of Bergson; but his patience and courtesy, his imperturbable fair-mindedness, his transparent simplicity and goodwill, together with his great scientific eminence and his easy command of English, French, and German, gave him at once the entire confidence and affection of the committee. He had the advantage, of course, of coming from a neutral country; he had no old enmities to forget, and his own devotion to the cause of international appeasement and common sense was so obvious that one never spoke of it. It could be taken for granted.

All the multifarious undertakings of the committee come before the chairman, and Lorentz had to arrange for the consideration of problems of bibliography, of art, and even of law, as well as of science proper. He never failed in lucidity and never lost patience. But above all he enabled his literary colleagues to understand and appreciate the noble simplicity of a great mind genuinely devoted to science. GILBERT MURRAY.

ALL physicists, young and old, realise and appreciate the importance of Lorentz's work. Those who are old enough to be his contemporaries, who read his papers as they appeared, or rather as they were translated, who know the views prevalent before they came out and the changes they produced, can perhaps realise more easily than the younger men the effect of his work and the magnitude of the influence it has had on the progress of science. This feeling will be especially acute in those who more than fifty years ago were convinced of the truth of Maxwell's theory of light and interested in its development, for Lorentz was the first pioneer of Maxwell's theory.

Lorentz's first work, a dissertation for the doctor's degree in 1875, was an application of Maxwell's theory to the problem of the reflection and refraction of light by dielectrics and also by metals. This, so far as my knowledge goes, was the first application of Maxwell's theory other than those made by Maxwell himself. This was followed by a still more important paper on the relation between the refractive index and the density of bodies; this was the first application of Maxwell's theory to a medium consisting of discrete molecules which could be polarised by electric forces. We have in the same connexion his great memoirs, "La Théorie électromagnétique de Maxwell et son application aux corps mouvants" (1892) and "Versuch einer Theorie der elektrischen und optischen Erscheinungen in bewegten Körpern" (1895), the second of these being the beginning of the great subject of relativity.

There is no space here to discuss Lorentz's work in any detail; it covered so much ground and his papers throw so much light on the state of scientific opinion when they were written that an edition of collected papers, which it is to be hoped will be one of the ways in which his memory will be commemorated, would supply invaluable material for the history of physics during the past half-century.

Lorentz's services to science were not confined to his own researches; he was an admirable expositor in many languages. Those who heard him give in 1923 the Rede Lecture in Cambridge on Maxwell's electromagnetic theory will remember that without any notes he spoke for an hour in perfect English, never hesitating for a word. In addition to expressing his own ideas clearly, he was remarkably quick at understanding the ideas of other people, and often, though he might not agree with them, put them more clearly than their author. These qualities, combined with unfailing courtesy and kindliness, made him unrivalled as the chairman at a scientific conference. He was, I should think, the most cosmopolitan man of science that ever lived. He travelled widely in many countries, and there can be but few universities either in the Old World or the New in which he had not lectured and inspired and encouraged both teachers and students, and stimulated them to undertake further investigations. Besides his own researches, great as these are, science owes to him many others of which he was directly or indirectly the begetter. J. J. THOMSON.

THE news of Prof. Lorentz's death will be heard with deep regret by many friends in England and Scotland who had come under the influence of his remarkable personal charm, and admired him for his grace, sincerity, and kindliness, no less than for his great scientific achievements.

Lorentz's fame will, I think, ultimately rest chiefly on his electron-theory and all that followed from it. The essential characteristics of this theory were that all electric, magnetic, and optical phenomena were supposed to be due to the presence or motion of individual electric charges, constituting the link between ponderable matter on one hand, and the ether on the other. Matter and ether were supposed not to interact directly, and to be capable of influencing each other only through the mediation of electrons: moreover, the electrons were assumed not to interact directly (as they had been supposed to do in the older electron-theories), and to be capable of influencing each other only through the mediation of the ether. The ether itself was conceived to be at rest everywhere and at all times, whereas in the earlier theories it had been regarded as entangled with the particles of bodies, and carried along with these when they

move: Lorentz's ether was, in fact, merely space endowed with certain properties. The general plan of the investigation was to reduce all the complicated cases of electric and magnetic action, *e.g.* the properties of dielectrics, metallic conduction, metallic reflection, the Hall effect, etc., to one simple and fundamental case, in which the field contained only free ether with electrons at rest or moving in it.

The theory was remarkably successful, unifying and simplifying everything, and, in particular, reconciling the electromagnetic equations with Fresnel's law of the propagation of light in moving bodies. But it was, in its original form, incompetent to explain the negative result of the Michelson-Morley experiment: to meet this difficulty, the additional hypothesis of the Fitzgerald contraction was adopted in 1892: and in 1895 Lorentz made another advance on the road to relativity by introducing the idea of 'local time.' Larmor in 1900 extended the analysis so as to include small quantities of the second order, and thereby discovered the connexion of Lorentz's theory of local time with FitzGerald's contraction: and in 1903 Lorentz went further still and obtained the exact transformation which is known by his name and is the basis of the theory of special relativity. The principle of relativity itself was first clearly enunciated in the following year by Lorentz and Poincaré, especially in the latter's address delivered in September 1904 before the International Congress of Arts and Science at St. Louis. To the subsequent development of the subject Lorentz made important contributions, though perhaps none so epoch-making as his great discoveries of the period 1892–1904.

E. T. Whittaker.

News and Views.

The Bill for the Stabilisation of Easter was advanced a stage in the House of Commons on Feb. 17, when, on the motion of Captain Bourne, seconded by Mr. Withers, it was read a second time. Following the suggestion of the League of Nations special committee of inquiry, the proposed date for Easter is the Sunday after the second Saturday in April, the purpose of this provision being (1) to make the festival coincide as nearly as possible with what appears to be the actual date of the event commemorated, and (2) to avoid the clashing of Passion Sunday with the Feast of the Annunciation (as actually happens this year when Easter falls on the second Sunday). Some of the speakers opposing the Bill urged that meteorological conditions are apt to be unfavourable at the period named, but such objections must be completely outweighed by a consideration of the historical grounds on which the proposed date has been chosen and the fact that Easter is a festival for all countries. A point which emerged clearly in the course of the debate is that the promoters of the Bill have no desire to override the ecclesiastical authorities. The Bill itself provides that it shall not come into operation without an order in Council, so as to give an opportunity for arrangement with the Churches, and the Home Secretary, in supporting the Bill, remarked that its promoters were willing to strengthen this safeguard by inserting a further clause under which such an order shall not be made without a resolution by Parliament in its favour. The Bill was actually a response to the desire of the ecclesiastical authorities for assurance that the stabilisation of the festival is demanded, and the Home Secretary said that its acceptance would be regarded as an instruction to set to work on the requisite negotiations. Sir H. Slesser, who had moved the rejection of the Bill, then withdrew his motion.

As regards the meteorological side to the problem of choosing the best period for a fixed Easter in April, statistics show that there is a slight general tendency over Great Britain as a whole for more rain to fall as the month grows older. This is due, no doubt, to the fact that the heating effect of the sun, and consequently the average temperature of the lower layers of the atmosphere during the middle of the day, is increasing rather rapidly, in consequence of which convectional rain of the type of the thunder shower becomes more common. This tendency is, however, too small to be of much practical importance. Some meteorologists believe that a sudden set-back of temperature is particularly liable to take place at certain fixed times in the spring and early summer, but even if this belief can be justified statistically—a matter of some doubt—the regularity of recurrence of these set-backs is not sufficient for the effect to be worth taking into account. That abrupt changes from summer warmth to winter cold do take place in most years at least once between the beginning of April and the end of May, is a matter of common knowledge, but it seems probable that this effect is associated with a marked annual variation in the frequency of occurrence of anticyclones over Greenland. The northerly or north-easterly winds that bring the cold weather normally descend to temperate latitudes along the eastern margins of such anticyclones; the maximum frequency is reached in May, and although a gradual increase takes place in the course of April, which gives the early part of the month some slight advantage, this is more than outweighed later by the greatly increased length of the day, and by the fact that not only does the earth then receive more heat and light from the sun, but also a higher proportion of the ultra-violet radiation, without which no holiday can be regarded as ideal from the point of view of health.

The Galton Lecture delivered on the anniversary of Sir Francis Galton's birthday is an annual feature of the Eugenics Society. The lecturer this year was Dr. C. J. Bond, of Leicester, who chose as his subject "The Distribution of Natural Capacity in the Population and the Need for a National Stocktaking." Though it cannot be said that Dr. Bond introduced his audience to any new ideas, yet he gave forceful expression to several well-established ones at present

too much neglected. He pointed out that in all societies aristocracies tend to die out, and that the great reservoir of vigour from which the life of the nation is recruited is to be found in the middle class. Since this class consists of those who by their energy and perseverance have raised themselves to a position of financial independence, and since in the last resort the life of the nation rests on the daring and enterprise of its citizens, this is what might be deduced from *a priori* consideration. The younger sons of middle-class families who go abroad on errands of commercial enterprise or colonial government are the legitimate successors of the merchant adventurers of Queen Elizabeth's time, who, although they used more questionable methods for the promotion of British trade, were the real founders of the British Empire. Dr. Bond pointed out, however, that the middle class is losing its reproductive capacity, and he attributed this chiefly to the practice of voluntary birth-control. The motive inducing this practice is largely the desire to avoid being crushed by the taxation levied on them to supply the needs of what Dr. Bond called the degenerate class—the cancer-cells of the social organism who reproduce recklessly without any thought of the morrow, and propagate stupidity and laziness from generation to generation. Dr. Bond's remedy is to give free knowledge of the means of birth-control to all who desire it, and if this is ineffective he boldly advocates the ultimate sterilisation of the thriftless. Though Dr. Bond's views may be unpopular in a sentimental age, the nation which neglects them is doomed to decline and degeneracy.

DR. BOND's plea for a 'stock-taking' or mental and physical measurement of the population, introduced more questionable considerations. The ultimate test of the fitness to survive which Nature applies to the citizen is his ability to maintain himself under existing conditions—in ultimate analysis, fitness is economic fitness. Leaving aside the pathological cases of the victims of hereditary disease or mental weakness, who only constitute at the worst a small percentage of the community, it seems to us impossible to devise an arbitrary test which shall separate the fit from the unfit. The Simon and Binet mental tests have proved disappointing in practice: often those whose response to these tests indicates a low mental age, prove better able to maintain themselves in the struggle for life than their supposedly better intellectually equipped brethren. Differences of physical development may be partly due to 'inborn characters,' but we are constantly receiving shocks in discovering that what were considered to be hereditary defects are really due to the handing on from generation to generation of bad diet and bad air. Dr. Bond rightly compared the aberrancies of human population to the 'sports' in domestic animals. He did not reflect, however, that 'sports,' although hereditary, must owe their origin to definite causes, and that the evidence before us justifies the belief that when these causes cease to operate the 'sport' ultimately reverts to the wild type. The ultimate cause of many of the physical defects in the population of England is overcrowding, due to over-population. When this is remedied such defects will disappear, if not entirely in one generation, at any rate in two or three.

PROF. HUGH S. TAYLOR, of Princeton University, has been awarded the Nichols medal for 1928 by the New York Section of the American Chemical Society. The medal, awarded for "the research published during the current year which in the opinion of the jury is most original and stimulative to further research," will be made to Prof. Taylor at a gathering of American chemists in Rumford Hall, 50 East 41st Street, on Mar. 9, when he will deliver an address on "Catalysis as an Inspiration of Fundamental Research." Prof. Taylor, who is widely known for his studies in catalysis, holds the David B. Jones research professorship of chemistry in Princeton, a chair founded last year by Miss Gwenathlyn Jones, of Chicago, in memory of her father, David B. Jones, and as part of the newly organised endowment for scientific research in Princeton. Prof. Taylor is English by birth and was educated at the University of Liverpool, and at the Nobel Institute, Stockholm, under Arrhenius, where he made his first investigations on catalysis, and at the Technische Hochschule at Hanover, where he carried out investigations with Prof. Max Bodenstein on photo-chemistry and reactions produced by the α-particles from radium. Prof. Taylor went to Princeton early in 1914 as instructor in physical chemistry and was made assistant professor in 1915. During the War he was employed on munition work by the Government of Great Britain on problems relating to the fixation of atmospheric nitrogen for use in explosives.

ON his return to Princeton in 1919, Prof. Taylor initiated a wide programme of research on the physical and chemical properties of the catalytic materials used in such important catalytic industries as ammonia synthesis, the hardening of oils to produce edible fats, and the more recent industrial synthesis of wood alcohol or methanol. This work led to the formulation, in the *Journal of Physical Chemistry*, in 1925, of a theory of the catalytic surface which is now accepted generally by students of catalysis. In attempting to explain the acceleration of chemical processes occurring at such surfaces, it was postulated that the reacting elements might exist on the surface of catalysts in the atomic condition. This was demonstrated experimentally and led to a study of the properties of free atomic hydrogen. In this work new methods of producing hydrogen peroxide and formaldehyde were worked out, the industrial applications of which are being studied in the United States and in Germany. During the last two years Prof. Taylor has been chairman of the Central Petroleum Committee of the U.S. National Research Council, in which capacity he has charge of the allocation of grants from the 500,000 dollar fund created by gifts from John D. Rockefeller, sen., and the Universal Oil Products Company for the promotion of fundamental research in the physics, chemistry, and geology of petroleum. In this connexion he has recently devoted considerable attention to the scientific problems involved in the conservation of gas and oil in the recovery of oil.

Prof. Taylor is the author, with Dr. E. K. Rideal, of "Catalysis in Theory and Practice," the editor and part author of a "Treatise on Physical Chemistry," and has written monographs on "Industrial Hydrogen" and on "Fuel Production and Utilisation."

WICKEN FEN, half-way between Ely and Newmarket, promises to become one of the most interesting of the reserves held under the National Trust for Places of Historic Interest or Natural Beauty. The history of old England lies in its sedge beds and is embedded in its peat, and the old story since the days when the walrus sported in the sea which covered the Fen area, lies, complete and untampered with by the hand of man, awaiting the unfolding of the naturalist. In a pamphlet which accompanies a new part of the "Natural History of Wicken Fen," Prof. Stanley Gardiner shows how circumstances have conspired to retain this aboriginal inlier in the midst of an area which man has interfered with, at latest since the Romans began to drain the marsh. A very large area of the marsh has been recovered, but, because of its position as an area for drainage concentration, Wicken Fen has not only never been cultivated, but also has never been deliberately drained. So that, if its peat layers retain the relics of successive faunas of prehistoric times, the Fen itself retains, so far as may be, the original fen fauna of earliest historic England. It may be said that similar native areas are to be found in the wilds of the Scottish Highlands. But there is a vital difference: Scottish and other moorland marshes are saturated with acid waters which breed their own special flora and fauna; Wicken, peculiar in possessing alkaline water, stands at the opposite pole as regards the composition of its plant and animal life. For this reason alone, it is worthy of preservation and investigation; but when it is added that it contains the relics of an old flora and fauna now rapidly disappearing, and that it offers almost the only opportunity of interpreting the changes which the centuries have wrought in the fen assemblages which predominated over a large part of ancient England, the need for preserving it intact for present and future generations becomes insistent.

UNFORTUNATELY, this keeping intact is not so easy of accomplishment at Wicken as in many another reserve. The sedge, under the deliberate cropping of centuries for the thatch of houses, grows so strongly that if left uncut it forms a tangle impenetrable to the delicate bills of wading birds, which nest in summer and resort in multitudes to the marsh in winter. Brushwood, which has conquered much of the surrounding land and has there reduced the fauna from about 6000 to less than 2000 species, gradually intrudes and has to be uprooted. Gunmen hire adjoining areas, and, like the professional collectors of rare insects and rare birds and their eggs, regard the abundance of preserved creatures as a godsend, and make the most of opportunities they have done nothing to create. Watchers must be hired to keep them at bay, an expensive item, which would be reduced if the outlying areas abutting on or penetrating into the reserve—and some are already derelict—could be purchased as they come into the market. The recurring annual upkeep and the need for non-recurring expenditure in purchasing such desirable extensions, cannot be met by the funds at the disposal of the local committee. We understand that the National Trust is at the present moment issuing an appeal for such sums as would make Wicken Fen a permanent and worthy acquisition for the nation and an inestimable boon to the naturalist and the scientific student of ecology and of the history of England's fauna and flora. Most heartily we commend to the attention and generosity of our readers this appeal, copies of which may be obtained from the secretary of the Trust, 7 Buckingham Palace Gardens, London, S.W.1.

A SECOND annual report upon "Bird Sanctuaries in Royal Parks in Scotland," by the Committee appointed by Viscount Peel, has just been issued by H.M. Stationery Office (Price 6*d.* net). It shows how effective, even in the course of a couple of years, may be the planting of suitable cover and food plants and the protection of an area in inducing the presence of additional species of birds. At Duddingston Loch, within the precincts of Edinburgh, twelve additional species nested during the summer of 1927, and five birds, not before recorded, visited the sanctuary, including a goldfinch, attracted by teazle which had been planted during the spring. It is now considered that sufficient additional cover has been provided. The population of this interesting area, which is particularly favoured by hosts of immigrant ducks during the autumn and winter, now numbers 39 nesting species, 33 regular visitors, and 23 casual visitors. The Committee has wisely enlisted the co-operation of local naturalists by appointing several recognised ornithologists as official observers. Further, in order that a scientific study of the inter-relationships of plant and animal life, and of the changes in fauna and flora brought about through the reversion of the sanctuary to a state of Nature, may be made, the Committee has in addition instituted a botanical and entomological survey of the area. In this it is fortunate to have enlisted the help of the officers of the Royal Botanic Garden, Edinburgh, and a summary of a detailed report on "The Plant Life of Duddingston Loch," by Mr. J. R. Matthews and Mr. G. Taylor, is appended to the Report.

IN a further lecture "From Faraday's Note Books" at the Royal Institution on Feb. 16, Sir William Bragg stated that Faraday's work on gold films and gold suspensions is one of the fundamental researches of the subject. He chose the subject for his Bakerian Lecture before the Royal Society in 1857; and few Royal Society papers have been more widely read and quoted. Curiously enough, his first inquiries were made without any consideration of the rich system of gold colours; and of course with no idea of the ultimate importance of his work to colloid chemistry. He wished to enter the field of research opened up by the then recent discoveries belonging to the undulatory theory of light. He thought that

if he could investigate the action upon light of particles or films which were so small or so thin that several of them could be contained in the length of a wave of light, then some special phenomenon might be found which would help him to extend the new theory. His thoughts turned towards the use of gold leaf; and he arranged for a visit to his friend Mr. Warren de la Rue, the well-known printer, who was the fortunate possessor of a fine microscope; and on Jan. 27, 1856, they "had a good evening together." This was the beginning of several months of hard work. His laboratory notes fill hundreds of pages; and hundreds of the specimens which he made still remain at the Royal Institution, carefully arranged and indexed. The problem opened out in unexpected directions. He was never able to co-ordinate completely all the extraordinary observations which he made; nor indeed has modern theory been able to complete the task with all satisfaction. It did not throw much light on the undulatory theory, but it has been invaluable to the colloid chemist engaged in an attempt to unravel the mysteries of one of the most complex, fascinating, and important of all the sciences.

THE publication of the first number of *Africa*, the journal of the International Institute of African Languages and Cultures, will afford a wider public an opportunity of appreciating the importance of this movement for placing African studies on a broader basis. In present conditions, political and other, international co-operation and co-ordination are essential in the solution of the many-sided problems presented by Africa. This is as true in the field of purely scientific research as it is in the domain of the practical problem of administration. Mr. Driberg, for example, in this number, in discussing primitive law in eastern Africa, emphasises the danger of generalisation from data which extended observation may show to be sporadic only, and perhaps even restricted to a certain area. The success of the Institute and the measure of support it may expect will depend upon the extent to which it is able to promote investigation on these lines, otherwise it merely enters into competition with existing organisations which deal with African studies. Its aims, as formulated here by Sir Frederick (now Lord) Lugard, are admirable, especially in so far as attention is to be given to the practical bearing of research on economic and administrative questions. Excellent as is the first number of *Africa*, however, it cannot be said that all the papers are of the type which might most usefully be published by the Institute; but Mr. Driberg's paper already mentioned, and Capt. Rattray's article on "Anthropology and Christian Missions," are very much to the point.

INVITATIONS are to be sent out shortly for the next meeting of the International Astronomical Union, to be held at Leyden on July 5-13 of this year, together with the provisional programme of the meeting. The president of the Union is making use of his statutory prerogative to invite persons belonging to nations that have not yet joined the Union, and it is expected with certainty that many of these will accept the invitation. The Leyden meeting of the Union will thus be the first of the congresses of the unions founded under the auspices of the International Research Council, that will be completely international in character and in which representatives of science belonging to countries that stood on opposite sides during the War will meet in a spirit of international brotherhood.

IN all fields of biology the importance of accurate measurements and quantitative data is being increasingly realised. Much work is not infrequently rendered useless, or at least much less useful than it might be, through neglect of simple precautions in the making, recording, analysis or presentation of such data. A committee of Section D (Zoology) of the British Association has concerned itself with these matters, and has issued a valuable report in which important recommendations are made. The committee found that the satisfactory presentation of statistical data is often impaired by the reluctance of editors to print extensive numerical data in full, and negotiated for the establishment of centrally placed archives for the reception of original data too extensive for complete publication. The Natural History Museum at South Kensington and the Royal Society of Edinburgh have both agreed to undertake this function. The data thus deposited in these archives will be available to students, and in this sense will have secured effective publication.

THE leaflet which has been issued by this Committee consists of a foreword illustrating the needs of biological work, followed by sections on (*a*) the planning and execution of research by metrical methods, (*b*) the methods of compact presentation of data and the recognised methods by which it can be adequately summarised, (*c*) the interpretation of statistical results and tests of significance, and (*d*) detailed references to text-books on the several types of tests generally required. The leaflet will be of the greatest possible service to biological workers, and should go far towards securing uniformity in the compilation and presentation of statistical data. It deserves to be widely known among workers in this field of biology.

SOME new picture postcards have been placed on sale at the Royal Botanic Gardens, Kew. The most interesting is probably a view of the Iris Garden, in natural colours, showing the beds of Iris in full bloom. Other pictures include *Angræcum sesquipedale*, an orchid which has a nectary up to 1½ feet in length: *Dendrobium thyrsiflorum*: *Prunus Lannesiana*. There is a set of six pictures in colour, representing several kinds of brilliantly coloured water-fowl which inhabit the neighbourhood of the pond; also a set of seven black-and-white cards showing some of the ornamental geese which are to be found near the lake. This set includes a picture of "Joey," the handsome Stanley crane which must be familiar to most visitors during the summer months. The prices are 6*d*. for a set of seven black-and-white cards, and 1*s*. for a set of six coloured cards with descriptive leaflet.

A VERY interesting feature of Section K at the Leeds meeting of the British Association in September last was Dr. Lotsy's demonstration of wild hybrids from various parts of the world, which attracted so much attention that it had to be twice repeated. The importance of such investigations, especially in relation to Dr. Lotsy's well-known views on the rôle of hybridisation in evolution, is so obvious as to require no special emphasis, and Dr. Lotsy is to be congratulated on the accumulation of a wealth of highly interesting material. Starting with coloured drawings illustrating the wide diversity in the second generation of crosses made in his own experimental garden between two varieties of pumpkins and between *Tragopogon pratensis* and *T. porrifolius* respectively, Dr. Lotsy proceeded to demonstrate the occurrence of similar hybrid swarms in Nature. In the first place, he showed a series of coloured drawings of segregates from the spontaneous cross *Primula auricula* × *P. viscosa*, found on the Weisshorn near Arosa, and prepared by their discoverer, Dr. Knoll. As an American example he demonstrated the wide range within certain species of Opuntia observed by him around Tucson in Arizona in connexion with Dr. MacDougal's investigations on artificial Opuntia-hybrids.

MANY of the examples used in Dr. Lotsy's demonstration were obtained in New Zealand, partly by Dr. Lotsy himself during three months' exploration of both islands under the invaluable guidance of Dr. L. Cockayne, the pioneer in this field in New Zealand, and partly by Dr. H. H. Allan, of Fielding, and Messrs. A. W. Thomson, J. Scott Thomson, and G. Simpson, of Dunedin. Even a three weeks' stay in Australia afforded some interesting cases, thanks to the help of Profs. Lawson and Osborn, as well as of Messrs. S. L. Kessel and C. A. Gardner, of the Forestry Department, and of Mr. W. H. Carne, of the Department of Agriculture, Perth. Finally, Dr. Lotsy showed a fine collection of coloured drawings by Dr. Goddyn, both of plant hybrids and of hybrids between different human races, from South Africa. In obtaining these he was materially assisted by Prof. Schönland, Dr. Marloth, and Mr. Dyer, of the Botanical Survey. In concluding, Dr. Lotsy expressed his great indebtedness to the many who assisted him in the search for wild hybrids, either directly or by extending hospitality to himself and his party, and also to the governments of the three Dominions who materially aided his investigations by providing free railway passes and other facilities.

MANY of us who scan the posters of the Empire Marketing Board may be inclined to ask whether, and to what extent, the Board is assisting the British agriculturist to extend his markets. These and other questions are answered in a pamphlet, "The Empire Marketing Board and the Home Producer," which will be sent free to any inquirer by the Board on application to its offices, 2 Queen Anne's Gate Buildings, Dartmouth Street, London, S.W.1. In this pamphlet the Board outlines briefly the methods by which, directly or indirectly, it has given real help to the British farmer, as distinct from the Colonial agriculturist. Its posters have advocated "home buying first"; grants have been made to the Ministry of Agriculture to enable the Ministry to conduct investigations into improved methods of packing, grading, and marketing produce (some of these, no doubt, based on the best experience of the Colonial producer); while the Ministry of Agriculture has, in turn, made substantial grants to various fruit growers' associations and agricultural research departments. Grants have also been made direct by the Empire Marketing Board to the Scottish National Milk and Health Association to enable the latter to carry out large-scale experiments on the feeding of school children in various Scottish centres upon milk, and to increase the consumption of milk in Scotland, while in Northern Ireland it is co-operating in investigations into the marketing of Northern Ireland butter and eggs. The Board is also now issuing a series of *Weekly Fruit Intelligence News*, to keep the British consumer up-to-date in the matter of supplies from the Colonies. Any one further interested in the work of the Board is recommended to obtain a free copy of the first report, "A Year's Progress," which gives fuller details of grants made and the research and other work to be covered by such grants.

THE annual Congress of The South-Eastern Union of Scientific Societies will be held at Rochester on June 6-9 inclusive, under the presidency of Sir Martin Conway.

MR. W. H. WRIGHT, of the Lick Observatory, has been appointed George Darwin lecturer for 1928 of the Royal Astronomical Society. The lecture will be delivered in June, and will probably deal with the photography of the planets with different colour filters.

SIR JOSEPH THOMSON will deliver the thirteenth Guthrie Lecture of the Physical Society, taking as his subject "Electrodeless Discharge through Gases." The lecture will be given on Friday, Mar. 9, at the Imperial College of Science and Technology, South Kensington, commencing at 5 o'clock. No tickets are required.

A PROVISIONAL programme has been issued of the summer meeting of the Institution of Electrical Engineers, to be held in Norway on June 9-24. The meeting will take the form of a tour, including Bergen, Dale, Eide and Ulvik, Odda, Voss, Oslo, and Gothenburg, where power stations, nitrate and other works will be visited.

AT the annual general meeting of the Quekett Microscopical Club on Feb. 4 the following were elected officers for the ensuing year: *President*, Dr. W. T. Calman; *Vice-Presidents*, Mr. C. D. Soar, Mr. D. J. Scourfield, Sir David Prain, Dr. C. Tierney; *Hon Treasurer*, Mr. F. J. Perks; *Hon. Secretary*, Mr. W. S. Warton; *Hon. Reporter*, Mr. A. Morley Jones; *Hon. Librarian*, Mr. C. S. Todd; *Hon. Curator*, Mr. C. J. Sidwell; *Hon. Editor*, Mr. W. S. Warton.

THE Society of Chemical Industry was first established at Merseyside, and an interesting account by Dr. A. Holt of the development of chemical industries

in Liverpool and the neighbouring districts is contained in its *Transactions* dated Dec. 2. Rather more than one hundred years ago, this part of Great Britain was chiefly given over to agriculture, but with the provision of cheap transport facilities its character has changed, until now almost every industry in which chemistry plays a part, from metallurgy to the manufacture of artificial silk, is carried on there. A summary is given of the progress of each separate industry.

A NEW catalogue (No. 301) has just reached us from Messrs. W. Heffer and Sons, Ltd., Cambridge. It deals with nearly 2400 second-hand works on mathematics, physics, astronomy, chemistry, chemical technology, metallurgy, dictionaries, and books of reference. It can be obtained free upon application to the publishers.

MESSRS. Dulau and Co., Ltd., announce the forthcoming publication by them of "Index Londinensis," containing illustrations of flowering plants, ferns, and fern allies, being an emended and enlarged edition, continued up to the end of the year 1920, of Pritzel's Alphabetical Register of representations of flowering plants and ferns. The work has been compiled by Dr. O. Stapf, and will comprise six volumes and be completed by 1930.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A lecturer in mathematics at University College, Dundee—The Secretary and Registrar, The University, St. Andrews (Mar. 2). An assistant pathologist and research fellow in the pathological department of the Hospital for Sick Children, Great Ormond Street—The Secretary, Hospital for Sick Children, Great Ormond Street, W.C.1 (Mar. 5). Teachers of mathematics and of science at the new boys' secondary school, Heaton, Newcastle-upon-Tyne—The Director of Education, Education Office, Northumberland Road, Newcastle-upon-Tyne (Mar. 10). A biologist at the Dove Marine Laboratory, Cullercoats—The Registrar, Armstrong College, Newcastle-upon-Tyne (Mar. 17). A senior lecturer in physiology in the University of the Witwatersrand, Johannesburg—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (April 16). A lecturer in mathematics at the University College of Hull—The Secretary, University College, Hull. A whole-time worker in the research department of St. George's Hospital Medical School—The Dean, St. George's Hospital Medical School, Hyde Park Corner, S.W.1. A lecture assistant in physical chemistry in the University of Bristol—The Registrar, The University, Bristol.

Our Astronomical Column.

HAS SIRIUS CHANGED COLOUR ?—Much has been written on this question in recent years. Prof. T. J. J. See, in a *Sondernummer* of vol. 229 of *Astr. Nach.*, collected a large amount of evidence from classical sources which certainly appeared on the face of it to establish that Sirius was ranked with orbs of undoubted redness like Antares. The *a priori* improbability of such a change in 2000 years is so great that most astronomers seek some way of escape from this conclusion. Sirius can be seen closer to the horizon than most stars, and in that position it is truly said that it "alters hue, and bickers into red and yellow." In Egypt especially, where the heliacal rising of Sirius was watched for as a sign of the rising of the Nile, it must often have been observed near the horizon.

E. Dittrich, in *Astr. Nach.*, No. 5542, examines an Assyrian tablet of the epoch 885 to 860 B.C., in which Sirius (Kaksidi) is described as "red as copper," and gives reasons for concluding that this refers to the time when Sirius rose at the beginning of the night, and that its rising at that time would be the occasion of special observations. He alludes to the fact that Sirius is now classed as a dwarf, though one of the brightest of the dwarfs; this increases the number of stages through which it must have passed since it was a red giant.

ANALYSIS OF CEPHEID VARIABLES.—W. Zessewitsch contributes a paper on this subject to *Astr. Nach.*, No. 5534. He notes that many of these variables show periodic changes both in their periods and in the form of the light-curves. These can be represented analytically by series of sine terms. He considers that a physical explanation is afforded by Jeans's suggestion that these stars have split into two orbs at a date that is recent (in the standards of cosmogony) and that the period of rotation is not equal to that of pulsation. The period of rotation would tend to lengthen owing to tidal friction; on the other hand, increasing density would shorten the period of pulsation. The two stars RW Draconis and XZ Cygni are mentioned as those that have been most carefully studied; the results, so far as they go at present, are considered to support Jeans's theory.

PERIODIC VARIATIONS IN TERRESTRIAL MAGNETISM.—In *Geofysiske Publikasjoner*, vol. 5, No. 3, K. F. Wasserfall discusses the presence of periodic variations in magnetic data obtained from the polar station at Gjøahavn, which was occupied by Amundsen from Nov. 1903 until June 1905. The geographical coordinates of this station, situated near the magnetic pole, are Lat. 68° 37′ N., and Long. 95° 55′ W. The data used in the discussion are daily means of horizontal force derived from photographic registers; temperature records for Gjøahavn and Oslo, and Wolfer's sunspot numbers for the same interval, are also used for comparative study. On analysis of the data, the author finds indications of various periods ranging from 3·3 days to 70 days. The distribution of sunspots in longitude is examined in some detail, and suggestions are offered to account for a relationship between the indicated periods in the magnetic and temperature records and the state of solar activity at the time. The results obtained from so very limited a series of observations are naturally open to much criticism in spite of the value of records from high latitude stations. The only consistent periods found in magnetic data which are of general acceptance as being related to the sun's activity are (1) the 11-year cycle of the sunspots and allied solar phenomena, and (2) a period of about 27¼ days, which corresponds to the sun's synodic rotation as given by the sunspot latitudes.

Research Items.

THE MALTESE CART-RUTS.—In *Man* for February, Miss M. A. Murray discusses, with a number of illustrations, the possible origin and purpose of the so-called cart-ruts of Malta. These cart-ruts are disappearing, but a series of air photographs, to be the basis of a complete map, is now being prepared by Prof. Zammit and Commodore Clark Hall. As regards their origin, it is clear that they are not the well-known natural parallel fissures which occur in limestone, for they curve, and are equidistant throughout their length, the gauge being a little greater than that of a Maltese cart. The depth is not great, being about a foot. The Greeks appear to have cut similar ruts to facilitate the passage of carts over rough ground, but the curves for passing do not occur in Malta. There is a network of the ruts all over the island, and short lengths are frequent in connexion with megalithic monuments. This is an indication of age, which is also supported by the fact that they were made when the configuration of the island was different. One at St. George's Bay was evidently made across a gulley now covered by the sea, as it appears on both sides of the bay. Tracks also lead to the edge of cliffs, where they end abruptly. A tradition says that the tracks were made for a boat which went on wheels. It is possible that they are part of a road system which was superseded by the Roman roads.

NEW DEEP SEA FISHES.—Among the collections of the third oceanographic expedition of the *Pawnee* were 32 specimens of the deep sea fishes of the suborder Ceratioidea, which are described by Mr. A. E. Parr in the *Bulletin of the Bingham Oceanographic Collection*, vol. 3, Art. 1, August 1927. The collection was composed of eighteen species, eleven of which are regarded as new to science. So little is known of the developmental stages of these deep sea anglers that the author makes a point of recording a number of different body measurements for each specimen. The commonest species was *Melanocetus Murrayii* Günther, of which there were ten specimens, covering a wide range of size, the smallest being 17 mm. in total length, and the largest 115 mm. without the caudal fin. In the same series of publications, vol. 1, Art. 1, October 1927, Mr. C. M. Breder, Jr., records the results for fishes collected on the first expedition of the *Pawnee* in the West Indies by Mr. Harry Payne Bingham. The area from which the fish were taken includes the coastal regions of South Florida, Bahamas, Cuba, Grand Cayman, and British Honduras. Records for large numbers of different species are given, mostly shallow water and shore forms, and twenty new species are described. The most remarkable was a small eel-like fish named *Anguillicthys bahamensis* nov. gen., n. sp., by Mr. L. L. Mowbray, from whom the collections were taken over. This fish, about 4½ in. in length, differed from other eels in having a well-developed lunate caudal fin, the insertion of the anal and dorsal fins behind the vent, and their separation from the caudal fin by a long peduncle. The specimens were taken at the surface at night and were very rapid swimmers. They were considered to be eels that have taken to a mid-water life, and to lie between Anguilla and the type of true fishes. Both publications are well illustrated by Mr. W. S. Bronson, who is also executing a number of coloured paintings for the collection.

RESEARCH WORK AT PORT ERIN.—The forty-first Annual Report of the Marine Biological Station of Port Erin, Isle of Man, drawn up by the Director, Dr. Jas. Johnstone, professor of oceanography in the University of Liverpool, states that the work has been carried on along the usual lines during the year 1927, the equipment for general biological and chemical investigations having been improved and being now quite satisfactory. The pupils of Dr. Margery Knight have added much to the knowledge of the algæ of the district, and a series of memoirs have been written. Among these the researches by Miss E. M. Higgins on *Colpomenia sinuosa* are of peculiar interest, as this alga, formerly known from warmer seas, has since 1905 been found on the British coasts, and in 1916 was freely floating in the Irish Sea. As it affects oysters by clinging to their shells and then forms vesicles having sufficient buoyancy to lift away the whole mollusc, it is of considerable economic importance. The plaice in the hatching ponds continue to spawn, upwards of 4,000,000 larvæ having been set free from February to April, and also more than 4000 larval lobsters, besides 387 lobsterlings reared in the laboratory and liberated at suitable places along the coast. Research in the bio-chemical laboratory has been chiefly on the physical and chemical side, the Naturalist of the Marine Station, Mr. J. R. Bruce, having completed papers on "The Physical Factors on a Sandy Beach" which are about to be published.

ICE-DRIFTS AND SEAL-FISHING.—In a note on Dr. Iversen's paper "Drivis og Selfangst" in our issue of Jan. 14, p. 71, it was stated that "The Bladder-nosed seals . . . defend their young, keeping with them for a longer time" than the Greenland seal does. Dr. Iversen writes to correct this, as it is the period during which births are known to occur which is longer for the Bladder-nosed seal than for the Greenland seal, not the length of time the young is cared for. He says: "The drift ice at Jan Mayen is the breeding-place both for Greenland seal and Hooded seal at the end of March and in April. The Hooded seal is believed to give birth to its young at about the same time as the Greenland seal, the period being, however, somewhat more extended and the breeding area generally situated a little more to the south." Further, referring to the statement that whole families of Bladder-nosed seals are often shot down, he says, "It is, of course, not possible to say whether the small flocks met with really represent an actual family, wherefore I have placed the word in question (*familien*) between inverted commas. Very little, as a matter of fact, is known about the habits of this species."

THE STORING OF EARTHWORMS BY MOLES.—In view of the fact that the most authoritative work on British mammals, by the late Major Barrett-Hamilton, throws grave doubt upon the reliability of the accounts of the deliberate storing of earthworms by moles, the experiments of M. Degerbøl deserve attention (*Vidensk. Medd. f. Dansk Naturh. Foren.*, Bd. 84). He recounts the plain evidence previously furnished by Fr. Dahl and Ritzema Bos, and shows how, during his own experiments, the supply of superabundant food led to underground storing by a captive mole. As many as 49 large earthworms were stored in underground runs in 40 minutes, and the storing ceased only because the earthworm store was exhausted. Careful excavation of the runs showed that the worms had been pushed into holes formed in compressed earth in the walls of the burrows. In each hole a series of worms was placed, from a depth of about 4 inches to the surface of the run, but each worm was separated from its neighbours by a thin layer of packed earth. The worms were all alive, and except when the mole was flustered by too great *embarras de*

richesse, the escape of the victims was provided against by the destruction of the first few head segments. The evidence of the experiments, as well as the evidence of other well-authenticated cases in natural conditions, suggests that the storing is not a provision against the appearance of dearth in hard weather, but is a direct reaction to over-abundant food supplies.

The Brewing Values and Antiseptic Powers of Hops.—In Great Britain the three principal methods for the analysis of hops in use at the present time are: a gravimetric method, Chapman's biological method (Nature, **115**, 244; 1925), and a method in which the amounts of lactic acid produced in a standard volume of malt wort by *Bacterium Delbruckii*, in the presence of varying quantities of a decoction of the hop, are determined by titration. The advantages of biological methods, the Chapman method in particular, include the speed with which they may be carried out, and the production of a result which depends on the actual antiseptic power of the hop. Gravimetric methods, on the other hand, though more readily standardised, depend on the extraction of the α- and β-resins by means of solvents and the grading of the hops in terms of an arbitrary factor connecting the two values obtained. The need for strict standardisation in the latter case is thus apparent, and papers by J. J. H. Hastings and T. K. Walker, and by A. H. Burgess and H. Martin (*Jour. Inst. Brew.*, **34**, 9, 13; 1928) may be welcomed as a step in this direction. Both pairs of authors have come to the same main conclusion, namely, that to secure a more complete extraction of the β-resin, which is of brewing value, the methyl alcohol used must be diluted. An improved method is thence described in which the ether extract of the hop is re-extracted with the necessary amount of methyl alcohol, the α-resin precipitated by lead acetate, and the β-resins determined by difference from the total soft resin content. Unfortunately, in the past a close correlation between resin content, preservative value, and the results of small-scale experimental brews has not always been obtained, and it is hoped that the improved method may to some extent remedy this.

Eucalypts in Scotland.—A paper by Mr. J. A. B. Macdonald in the *Scottish Forestry Journal* for October last affords some interesting details of the growth of certain species of Eucalyptus which were planted out from thirty to thirty-three years ago at Kinlochourn, Inverness-shire, by the late Mr. R. Birbeck. The site is a steep sheltered slope, with a southern aspect; the rainfall varies from 90 to 140 inches per annum; and although the climate is generally mild, the sea loch is frozen over on very rare occasions. It was observed by Mr. Birbeck that the trees, when planted in a well-drained soil, enjoyed the high rainfall; the young trees, however, were tried severely by the Atlantic gales. *E. amygdalina*, *E. coriacea*, *E. regnans*, *E. rudis*, and *E. resinifera* suffered from the climate, and *E. globulus* was killed by fifteen or twenty degrees of frost. Specimens of *E. vernicosa*, *E. alpina*, *E. angustifolia*, *E. cordata*, and *E. viminalis* were flourishing in 1899 at the time of Mr. Birbeck's report; but of some fifty species originally planted out, the hardiest were *E. coccifera*, *E. Gunnii*, and *E. urnigera*. Three species have recently been identified and examined. A specimen of *E. cordata* measures 35 feet in height, with a girth of 81 inches; a specimen of *E. Muelleri* is 40 feet in height and 57 inches in girth. The commonest species is *E. coccifera*, which has attained a maximum height of 65 feet, with a girth of 45 inches. There are also other species in the area; all of them appear to fruit profusely, but no seedlings have been found. The members of a neighbouring group of birch trees of the same age vary from 20 to 35 feet in height, with an average girth of 25 inches, and the tallest trees in a group of Scots pines growing alongside are about 35 feet in height, with a girth of 32 inches. *E. coccifera* is one of the few endemic eucalypts of Tasmania, where it grows on or near the snow-line; it belongs to the 'peppermint' group, and yields an essential oil containing α-phellandrene and piperitone; like *E. Gunnii*—the 'cider gum' of Tasmania and the highlands of Victoria and New South Wales—it has no economic value as an oil-producing tree. *E. cordata*, *E. Muelleri*, and *E. urnigera* are Tasmanian species which yield a good type of oil containing cineole and pinene.

The Effect of Heat on Common Hornblende.—The *Science Reports of the Tôhoku Imperial University*, Ser. 3, vol. 3, No. 2, Nov. 1927, contain a preliminary paper on the dissociation temperature of brown hornblende by S. Kôzu and B. Yoshiki, which is followed by a more detailed account (with the additional collaboration of K. Kani) of the transformation of common hornblende into the basaltic variety at 750° C. At this temperature the refractive indices and birefringences rapidly increase, and the extinction angles decrease to nearly zero on the prism face. The pleochroism also changes from various tints of green to brownish green into the characteristic reddish-brown shades of the basaltic type. The expansion on heating gradually increases to 750° C., and then changes suddenly to a contraction; at 790° expansion begins again. Natural basaltic hornblende shows none of these changes on being heated, but has from the start almost the same properties as those reached by ordinary hornblende beyond 750° C. The expansion curve shows no break until 1080° C. is reached, at which point there is great expansion accompanying the dissociation of the mineral. These results clearly have petrological implications of considerable importance.

Basalts of the Galapagos Islands.—A paper by H. S. Washington and Mary G. Keyes in the *Jour. Wash. Acad. Sci.*, Dec. 19, 1927, contains an account, with chemical analyses, of some specimens collected on the islet of Eden. These are mainly palagonite tuffs and an olivine-andesine-basalt closely resembling a common Hawaiian type. The authors make no mention of the recent *St. George* Scientific Expedition (*Geol. Mag.*, 1925, p. 371) or of the collections of lavas then made by L. J. Chubb. Some of these, from Albemarle and James, have already been analysed by Raoult and described by Lacroix (*Mém. de l'Acad. des Sciences*, p. 69; 1927). Chubb's basalts are more basic than the one from Eden; they are respectively rich in bytownite and olivine. All the authors cited are agreed that there is close similarity between the Galapagos basalts and those of the Central Pacific. Lacroix points out the striking difference of the lavas from those of the andesitic types of the Circum-Pacific belt. Washington and Miss Keyes direct attention to the earlier observations of Gooch, which indicate the presence of trachyte and trachybasalt on some of the islands. It is clear, therefore, that the Galapagos Islands afford another example of the frequent oceanic association of common basalt with trachytic and melanocratic differentiates.

The Absorption Spectrum of Nitrogen Peroxide.—The results of a careful investigation of the absorption spectrum of nitrogen peroxide are embodied in a dissertation by L. C. K. Carvile, presented

to the Academic Faculty of the University of Virginia. The spectrum was photographed with a 21-ft. Rowland grating, but in consequence of the difficulty of maintaining constant temperature during the long exposures required, the average deviation from the mean for the same line on different plates amounted to 0·03A. This, however, is a great advance on any previous measurements, and the new determinations will provide a substantial basis for an investigation of the structure of this spectrum. About 6600 lines, covering the range λ3978 to λ6323, are included in the catalogue. No change in the positions of the lines could be detected when the temperature of the absorbing gas was raised from 4° to 26° C. Anyone interested may obtain a copy of the dissertation gratis on application to the Director of the Rouss Physical Laboratory, the University, Virginia, U.S.A.

GASEOUS BEARINGS.—The issue of the *Journal de Physique* for November contains a communication from MM. E. Henriot and E. Huguenard on the use of gaseous bearings for small rotors and on the extremely high speeds of rotation which can be obtained in this way. The fixed part of the bearing is a vertical cone of semivertical angle about 60° and 1 cm. side. Half-way down the side there are 8 or 10 holes up which air or carbonic acid gas at 2 to 6 atmospheres pressure is forced. The rotary part is coned underneath, the semivertical angle being about 65°, and the conical surface is provided with fine grooves along its generating lines. With a rotor of 1 cm. diameter a speed of 11,000 revolutions per second was obtained, and with it the Foucault measurement of the speed of light could be made with the reflecting mirror only 1 m. away. Rotors of 2·5 kilograms have been driven at 1100 revolutions per second. In all cases it is found desirable to mount the fixed part of the bearing so that a little side play is possible.

MICROSCOPE TECHNIQUE.—In the January issue of *Watson's Microscope Record*, T. Thorne Baker discusses the use of light filters for increasing contrast in photomicrography. Contrast filters should be complementary in colour either to the primary object or to the background. To get the best results a plate suitable to the composition of the contrast filter must be used. Ordinary plates are suitable for use with violet or blue filters; orthochromatic plates with green or yellowish-green filters; and panchromatic plates with orange, red, or deep red filters. A list is given of some common microscopic stains and the colours of the most suitable contrast filters for use with them. Various methods of preparing metal specimens for microscopical examination are described by W. Cartwright. The structure of the metal may be developed by polish attack instead of by etching. In this method the polishing process is carried on in the presence of a slightly corrosive liquid. The method of heat tinting is useful for the detection of small differences in concentration of solid solutions, whilst electrolytic etching is of value in special cases. The journal also contains articles on measurements with the microscope, and on the use of the microscope in the textile industries and in the paper industry.

A NOVEL DISTILLATION FLASK.—A novel type of distillation flask is described in the *Chemiker-Zeitung* of Dec. 21, which, it is claimed, possesses many advantages over the ordinary Claisen-flasks used in distilling liquids under reduced pressure. By means of a simple device, any liquid which may be carried forward mechanically with the vapour is separated from the latter and returned automatically to the main bulk of liquid. The apparatus is supplied by the firm of Emil Gundelach, Gehlberg, Thüringer Wald.

THE CHLORINATION OF MUSTARD GAS.—Although mustard gas (β, β-dichloroethyl sulphide) may be destroyed in small quantities by treatment with nitric acid or steam, the only practical methods for its removal involve the use of chlorine. Almost all the compounds theoretically possible on treating mustard gas with chlorine have been isolated by T. P. Dawson and W. E. Lawson, and an account of their properties is contained in two papers in the December number of the *Journal of the American Chemical Society*. All the chloro-derivatives below the hexa-compound are, with one exception, unstable, and on distillation form unsaturated compounds with evolution of hydrogen chloride. All the chlorination products of mustard gas are non-vesicant, that is, they do not cause blistering of the skin.

STUDIES ON INFLAMMABILITY OF HYDROGEN.—The influence of dimethyl selenide and telluride on the limits of inflammability of hydrogen-air mixtures has been investigated by Yoshio Tanaka and Yuzaburo Nagai, and their results are described in the *Journal of the Society of Chemical Industry of Japan* (vol. 30, No. 10). The addition of two molecular per cent. of dimethyl selenide caused the molecular per cent. of hydrogen to fall from 71 to 37·5 in the case of upper limit mixtures, while with the same amount of telluride the molecular per cent. of hydrogen was 40. Hydrogen selenide and dimethyl and diethyl selenides have the same theoretical flame propagation temperature, namely, 1750° C., but different amounts of each are required to raise the flame propagation temperature of hydrogen from its initial value of 1090° C. to 1750° C. This appears to be due to differences in the mean cross-sectional areas of the molecules of the selenides giving rise to different collision probabilities for the selenide molecules with the activated hydrogen molecules.

THE COPPER-OXIDE RECTIFIER.—At the National Radio Exhibition considerable interest was shown in a new and very efficient form of rectifier called the copper-oxide rectifier. The phenomenon on which the working of the device depends was described by Grondahl and Geiger in April 1926 to the American Physical Society. A full account of the construction and properties of actual rectifiers appeared in the *Jour. Amer. Inst. Elect. Eng.* for March last, and a brief account is given in *Experimental Wireless* for January 1928. Grondahl found that when a layer of oxide is formed on a sheet of copper and contact is made through a piece of lead pressed against the oxide, the resistance to an electric current passing from the lead to the copper is in certain cases very much less than when the current flows in the opposite direction. The action is analogous to a slightly leaky hydraulic valve, in which the water flows easily in one direction and scarcely at all in the other. For an applied pressure of four volts, the resistance in one direction is 12,000 times that in the other. In practice the rectifier consists of an oxidised copper disc against which a leaden ring is clamped. If properly designed for the output required, an efficiency of 80 per cent. can be obtained. The film of oxide is only about one-thousandth part of an inch thick, and no satisfactory theory has yet been given of the action of the valve. This type of rectifier has many advantages, from the engineering point of view, over the liquid types at present in use for rectification, as there is no liquid to spill or evaporate. There are also no moving parts. It is being made for many purposes. One form can be used for charging a six-volt battery at a two ampere rate. Another form can be used for charging the high tension batteries used in broadcasting.

Royal Society Election.

SELECTED CANDIDATES.

THE president and council of the Royal Society have recommended the following candidates for election as fellows of the Society:

G. ANREP, M.D., D.Sc. Distinguished as a physiologist, especially for his work on conditioned reflexes, nature of the secretory process, physiology of digestion, and significance of adrenaline. Has during the last few years conducted a series of masterly researches on the central and reflex regulation of the heart and circulation, and of the blood supply to the heart muscle, based on the use of the innervated heart lung preparation, which was invented for this purpose.

H. BATEMAN, M.A., Ph.D. Professor of Mathematical Physics in the California Institute of Technology, Pasadena. Formerly Fellow of Trinity College, Cambridge. Introduced (*Proc. Lond. Math. Soc.*, 1909) into the relativity theory of the electromagnetic equations a general quadratic form whose coefficients are characteristic of the medium supporting the field—partial anticipation of general relativity. Discovered the integral equation by which seismic rays in the earth's interior were afterwards calculated by Knott (*Phil. Mag.*, 1910). Has greatly extended the theory of solutions of partial differential equations, especially those occurring in physics. Has published solutions, both analytical and numerical, of various types of integral equations; also papers on radiation and geometry.

C. H. BROWNING, M.D., D.P.H. Professor of Bacteriology, University of Glasgow. Distinguished for his researches in bacteriology, immunity, and chemotherapy. Author of "Recent Methods in the Diagnosis and Treatment of Syphilis" (with J. Mackenzie, 1911); "Applied Bacteriology" (1918); "Chemotherapy in Trypanosome Infections" (*Jour. Path.*, 1908); a number of papers on an analysis of the Wassermann reaction, especially on the action of cholesterin and lecithin; "Isolation of Typhoid Bacilli by means of Brilliant Green" (*Jour. Hyg.*, 1913); "On Flavine and Brilliant Green" (*Brit. Med. Jour.*, 1917); "Bactericidal Action of Ultra-violet Radiation" (*Proc. Roy. Soc.*, 1917, with S. Russ); "Bactericidal Properties conferred on the Blood by Diamino-Acridine Sulphate" (*ibid.*, 1918); papers on antiseptic action and chemical constitution (*ibid.*, 1922, 1924, jointly); and others.

STANLEY S. COOK. Engineer. Since 1906, controlling calculation steam turbines for Parsons' Marine Steam Turbine Co., and licences all principal countries. On Sub-Committee of B.I.R., calculated pressures attained by collapsing water cavities, results independently confirmed by Lord Rayleigh. Calculated temperatures reached by compression of flame. Joint author of "Compressibility" (*Proc. Roy. Soc.*); "Erosion of Propellers" (*Inst. Naval Arch.*, 1919); "Mechanical Double Reduction Gears, investigating Torsional Vibration" (*ibid.*, 1921): "Mechanical Gearing, investigating Oil-quenched Nickel Steel Pinions" (*ibid.*, 1923). Roy. Soc. Arts, Howard Lectures, 1923.

W. D. DYE, D.Sc. (Lond.), A.C.G.I. Head of Electrical Standards and Measurements Section of the National Physical Laboratory. Has established accurate and permanent standards of capacity and inductance suitable for radio frequencies, and has developed a self-contained standard of radio frequencies of high accuracy embodying a tuning fork control. Member of the National Committee for Wireless Telegraphy and of the International Committee for Radio Standards and Measurements. An authority on electrical standard measurements and precision measurements and on the magnetic properties of materials. Publications: "Calculation of a Primary Standard of Mutual Inductance" (*Proc. Roy. Soc.*, A, **101**); "The Valve maintained Tuning Fork as a Precision Time Standard" (*ibid.*, A, **103**); "A Self-contained Standard Harmonic Wavemeter". (*Phil. Trans.*, A, **224**). Author of articles on magnetic measurements and on radio measurements in Glazebrook's "Dictionary of Physics."

C. C. FARR, D.Sc. Professor of Physics, Canterbury College, N.Z. Fellow and Hector Medallist, New Zealand Institute. Distinguished for his contributions to general physics. As Director of Christchurch Magnetic Observatory, he made a complete magnetic survey of New Zealand and outlying islands. The results were published by the New Zealand Government. Author of many papers including "Interpretation of Milne Seismograms" (*Phil. Mag.*, 1903); "Continuous Observations of Dissipation of Electric Charges in Open Air" (*Proc. Roy. Soc.*, 1905); "Radium Contents of Igneous Rocks from Subantarctic Islands of New Zealand," with D. C. Florance (*Phil. Mag.*, 1909); "The Viscosity of Sulphur," with D. B. Macleod (*Proc. Roy. Soc.*, 1920).

MAJOR GREENWOOD, F.R.C.P. Has applied the statistical method to the elucidation of many problems of physiology, pathology, hygiene, and epidemiology. Is the author, or joint author, of more than sixty papers dealing with these applications, including important contributions to the experimental study of epidemiology (*Jour. Hyg.*, **24**, 1925, Greenwood and Topley; *ibid.*, **25**, 1926, Greenwood, Newbold, Topley, and Wilson). Has done much to encourage and develop the use of modern statistical methods by medical laboratory investigators, and, as chairman of the Medical Research Council's Statistical Committee, to secure the adequate planning and execution of field investigations.

J. W. H. HARRISON, D.Sc. Lecturer in Zoology at University College (Armstrong College), Newcastle-on-Tyne. Distinguished for his original work in experimental zoology, demonstrating the non-Mendelian inheritance of specific characters and the breaking down of a Mendelian unit-character (melanism) in interspecific crosses in Lepidoptera; the induction of melanism in Lepidoptera by feeding larvæ on plants charged with metallic salts and its subsequent inheritance on a Mendelian basis; the inheritance of acquired egg-laying instincts in Hymenoptera and the importance of extraneous influence in the determination of sex. He has also studied the cytology of the varieties and hybrids of British roses and willows.

W. N. HAWORTH, D.Sc. (Manc.), Ph. D. (Göttingen). Professor of Chemistry in the University of Birmingham. Author or joint author of many memoirs, published chiefly in the *Journal of the Chemical Society*, on organic synthesis and on the constitution of some terpenes and carbohydrates. He had determined the structure of many of the di- and trisaccharides, including sucrose, maltose, lactose, melibiose, cellobiose, gentiobiose, raffinose, and gentiacrose, and has synthesised amygdalin.

D. KEILIN, M.A. (Cantab.), D.Sc. (Paris). University Lecturer in Parasitology, Cambridge. Distinguished for his researches on (*a*) Insecta, their anatomy, biology, and physiology; (*b*) Protista, having made important contributions dealing with the life history of new parasitic forms; (*c*) Cellular respiration, having made a fundamental discovery in the intra-

cellular pigment 'cytochrome' which is present in all organisms.

F. L. KITCHIN, Sc.D. (Camb.), Ph.D. (Munich). Palæontologist to the Geological Survey of Great Britain. Distinguished for his researches in invertebrate palæontology, especially in its application to stratigraphical geology. Has elucidated the lower Cretaceous fauna of South Africa (*Annals S. African Museum*, 1908) and the Jurassic Brachiopoda and Lamellibranchia of India (*Palæontologia Indica*, 1900, 1903). Has thoroughly investigated the faunas and correlation of zones in the concealed Mesozoic rocks of the Weald (*Mem. Geol. Survey*, 1911, 1923); has investigated the zonal representation and relations of the Gault of England (*Geol. Mag.*, 1920, 1922). Author of many palæontological contributions to Geological Survey memoirs.

F. S. MACAULAY. Distinguished for his contributions to the theory of modular systems. Author of "On the Resolution of a Firm Modular System into Primary Systems" (*Math. Ann.*, **74**, 1913); "The Algebraic Theory of Modular Systems" (Camb. Math. Tracts, No. 19, 1916); "The Resultant of a Number of Polynomial of the same Degree" (*Proc. Lond. Math. Soc.*, **21**, 1922); "Some Properties of Enumeration in the Theory of Modular Systems" (*ibid.*, **26**, 1927). Also of various papers on algebraic geometry.

S. B. SCHRYVER, Ph.D., D.Sc. Professor of Biochemistry, Imperial College of Science and Technology. Distinguished for original investigation in chemistry, especially biochemistry. He has made valuable contribution to our knowledge of morphia alkaloids (*Trans. Chem. Soc.*, 1900); autolysis (*Jour. of Physiol.*, 1904); Aggregation in colloids, especially clotting (*Proc. Roy. Soc.*, 1910–16); "The Chemical Aspects of Proteins, especially Gelatine" (*Biochem. Jour.*, 1920, onwards). He has done valuable work in chemistry in relation to plant physiology, including studies of the nitrogenous metabolism of plants (*ibid.*, 1920), of pectic substances and hæmicelluloses (*ibid.*, 1918, onwards). In addition he has been the instigator of much other research work issuing from his laboratory. A series of papers has been published on the hydrolysis of proteins and on the discovery of hitherto unknown hydrolysis products of these substances.

W. STILES, Sc.D. Professor of Botany, University of Reading. Distinguished for contributions to plant physiology. In his work on permeability he developed new methods, and his investigation of the equilibria concentrations of salts within and without the cell are of particular importance. He has made valuable contributions to knowledge of the action of cold on tissues, "The Preservation of Food by Freezing" (1922), and on "Diffusion through Gels." His books on the assimilation of plants (Jørgenson and Stiles), "Carbon Assimilation" (1917), and on "Cell Permeability" (1923), exhibit critical powers of a very high order and are of great value in the further development of research work in these fields.

R. WHYTLAW-GRAY. Professor of Chemistry, University of Leeds. Distinguished for his researches in physical and inorganic chemistry, especially in the application of the determinations of the densities and combining volumes of gases to the atomic weights of the constituent elements. Was the first to correct Stas' atomic weight of nitrogen. With Sir William Ramsay determined the density of radium emanation and the atomic weight of radium. With collaborators carried out various researches on the compressibilities and limiting densities of various gases. Determined the critical constants and orthobaric densities of xenon. Has carried out extensive researches for the Chemical Warfare Department on the behaviour of clouds and smokes.

The Gold Coast Forests.

AN important monograph has been drawn up recently by Dr. T. F. Chipp, entitled the "Gold Coast Forests: a study in Synecology" (Oxford Forest Memoirs, No. 7, 1927). In the introduction it is pointed out that no purely ecological study of the Gold Coast forests has been recorded, and that such a study has been impossible so long as the component units forming the structure of this mass of tropical vegetation have remained undetermined and uninvestigated. Considerable progress has been made in the floristic study of this forest area, as evidenced in the gradual expansion of the enumeration of the flora in the successive volumes of the "Flora of Tropical Africa," a work commenced in 1868 and only now approaching completion. A similar advance has also been made in the study of the plant distribution, and Engler's comprehensive survey in "Die Vegetation der Erde" (1908–10) is passing out of date.

The study of economic botany has made rapid progress with the establishment and expansion of the Agricultural and Forestry Departments. This progress is also depicted by such publications as "The Useful Plants of Nigeria" (*Kew Bull.*, Ad. Ser. 9) which includes the economic plants of the Gold Coast. Climatology has also recently received considerable attention. Apart from ecology, the area covered by the forest mass has been definitely determined, the chief physiognomic types of the forest have been recognised, and variations corresponding to the chief changes in climatic and edaphic factors have been recorded. Thompson's "Report on Forests: Gold Coast" (1910) recognises certain serial stages, plants, and communities of indicator value, and discusses the reaction of the population to the forest; he also adds lists of species occurring in different parts of the forest. Dr. August Chevalier in "Les végétaux utiles de l'Afrique tropicale française" has enabled the Gold Coast Forest, as a whole, to be viewed in its right perspective in relation to the rest of the vegetation in West Africa. During the War, A. Bertin, Conservateur des Eaux et Forêts, travelled extensively in some of the forest areas in the French possessions in this region, and published descriptions of the trees and their economic uses in five volumes, "Mission forestière coloniale," of high interest. As an outcome, soon after the termination of the War, Bertin was entrusted with the formation of a forest department to have charge of these areas. At the International Forestry Congress held at Rome in May 1926, Bertin read a paper on these forests, having for its object the placing of some of their timbers on the Italian market, Italy importing a considerable proportion of her annual timber requirements.

As Dr. Chipp points out, and the remark applies equally to several of our other Colonies and Protectorates. In a new country like the Gold Coast, where agriculture and forest exploitation have only assumed importance during the present generation, the tendency has been to concentrate all study and investigation on these, for they alone have an immediate economic bearing. In the meantime, the natural covering, a knowledge of the stages in development of which may prove of great economic importance to the inhabitants, is rapidly disappearing. The value of a study, in time, of the indicator communities and individuals may prove of equal importance from the protective point of view; such a study will indicate the parts of a country which it is

vital to keep afforested. For example, in the case here considered, to check the oncoming effects from the desert to the north, to ascertain over what areas forest will naturally replace destructive forest exploitation, the protection required in the catchment areas of the rivers and springs of the country, and whether hill systems or isolated peaks may be deforested with impunity. Dr. Chipp well sums up the case as to the importance of such investigations in the following:

"The value of the economic interpretations resulting from such a study cannot be over-estimated in the case of a country almost entirely dependent on the character and maintenance of its vegetation, not only for its material wealth, but ultimately for the very existence of its inhabitants. A narrow strip of country abounding in natural and easily exploitable wealth and actually 'sandwiched' between an ever-encroaching desert and the sea, is literally dependent on scientific management to retain its existence. Such management must of necessity be based on studies such as the present, carried out in the field and worked out in the light of a knowledge of similar problems that have been encountered elsewhere."

Dr. Chipp therefore set himself the task of studying the forest-mass from the point of view of the basic units of which it was composed, their characteristics, the factors controlling them, and the scheme by which they joined together to constitute the whole. This, as he says, is where the present work breaks ground. It is impossible, within a limited space, to consider at any length the results achieved, but it may be stated that Dr. Chipp has carried out his object in a most painstaking manner, and it may be hoped that the valuable monograph, of value alike to the forester and the ecologist, is but the forerunner of others undertaken for other parts of the Empire. The work is illustrated with a number of interesting photographs, charts, and plans which serve to interpret the text in the clearest fashion.

University and Educational Intelligence.

CAMBRIDGE.—A very important development is indicated in a report of the Council recommending the institution of a library building fund. The need to move the University Library to a fresh site, where it would have room to grow up to its present needs, while keeping an eye on the future, has been urgently before the University for some years, but the sum of £500,000 required for the complete scheme has seemed prohibitive. The Council has, however, found ways and means to finance a scheme of half that amount, and that would enable a substantial part of the new library to be erected. A recent bequest of £65,000 and other available monies are all to be devoted to this one purpose, and a recent increase in the University income under the new statute is in large part also to be assigned to the Library.

The Gordon Wigan prize in chemistry has been divided between A. Caress, Trinity Hall, for an investigation on "The Chemical Reactions of Atoms and Molecules Activated by Electron Collisions," and F. F. P. Smith, Peterhouse, for an investigation on "Studies in Chemical Reactivity."

Mr. J. E. Littlewood, F.R.S., fellow and lecturer in mathematics, Trinity College, has been appointed to the newly established Rouse Ball chair of mathematics.

LONDON.—A course of three free public lectures on "Heredity" will be delivered at Birkbeck College on Feb. 29, Mar. 7 and 9, at 5.30, by Dr. F. A. E. Crew, of the Animal Breeding Research Station, Edinburgh.

ST. ANDREWS.—At a meeting of the University Court on Feb. 17, a resolution was adopted recording the "deep sense of sorrow and loss" occasioned by the death on Jan. 29 of Field-Marshal the Earl Haig of Bemersyde, Chancellor of the University for the past six years.

AN election to Beit fellowships for scientific research will take place in July next. Forms of application and all information concerning the fellowships may be obtained by letter addressed to the Rector, Imperial College of Science and Technology, South Kensington, S.W.7. The latest date for the return of application forms is April 20.

PROF. J. H. DIBLE, professor of pathology in the University of London and honorary pathologist to the Royal Free Hospital, has been appointed to the chair of pathology in the Welsh National School of Medicine (University College, Cardiff), in succession to Prof. E. H. Kettle. Prof. Dible previously held pathological appointments in the Universities of Sheffield and Manchester.

DR. LARS G. ROMELL, of the Swedish Forest Experiment Station at Stockholm, has been appointed to the Charles Lathrop Pack research professorship in forest soils at Cornell University. The establishment of this professorship, the first of its kind in an American university, has been made possible by the endowment of 130,000 dollars for the chair, together with important additional gifts for its operating funds, from the Charles Lathrop Pack Forestry Trust, founded by Charles Lathrop Pack, of Lakewood, N.J., president and founder of the American Tree Association. The new investigation will co-ordinate studies in several fields of science, and apply all the obtainable and applicable knowledge to the special problems of forest soils. Dr. Romell studied at the University of Stockholm, and has done special work in botany at the University of Strasbourg under Prof. Jost, and in botany and cytology at the University of Lund under Prof. Lundegardh; he has also worked on the bacteriology of soils with Dr. Winogradsky near Paris. Since 1918 he has held an appointment at the Swedish Forest Experiment Station, in association with Dr. H. Hesselman, dealing with forest soils. The results of this pioneer work in America will be watched with interest by those concerned in the conservation of wood supply.

THE International Federation of University Women has published a report of its eleventh council meeting held at Vienna last July. At the opening, semi-public, session, Madame Puech, of the French Association, pleaded for a united effort against the exaggerated spirit of nationalism. In former times men of science and letters were to some extent supernational, but the modern, general, and democratic educational systems tend to foster a spirit which, far from "making the world safe for democracy," creates a feeling in the nationals of each country that it is entitled to a proprietary right in those intellects whose work should be regarded as the common property of humanity, and intellectual workers are thus tempted to adopt an antagonistic attitude towards other nations. To this the Federation can and does oppose its ideal of the open and friendly forum for university women of all countries. Reports from national associations of the United States, Austria, Belgium, Bulgaria, Canada, Czecho-Slovakia, Denmark, Estonia, Finland, France, Germany, Great Britain, Holland, Hungary, Ireland, Italy, Norway, Poland, Rumania, South Africa, Spain, Sweden, and Switzerland, show that all are actively engaged in promoting this ideal. The Federation is financed, however, mainly from America, whence came, last year, nine-tenths of the gifts and subscriptions. The headquarters of the Federation have been transferred from Victoria Street to Crosby Hall, Cheyne Walk, London, S.W.3.

Calendar of Customs and Festivals.

February 26.

FIRST SUNDAY IN LENT.—Known in Ireland as Chalk Sunday. It was customary for a great number of marriages to be celebrated in Ireland on Shrove Tuesday as the last opportunity before Lent. On the following Sunday, the girls surreptitiously chalked the coats of eligible young men who had not availed themselves of the occasion, thus exposing them to ridicule.

February 27.

SCAMBLING DAYS.—The Mondays and Saturdays in Lent were known as Scambling Days. On these days no regular meals were provided and the members of the great households 'scambled,' *i.e.* made their meals off food obtained as best they could.

Feb. 27 is assigned as the day of several saints, of whom not unnoteworthy is St. Thalilæus of Syria, who "wept almost without intermission for sixty years and for ten years lived in a cage."

March 1.

ST. DAVID'S DAY.—St. David, Archbishop of Menevia, afterwards called St. David's. This saint flourished in the fifth and sixth centuries and is reputed to have died at the age of 146 years. He is said to have been of royal extraction but illegitimate, his father being one of the Welsh princes, his mother Non, daughter of Ynyr of Caer Gawch. In another account he is stated to have been an uncle of King Arthur—a matter of interest in view of the association of St. David with Glastonbury, where he founded a monastery, and to which place, it was said, his relics were translated in the tenth century.

St. David took a prominent part in the synod for the suppression of the Pelagian heresy held at Brevy in Cardiganshire. On this occasion he restored a child to life, and the ground whereon he stood to preach rose under him until it became a hill. When, after this synod, he designed to repair to his Glastonbury Monastery, he was forbidden by Our Lord in a vision, who with his finger pierced a hole in the saint's hand which remained open until the next day. St. David is also said to have been responsible for the heat of the waters of Bath, which he "cured of an infection." Many centuries after his death, in the reign of King Stephen, he caused the brook in the churchyard of St. David's to flow with wine, and the well near by to send forth milk instead of water.

St. David's Day, as that of the national saint of Wales, was at one time observed in the Principality with much festivity in rural areas. The wearing of the leek was general. It was the occasion for the exercise of a number of primitive beliefs. For example, the churchyards were visited at night to watch for corpse candles. The families on whose graves these appeared would, it was believed, lose a member within the next twelve months. A shoe thrown over the head indicated by the direction in which its toe pointed whether the thrower would move from that house or die within the year. If anyone walked round the bed of leeks three times in silence on St. David's Eve, he or she would see future wife or husband as the case might be.

The great feature in the observance of a saint's day in Wales, especially a local patron saint, was the Mabsant-revels which were celebrated up to so late as 1840 or 1850, and corresponded to the Irish Pattern and Breton Pardon. Their celebration on St. David's Day was, of course, general and not restricted to one locality. Religious services and processions were followed by feasting and dancing in the village inn.

It is clear that popular tradition has associated with St. David something over and above the miraculous element found in the lives of most early saints. This is shown, for example, by the Mabsant and in his reputed relationship to King Arthur. The wearing of the leek is linked with St. David, yet it is probable that the custom is much older. The traditional account is that it commemorates a battle in which the Saxons were defeated by the Welsh, who, at the instigation of St. David, wore the leek as a distinguishing badge. Another explanation is that the leek was worn to perpetuate the memory of David's abstinence in subsisting on this and other roots of the ground for many years.

It has been suggested that the veneration for the leek arose from its use by the Druids as a symbol. Possibly, however, it is connected with the custom of *cymhortha*, when farmers joined together to plough their lands in co-operation. It is said that each farmer had to provide a portion of leeks to make up the common meal. The closely interrelated interests of a small community with lands partly in common made it desirable that agricultural operations should be carried out more or less simultaneously, while for the heavier work, co-operation was essential. This can still be seen in remoter parts where one great plough, which can be drawn only by a large number of horses, has to serve the needs of all the farms of a district. The leek thus becomes a symbol of the vegetation to spring from this communal activity at the beginning of March, of which the termination was marked by a feast—the Mabsant. The saying, "On St. David's Day put oats and barley in the clay," may be an indication of some such communal activity as well as a mnemonic. The custom in London of burning a Welshman in effigy, to which Pepys refers in 1667, and of hanging up 'Taffies' or Welshmen of ginger-bread for sale on St. David's Day, may be a topical adaptation of the traditional lay figure of the spring observances to which reference has been made previously.

March 2.

ST. CHAD. A.D. 673.—Founder and bishop of the See of Lichfield. One of the numerous holy wells of London was dedicated to St. Chad. This was situated near Battle Bridge, and was still frequented for its medicinal virtues in the late eighteenth and early nineteenth centuries.

Friday in Lide, from *Lide*, A.S. March. In Cornwall on the first Friday in March, so called, a young lad was sent to the top of a mound or hillock and allowed to sleep there as long as he could, the length of his sleep fixing the duration of the tinners' midday rest for the next twelve months.

March 3.

ST. WINNOLD.—ST. WINWALOE, son of Fragan, who was nearly related to a prince of Wales, and took part in the Welsh migration to Armorica on account of the Saxon invasions. He gave his name to Plou-Fragan. Winwaloe founded a monastery at Landevinech near Brest, and, with other members of his family, is prominent in the hagiology of Brittany.

A priory in the Parish of Wereham, Norfolk, was dedicated to St. Winnold by the family of Clare at some date before 1206. Associated with it was Winnold's Fair for horses and cattle, at one time the largest and the oldest of the fairs in England. The name was retained though the fair was moved twice, first to Wimbolsham and then to Downham, after the Dissolution.

Societies and Academies.

LONDON.

Royal Society, Feb. 16.—**A. Fowler** and **E. W. H. Selwyn**: The arc spectrum of carbon. Further observations of the arc spectrum of carbon (C I) have been made, and the classification of the lines has been considerably extended. The deepest term is a triplet P_0, the value of which is estimated as 90107, corresponding to an ionisation potential of 11·2 volts.

R. H. Fowler: The chemical constant of hydrogen vapour and the failure of Nernst's heat theorem. Dennison's theory of the specific heat of hydrogen requires that at ordinary and low temperatures it should behave as a non-combining mixture of two different sorts of molecules, the symmetrical and the antisymmetrical, in the proportion 1 to 3. It follows that the observed constant in the vapour pressure equation will be given only if liquid and solid hydrogen are equally mixtures of the two non-combining molecules in the same proportion. It then follows that the weight of the lowest state of solid hydrogen cannot have the value 1, so that the entropy of the solid remains positive at the absolute zero.

A. H. Wilson: The ionised hydrogen molecule. Schrödinger's method is applied to the quantisation of a molecular system consisting of one electron and two protons. If wave functions which are bounded in the whole of three dimensional space are used, the system admits of no stationary states. By employing a wave function which becomes infinite at the two nuclei and along the line joining them, stationary states exist for all distances apart of the nuclei. Formulæ are given for the calculation of the energy of the lowest state, and the minimum value of this for different nuclear separations gives the energy of the ion H_2^+.

A. H. Wilson: A generalised spheroidal wave equation. The equation is a second-order differential equation with three real singular points, two regular and the third irregular. It contains three independent parameters, and there are many types of solutions, but only two are of importance. The first class consists of those functions which are bounded in the real interval joining the two regular singularities. To obtain these functions it is necessary to impose one relation on the parameters. The second class of functions consists of those bounded in the real interval joining a regular singularity to the irregular point, and two algebraic relations must be imposed on the three parameters.

O. H. Walters and **S. Barratt**: The alkaline earth halide spectra and their origin. A method has been found by which the alkaline earth halide spectra can all be observed in absorption. The conditions of experiment prove that the spectra originate from subhalide molecules, probably of the type MX, and not from the normal salts. These subhalides exist in stable equilibrium with the metal and the normal salt as vapours at 1000° C. The spectra have been examined by the absorption method, and new band groups have been observed in the ultra-violet. The calcium fluoride band 5292 has been examined under high dispersion. Its structures, in absorption and emission, have proved to be very different.

T. R. Merton: On a new effect in the electric discharge. A new type of electric discharge has been observed in vacuum tubes containing helium and carbon. The principal feature consists in the formation of bright discs which, unlike the striæ usually observed in vacuum tubes, are unaffected by weak magnetic fields. A violent disturbance, such as the passage of a condensed discharge, is necessary to start the formation of the discs, which can only be maintained with alternating currents. When a direct current is superposed on the alternating current the disc moves towards the anode. When the tubes are excited by direct current there is a migration of carbon compounds to the cathode. The phenomena have been investigated by stroboscopic methods. Carbon monoxide is decomposed in the discs with the formation of a particulate cloud of carbon. The effects are discussed in relation to the phenomenon known as ball lightning.

P. A. M. Dirac: The quantum theory of the electron (Part 2). Proof is given of the conservation theorem, and further developments are made in the application to spectra of atoms with single electrons. The various series of terms are described by a single quantum number j, taking both positive and negative integral values. The selection rule for j is equivalent to the two selection rules of the previous theory. Relative intensities of lines of a multiplet, and the anomalous Zeeman effect for weak and strong fields, also give results in agreement with previous theories.

S. W. Watson and **M. C. Henderson**: The heating effects of thorium and radium products. A resistance thermometer method was employed, the calorimeter wall having an absorbing thickness equivalent to 0·7 mm. of aluminium. Using the known rate of emission of particles by thorium C relative to radium C, the ratio of observed to calculated heating is constant within experimental error for all five products, and agrees well with Hess and Lawson's value of Z, namely, $3{\cdot}72 \times 10^{10}$ α-particles per gm. per sec. The discrepancy in the worst case, namely, thorium (B + C), is 2 per cent. If Geiger and Werner's value of Z, namely, $3{\cdot}40 \times 10^{10}$, be correct, the excess heat over and above that provided by the known radiations must be a nearly constant fraction of the whole (9 to 12 per cent.) for all the substances investigated. It must also be in a form easily absorbed by 0·7 mm. of aluminium, and if electromagnetic would require about 40 quanta at least per atom disintegrating.

H. F. Baker: Note on the paper "Commutative Ordinary Differential Operators" by J. L. Burchnell and T. W. Chaundy. In the classical theory of Abelian functions, the passage from the algebraic functions to the theta functions is made by a function which is the exponential of a sum of integrals of the third kind; the upper limits of these depend on arguments determined by an inversion theorem. Messrs. Burchnell and Chaundy's paper deals with the particular case of this when all these arguments except one are zero. They use an extended inversion theorem which disguises the essential character of the coefficients in the differential equations obtained. Simplification is possible in the modular expression of algebraic integrals when the fundamental algebraic equation has the canonical Weierstrass form.

L. S. Ornstein, W. Kapuscinski, and **J. G. Eyners**: Intensity measurements in the secondary spectrum of hydrogen. The intensities of the lines in the secondary spectrum of hydrogen have been measured in the region 4500-4900 A. by the Utrecht method.

Optical Society, Jan. 19.—**T. Smith**: (1) On toric lenses. A system of toric lenses having a common normal to all their surfaces possesses in general ten independent primordial coefficients. A single surface has only three degrees of freedom, and this number also holds for any system of negligible axial depth. Formulæ are given for the calculation of the ten coefficients, which are only all independent when the system includes at least three separated toric refract-

ing surfaces with their planes of principal curvature finitely inclined to one another. An eye with both its cornea and its crystalline lens astigmatic and the meridians of principal curvature different has more independent coefficients than a spectacle lens has effective degrees of freedom. (2) Canonical forms in the theory of asymmetrical optical systems. Canonical forms for the quadratic terms of the eikonal and of the characteristic function for any optical instrument involve only six arbitrary constants. The seven constant canonical form of the characteristic function obtained by Larmor is not general. Larmor's theorem on the equivalence of any optical system to a symmetrical instrument together with two thin astigmatic lenses also fails. Three separated astigmatic lenses are needed to represent the general system.—**M. Herzberger**: Some remarks on an extension of the optical cosine law. In this note reference is made to an extension of the optical cosine law, a full description of which will appear in the *Zeitschrift für Physik*.

Physical Society, Jan. 27.—**W. E. Pretty**: The Swan band spectrum of carbon. The Swan spectrum has been obtained in carbon monoxide and in the carbon spark in the absence of hydrogen. A discussion of the results of experiment and theory leads to the conclusion that the emitter of the Swan band system is the molecule of carbon (C_2).—**T. Smith**: On some misapplications of the law of errors and on the intrinsic error in focometry. In some physical measurements the uncertainty due to a single cause is not infinitesimal, and the precision of the mean of a large number of observations given by the law of errors is not then physically significant. An example is afforded in attempts to identify the position of an optical image. According to geometrical optics, this lies in a definite surface; but, owing to the physical properties of light, this surface cannot be identified experimentally. The use of a double cylindrical lens as a means of limiting more narrowly the space in which this surface lies is discussed.—**A. H. Davis**: Some acoustical phenomena illustrated by ripples—transmission through Quincke filters, curved conduits and vibrating partitions. The paper employs ripple photographs to illustrate the action of the Quincke acoustical filter, and directs attention to the filtering action which is likely to occur at bends in curved sound conduits or in curved horns owing to resonant transverse vibration of the contained air. It also illustrates by the ripple analogy the transmission of sound through partitions.

EDINBURGH.

Royal Society, Jan. 9.—**Penelope M. Jenkin**: Note on the sympathetic nervous system of *Lepidosiren paradoxa*. A slender sympathetic trunk without obvious ganglionic swellings runs along each side of the dorsal aorta, receiving a *ramus communicans* from each spinal nerve throughout the length of the splanchnocœle. The trunk could be traced for a short distance into the tail region; anteriorly it could not be traced farther forwards than the first spinal nerve. Ganglion cells were found diffusely scattered through the trunk. No communication with the vagus ganglion, no collateral trunk, no medullated fibres, could be detected. On the whole, the sympathetic of Lepidosiren shows most close affinity to that of *Salamandrine urodeles*.—**D. Noël Paton**: Reflex postural adjustments of balance in the duck. A series of reflexes in the intact and in the decerebrated duck induced by disturbing the balance round antero-posterior and a transverse axes are described and analysed and explained as developed for the readjustment of equilibrium.—**E. A. Baker**: The law of blackening of the photographic plate at low densities (3). The dependence of the density of a photographic deposit on the conditions of exposure and development, in particular when the density is low, is interpreted as indicating that several distinct latent images are formed, the most important being a slowly developing image involving two consecutive quantum absorptions; a rapidly developing image involving three absorptions, together with an intervening 'emission' and a very slowly developing 'reversed' image involving three consecutive absorptions. Various phenomena, including those involving two separated exposures, are successfully predicted.—**Edith Philip Smith**: A comparative study of the stem structure of the genus Clematis, with special reference to anatomical changes induced by vegetative propagation. The genus includes 160 species, of cosmopolitan distribution, ranging in habit from lianes to woody herbs. Of these, 137 were examined. The general vascular anatomy of the genus is remarkably consistent, centring round the simple Vitalba-type with 12 foliar bundles. The origin of callus is from the interfascicular cambium: adventitious roots come from the fascicular cambium. Propagation by stem cuttings is made easier by previous partial etiolation: the anatomical effects of this treatment are discussed.

PARIS.

Academy of Sciences, Jan. 16.—**Pierre Termier**: The *pays de nappes* of the French Alps.—**E. Leclainche** and **H. Vallée**: Vaccination against anthrax. A description of improved methods of preparing immunising sera from *Clostridium Chauvœi*. Filtration has been abandoned for supercentrifugation with subsequent addition of formaldehyde, and a mixed culture of various strains and different ages is used. Details are given of the results of the practical application of the sera, which is shown to be safe and effective.—**Nemours-Auguste** and **A. R. Barrieu**: The treatment of angina pectoris by radiotherapy.—**G. Nicoladzé**: An arithmometer with purely electrical direct multiplication.—**d'Ocagne**: Remarks on the preceding communication.—**Charles Colombi**: The number of specific turns of steam turbines.—**Emile Merlin**: Fluids with cylindrical stratification in rotation round an axis.—**Jean Fieux**: A new gyroscopic apparatus for preventing rolling of vessels. A description and drawing of the proposed apparatus is given, together with a curve showing the result of applying the apparatus to a vessel of 880 tons displacement.—**A. Lévêque**: The difference of the variation of temperature along the surface of exchange on the transmission of heat between this surface and a fluid in motion.—**A. Lafay**: The electromotive force of friction of metals. Subject to certain precautions described, it has been proved experimentally that the E.M.F. produced by the friction of metals is proportional to the relative velocities of the rubbing substances, and is independent of the pressure maintaining them in contact.—**H. Jedrzejowski**: The phenomenon of inversion in biotite submitted to the action of the α-rays. Joly, in discussing the explanation of the ring structure of the haloes in biotite, has suggested an inversion analogous with that shown by over-exposed photographic plates as the cause. This view is confirmed experimentally, and it is proved that in consequence the determination of the age of minerals by the haloes may lead to erroneous conclusions.—**Frilley**: Spectrography of the γ-rays by crystalline diffraction. The apparatus, described in detail, furnishes a parallel bundle of γ-rays, freed from β-rays, and the spectrum is obtained by the rotating crystal method (rock salt).

The lines attributable to radium *B* and radium *C* are comprised between 35 and 284 U.X.—**Georges Simon**: The development of a Daguerre plate by cathode pulverisation.—**Henri Chrétien**: Photographic method with high luminosity.—**H. Colin and Mlle. A. Chaudun**: Velocity of hydrolysis and hydrogen ion concentration. The results of experiments on the hydrolysis of sugar are given, in which the effect of various acids and addition of salts were studied: it was found that the variations of the hydrolysis constant are never parallel with the variations in hydrogen ion concentration.—**Pierre Chevenard and Albert Portevin**: Causes of the variation of volume accompanying the hardening of the light aluminium-copper alloys.—**P. Laffitte and P. Dumanois**: The velocity of the explosive wave. The velocities of the explosive wave in mixtures of hydrogen and oxygen and methane with oxygen, at varying initial pressures, have been measured by the photographic method both with and without added lead tetraethyl. The velocity of propagation of the explosive wave proved to be independent of the presence of the antidetonant in the gaseous mixture.—**Max and Michel Polonovski**: ψ-scopine and scopoline.—**E. Tassilly, A. Belot, and M. Descombes**: The saponification of ethyl phenylethylmalonate by alkalis. In this saponification, some phenylethylacetic acid is always formed, this forming the main product of the saponification in hot alcoholic solution.—**J. Bougault and L. Daniel**: The sulphoxytriazines.—**A. Apard**: The metallic complexes of the cellulose nitrates.—**Jacques Bourcart and M. E. Denaeyer**: The lithological characters of the intrusive rocks of the Central Sahara Massif (Jacques Bourcart expedition, 1922-1923).—**Paul Fallot**: The central part of the Sierras of Segura (Andalusia).—**F. Bordas and A. Desfemmes**: Rains containing dust and salt.—**A. Guilliermond**: Some new facts relative to the development of *Spermophthora gossypii*.—**P. Gavaudan**: The relations between the vacuome and the oil-bearing system of the Jungermanniaceæ.—**J. Amar**: The respiratory quotient.—**A. Fessard, H. Laugier, and S. Nouel**: The recovery index of a neuro-muscular system in the course of work.—**Philippe Fabre**: The form of the muscular contractions in indirect stimulation by linear currents.—**J. M. Le Goff**: The vasodilative action of the salts of cobalt.—**C. Dawydoff**: Some observations on the development of the Enteropneusts.—**L. Léger and C. Motas**: The lacustral fauna of the Grand Lautien.—**C. Mathis**: The experimental transmission of the spirochæte of the shrew mouse by the louse.—**Cordier, Lesbouyries, and Verge**: Hypoglycæmic syndrome and vitular fever.—**Marcel Labbé, H. Roubeau, and F. Nepveux**: The action of nickel and cobalt salts on the hypoglycæmic power of insulin in diabetes.—**Léon Blum and P. Grabar**: The alterations in the renal function by hypochlorination. An account of changes in the renal secretions, simulating nephritis of toxic origin, due to a deficiency of sodium chloride.—**Jean Saidman**: The therapeutic properties of X-rays of wave-length 8 A.

ROME.

Royal National Academy of the Lincei. Communications received during the vacation, 1927.—**U. Cisotti**: Spiral vortices.—**E. Bompiani**: Darboux quadratics and projective normal in a point of a surface.—**C. Rosati**: Riemann matrices.—**S. Cherubino**: Notions of parity and the real character of real Abelian varieties (1). Subnormal Riemannian matrices.—**G. Vitali**: A covariant derivation in generalised absolute calculus.—**Francesco Sbrana**: Theorems of the mean for the solutions of certain equations with partial derivatives.—**B. Finzi**: Biharmonic functions on a surface.—**A. Terracini**: Differential projective geometry of hyper surfaces.—**A. Masotti**: Observations on the motions of a fluid in which the distribution of the vortex is stationary.—**F. Ruda**: Explanation of the green ray. The variations in the colour of the last rays of the setting sun from green to blue may be attributed to the variable dimensions of the corpuscles held in suspension in the atmosphere, especially in the lower layers near to the earth's surface. When the absorption is very intense, the green or blue ray is naturally not seen, this being the case when the sun is red. Various factors may intervene to cause the divergence, at times considerable, between the theoretical and the actual durations of the phenomenon.—**C. G. Fontana**: Gold purple (2). Substances analogous to purple of Cassius may be obtained without the use of a stannous salt, the hydroxide of aluminium, zirconium, or thorium being utilised as a supporting material. In such cases the preparation is effected by means of a red, alkaline gold sol. The structure of aluminium gold purple and zirconium gold purple are completely analogous to that of purple of Cassius, the gold being present in the elementary condition and with the same high degree of dispersion. No such conclusion is found possible with the thorium gold purple.—**A. Desio**: The presence of the Miocene in the neighbourhood of El-Abiàr (Cyrenaica).—**S. Ranzi**: Differential inhibition in the development of cephalopods and considerations on the so-called axial gradient. The phenomena which, in embryos, seem to indicate the presence of an axial gradient, have their *raison d'être* in the special manner of development of the forms in question. The so-called axial gradient is not a regulator of the development, but a resultant, more apparent than real, of the occurrent phenomena, which in all cases diverge widely from Child's scheme of one or two dominant points (at the cephalic and caudal extremities).—**D. Cattaneo**: Ultramicroscopic investigations on the crystalline lens (3). Modifications of the ultramicroscopic structure by the action of disimbibition in dry air, of hydration in water, and of low and high temperatures. When the crystalline lens of the eye of the ox is kept in a desiccator containing calcium chloride for a period exceeding 24 hours, the surface fibres become slender and assume a diffuse and marked refractivity, the chondriosomes being then no longer visible; this condition of the fibres persists even if the lens is afterwards placed in water, in which the lenticular substance swells. When the fresh lens is immersed in water, the imbibition occurring reveals itself in gradual and rapid diminution up to complete disappearance of the chondriome, that is, of the differentiated part of the lenticular protoplasm. The changes produced in the lens by the action of cold are those which are manifested after the death of the cells and are thus not directly dependent on the lowering of the temperature. The effects of a high temperature on the crystalline fibres are a gradual disappearance of the differentiated part and a precipitation of the colloids constituting the fundamental protoplasm, which loses its homogeneity and becomes granular; this is essentially the phenomenon determined by the action of acids.—**A. Galamini**: The daily thermal curve of the albino rat. In accordance with the life habits of the albino rat, its temperature-time curve exhibits two maxima, at 7 A.M. and 10 P.M.-midnight, and two minima, at 1 P.M.-5 P.M. and 4 A.M. respectively.—**C. Artom**: The circulating elements of the hæmolymph of euphyllopod crustaceans. As is the case with other entomostracans, the functions of these elements seem to consist of elaboration of the fats absorbed by the epithelium of the intestine and of transport of the elaborated fats to the various tissues.

Official Publications Received.

British.

Trinidad and Tobago: Council Paper No. 90 of 1927. Department of Agriculture: Administration Report of the Director of Agriculture for the Year 1926. Pp. 42. (Trinidad: Government Printing Office, Port-of-Spain.) 1s. 6d.

The Victoria Bush Nursing Association. Report and Statement of Accounts to 30th June 1927. Pp. 205. (Melbourne.)

Department of Agriculture, Ceylon. Bulletin No. 82: Field Experimentation with Rubber (Hevea brasiliensis). By L. Lord and L. Abeyesundera. Pp. 21. (Peradeniya.) 40 cents.

The Chemist in the Photographic Industry. By O. F. Bloch. (Streatfeild Memorial Lecture, 1927.) Pp. 18. (London: Institute of Chemistry of Great Britain and Ireland.)

The Institute of Chemistry of Great Britain and Ireland. Jubilee Celebration, 14th-15th December 1927. Pp. 53. (London.)

Journal of the Chemical Society: containing Papers communicated to the Society. January. Pp. viii+iv+255. (London: Gurney and Jackson.)

Aeronautical Research Committee: Reports and Memoranda. No. 1104 (Ae. 281): On the Flow of Air behind an Inclined Flat Plate of Infinite Span. By A. Fage and F. C. Johansen. (A.1.b. Photographic Work-Flow, etc. 18.—T. 2401.) Pp. 26+3 plates. 1s. 3d. net. No. 1105 (Ae. 282): The Aerodynamics of a Simple Servo-Rudder System. By H. M. Garner and F./Lt. C. E. W. Lockyer. (A.3.b. Fins and Rudders, 10.—T. 2488.) Pp. 8+2 plates. 6d. net. (London: H.M. Stationery Office.)

Navy (Health). Statistical Report of the Health of the Navy for the Year 1925. Pp. v+189. (London: H.M. Stationery Office.) 4s. 6d. net.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Lucia, 1926. Pp. iv+29. (Trinidad, B.W.I.) 6d.

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, 1927. Pp. iv+432+98+8 plates. (London: H.M. Stationery Office.) 12s. 6d. net.

Transactions and Proceedings of the Perthshire Society of Natural Science. Vol. 8, Part 4, 1926-27. Pp. 159-233+xxxix-xlix+10 plates. (Perth.) 3s. 6d.; to Members, 2s. 6d.

Journal of the Indian Institute of Science. Vol. 10A, Part 7: Esterification in mixed Solvents. By B. V. Bhide and H. E. Watson. Pp. 71-77. 8 annas. Vol. 10A, Part 8: Nitrogen Fixation by 'Azotobacter Chroococcum.' By S. Ranganathan and Roland V. Norris. Pp. 79-96. 1.4 rupees. (Bangalore.)

Records of the Botanical Survey of India. Vol. 11, No. 2: The Flora of the Chakaria Sundarbans. By Dr. J. M. Cowan. Pp. 197-225. (Calcutta: Government of India Central Publication Branch.) 10 annas; 1s.

Committee of the Privy Council for Medical Research. Report of the Medical Research Council for the Year 1926–1927. (Cmd. 3013.) Pp. 152. (London: H.M. Stationery Office.) 3s. net.

Colony and Protectorate of Kenya. Bulletin 18: The Common Coffee Mealy-Bug (*Pseudococcus Lilacinus*, Ckll.) in Kenya Colony. By T. W. Kirkpatrick. Pp. viii+110+6 plates. (Nairobi: Government Printer.)

Proceedings of the Royal Society of Victoria. Vol. 39 (New Series), Part 2. Pp. 53-203. (Melbourne.)

Proceedings of the Fourteenth Indian Science Congress, Lahore 1927 (Second Circuit). Pp. xxiv+384. (Calcutta: Asiatic Society of Bengal.)

Department of Public Instruction, Technical Education Branch: New South Wales. Technological Museum: Extracts from the Curator's Annual Report for Year ended 31st December 1926. Pp. 4. (Sydney, N.S.W.: Alfred James Kent.)

Aeronautical Research Committee: Reports and Memoranda. No. 1108: The Rotating Wing in Aircraft. By H. E. Wimperis. Pp. 7+1 plate. 6d. net. No. 1109: The High-duty Compression-Ignition Engine. By D. R. Pye. Pp. 15. 9d. net (London: H.M. Stationery Office.)

Proceedings of the Royal Irish Academy. Vol. 38, Section A, No. 1: Observations on Atmospheric Electrical Conductivity in connection with the Solar Eclipse of 29th June 1927. By Dr. P. J. Nolan and Cillian O Brolchain. Pp. 17. 6d. Vol. 38, Section A, No. 2: Undulating Theory of Two Electron Orbits. By A. W. Conway. Pp. 18-28. 6d. (Dublin: Hodges, Figgis and Co.)

The Journal of the Royal Horticultural Society. Edited by F. J. Chittenden. Vol. 53, Part 1. Pp. 199+lxxx+xviii+25 plates. (London.) 7s. 6d.

Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1926-27. (Cmd. 3002.) Pp. iv+157. (London: H.M. Stationery Office.) 3s. net.

Margarine and the Vitamin Problem. Pp. 18. (Bromboro Port, Cheshire: Planters Foods, Ltd.)

Foreign.

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 596-E: Quality of the Surface Waters of New Jersey. By W. D. Collins and C. S. Howard. (Contributions to the Hydrology of the United States, 1927.) Pp. iv+89-119+plate 10. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Bulletin 795-D: The Brown Iron Ores of West-Middle Tennessee. By Ernest F. Burchard. (Contributions to Economic Geology, 1927, Part 1.) Pp. iv+53-112+plates 4-8. 15 cents. Bulletin 795-E: Quicksilver Deposits of the Pilot Mountains, Mineral County, Nevada. By William F. Foshag. (Contributions to Economic Geology, 1927, Part 1.) Pp. ii+113-123+plate 9. 5 cents. Bulletin 796-A: The Gillette Coal Field, Northeastern Wyoming. By C. E. Dobbin and V. H. Barnett; with a Chapter on the Minturn District and the Northwestern Part of the Gillette Field, by W. T. Thom, Jr. (Contributions to Economic Geology, 1927, Part 2.) Pp. v+64+15 plates. 35 cents. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Professional Paper 150 A: Cephalopods from the Lower Part of the Cody Shale of Oregon Basin, Wyoming. By John B. Reeside, Jr. (Shorter Contributions to General Geology, 1927.) Pp. ii+19+8 plates. 15 cents. Professional Paper 150-B: The Scaphites, an Upper Cretaceous Ammonite Group. By John B. Reeside, Jr. (Shorter Contributions to General Geology, 1927.) Pp. ii+21-86+plates 9-11. 10 cents. Professional Paper 151: The Cephalopods of the Eagle Sandstone and related Formations in the Western Interior of the United States. By John B. Reeside, Jr. Pp. iii+87+45 plates. 60 cents. (Washington, D.C.: Government Printing Office.)

Carnegie Institution of Washington. Publication No. 378: Steam Wells and other Thermal Activity at "The Geysers," California. By E. T. Allen and Arthur L. Day. Pp. 106. (Washington, D.C.: Carnegie Institution.)

Carnegie Institute of Washington. Publication No. 322B: The Pleistocene of the Western Region of North America and its Vertebrated Animals. By Oliver P. Hay. Pp. v+346+12 plates. (Washington, D.C.: Carnegie Institution.)

Carnegie Instution of Washington. Publication No. 380: Contributions to Embryology, Vol. 19, Nos. 98-108. No. 98: The Menstrual Cycle of the Monkey, *Macacus rhesus*; Observations on Normal Animals, the Effects of Removal of the Ovaries and the Effects of Injections of Ovaries and Placental Extracts into the Spayed Animals, by Edgar Allen; No. 99: Embryology of the Neuromuscular Spindle, by Fidel Cuajunco; No. 100: Development of the Mesoblast and Notochord in Pig Embryos, by George L. Streeter; No. 101: Growth of the Human Foot and its Evolutionary Significance, by William L. Straus, Jr.; No. 102: Lymphatics of the Fallopian Tube of the Sow, by Dorothy H. Anderson; No. 103: Correlated Physiological and Morphological Studies on the Development of Electrically Responsive Areas in the Cerebral Cortex of the Opossum, by Orthello R. Langworthy; No. 104: Histological Development of Cerebral Motor Areas in young Kittens correlated with their Physiological Reaction to Electrical Stimulation, by Orthello R. Langworthy; No. 105: On the Placentation of the Tridactyl Sloth, *Bradypus griseus*, with a Description of some Characters of the Fetus, by George B. Wislocki; No. 106: A Study of the Implantation of the Ovum of the Pig from the Stage of the Bilaminar Blastocyst to the completion of the Fetal Membranes, by Chester H. Heuser; No. 107: Development of the Human Heart from its First Appearance to the Stage found in Embryos of 20 Paired Somites, by Carl L. Davis; No. 108: Observations on the Ovary of the Opossum, *Didelphis virginiana*, by Carl G. Hartman. Pp. iv+300+60 plates. (Washington, D.C.: Carnegie Institution.)

Agricultural Experiment Station, Michigan State College of Agriculture and Applied Science. Technical Bulletin No. 84: The Clarifier and the Filter in Processing Milk. By P. S. Lucas, L. H. Cooledge, O. T. Goodwin and R. J. Werdon. Pp. 27. (East Lansing, Mich.)

Technical Books of 1926: a Selection. Compiled by Donald Hendry. Pp. 28. (Brooklyn, N.Y.: Pratt Institute Free Library.)

Institut de France: Académie des Sciences. Annuaire pour 1928. Pp. 384. (Paris: Gauthier-Villars et Cie.)

Proceedings of the United States National Museum. Vol. 72, Art. 7: Insects of the Subclass Apterygota from Central America and the West Indies. By J. W. Folsom. (No. 2702.) Pp. 16+8 plates. Vol. 72, Art. 19: The Green Pit Viper, *Trimeresurus gramineus*, in China. By Leonard Stejneger. (No. 2715.) Pp. 10. (Washington, D.C.: Government Printing Office.)

Société des Nations (League of Nations). Bulletins de l'Institut International de Coopération intellectuelle: Bulletin des Relations scientifiques. 2me année, No. 4, Décembre. Pp. ii+403-458. (Paris: Les Presses universitaires de France.) 8 francs.

El Observatorio del Ebro: idea general sobre el mismo. Por Rev. P. Ignacio Puig. Pp. viii+188. (Tortosa.)

Rendiconti del Seminario Matematico e Fisico di Milano. Vol. 1, (1927-V). Pp. viii+123. (Milano.)

United States Department of Agriculture. Technical Bulletin No. 53: Scouting, Quarantine and Control for the European Corn Borer, 1917–1926. By L. H. Worthley and D. J. Caffrey. Pp. 148. (Washington, D.C.: Government Printing Office.) 30 cents.

New York Academy of Sciences. Scientific Survey of Porto Rico and the Virgin Islands. Vol. 9, Part 4: The Birds of Porto Rico and the Virgin Islands. Psittaciformes to Passeriformes. By Alexander Wetmore. Pp. 409-598+xiii+plates 62-65. (New York City.)

Marine Borers and their Relation to Marine Construction on the Pacific Coast: being the Final Report of the San Francisco Bay Marine Piling Committee. C. L. Hill and C. A. Kofoid, Editors-in-Chief. Prepared under the direction of the San Francisco Bay Marine Piling Committee cooperating with the National Research Council and the American Wood-Preservers' Association. Pp. ix+357. (Berkeley, Cal.: University of California Press.) 4 dollars.

Annual Report of the Naval Observatory for the Fiscal Year 1927. (Appendix No. 2 to Annual Report of the Chief of the Bureau of Navigation, 1927.) Pp. 16. (Washington, D.C.: Government Printing Office.)

Proceedings of the United States National Museum. Vol. 72, Art. 20: Foraminifera of the Genus Siphonina and related Genera. By Joseph Cushman. (No. 2716.) Pp. 15+4 plates. Vol. 72, Art. 28: The Flora of the Esmeralda Formation in Western Nevada. By Edward W. Berry. (No. 2719.) Pp. 15+2 plates. (Washington, D.C.: Government Printing Office.)

Veröffentlichungen des Geophysikalischen Instituts der Universitat Leipzig. Zweite Serie: Spezialarbeiten aus dem Geophysikalischen Institut. Band 3, Heft 4: Über warme Hochdruckgebiete und ihre Rolle im atmosphärischen Wärmehaushalt. Von R. Mugge. Pp. 239-266. Band 3, Heft 5: Beziehungen zwischen Luftdruck- und Temperaturänderungen; ein Beitrag zur Frage des "Sitzes" der Luftdruckschwankungen. Von Bernard Haurwitz. Pp. 267-330+4 Tafeln. (Leipzig.)

The University of Colorado Studies. Vol. 16, No. 1, June. Pp. ii+74+9 plates. (Boulder, Colo.)

U.S. Department of Agriculture. Technical Bulletin No. 26: Our Migrant Shorebirds in Southern South America. By Alexander Wetmore. Pp. 24. (Washington, D.C.: Government Printing Office.) 5 cents.

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards. No. 564: Absolute Measurement of Capacitance by Maxwell's Method. By Harvey L. Curtis and Charles Moon. Pp. 487-531. 15 cents. No. 565: Thermal Expansion of Beryllium and Aluminium-Beryllium Alloys. By Peter Hidnert and W. T. Sweeney. Pp. 533-545. 10 cents. No. 566: Indeterminateness of Electrical Charge. By Chester Snow. Pp. 547-556. 5 cents. (Washington, D.C.: Government Printing Office.)

Journal of the Faculty of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 21, Part 3: Beiträge zu einer Monographie der Gattung *Pucciniastrum* Otth. Von Naohide Hiratsuka. Pp. 63-119+1 Tafel. (Tokyo: Maruzen Co., Ltd.)

Calendario del Santuario e delle Opere di Beneficenza Cristiana di Valle di Pompei, 1928. Pp. 256. (Valle di Pompei.)

Abisko Naturvetenskapliga Station. Observations météorologiques à Abisko en 1914. Rédigées par F. Lindholm et Bruno Rolf. Pp. ii+76. Observations météorologiques à Abisko en 1925. Rédigées par Bruno Rolf. Pp. iv+66. (Stockholm.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 7, 1925. iii: Vattenståndet vid Rikets kuster. Pp. ii+21. (Stockholm.) 2.00 kr.

Diary of Societies.

SATURDAY, FEBRUARY 25.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students' Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.- Dr. R. J. Perring: Miners' Nystagmus.—*Paper open for further discussion*:—A Contribution to the Solution of the Problem of Underground Haulage Accidents, with special reference to the Northern Mines Inspection Division, by A. M. Bryan.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—C. Dodgson: The Life and Work of Albrecht Durer (I).

MONDAY, FEBRUARY 27.

INSTITUTE OF ACTUARIES, at 5.—C. F. Warren: Further Notes on an Investigation into the Mortality Experienced by Pensioners of the Staffs of Banks and Insurance Companies.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—L. Emanueli and others: Discussion on 130,000-volt Cables.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—D. S. Munro: Modern Electrical Wiring, particularly as applied to Small Houses.

ROYAL SOCIETY OF ARTS, at 8.—Dr. H. Gough: Fatigue Phenomena, with special reference to Single Crystals (Cantor Lectures) (III.).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Mrs. Lilian Lindsay: Dentistry as one of the Fine Arts.—A. T. Marston: A Case of Necrosis of the Mandible.

TUESDAY, FEBRUARY 28.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Meeting), at 4.30.—Sir Stephen Montagu Burrows: The Ancient Civilisation of Ceylon.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.—Dr. H. L. Tidy: Hemorrhagic Diathesis.

ILLUMINATING ENGINEERING SOCIETY (at E.L.M.A. Lighting Service Bureau), at 6.30.—W. E. Bush: The Activities of the E.L.M.A. Lighting Service Bureau.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at Loughborough College), at 6.45.—H. B. Poynder: Some Practical Considerations in the Design of Automatic Equipments for Heavy Traction Substations.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—C. H. Oakden: The Photographic Work of the Rev. J. B. Reade.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—E. K. Tratman: Aveline's Hole, a late Upper Palæolithic Station in Somerset.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 8.30.—Prof. R. V. Wheeler and Dr. G. B. Maxwell: Flame Characteristics of Pinking and Non-Pinking Fuels.

WEDNESDAY, FEBRUARY 29.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: The Behaviour of Animals (II.).

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at Wellcome Historical Medical Museum, 54A Wigmore Street), at 5.30.

ROYAL SOCIETY OF ARTS, at 8.—A. Crawford: Industry Fifty Years Hence.

BRITISH ASTRONOMICAL ASSOCIATION (at Sion College, Victoria Embankment).

THURSDAY, MARCH 1.

ROYAL SOCIETY, at 4.30.—Dr. A. E. H. Tutton: The Hexahydrated Double Sulphates containing Thallium.—The Hexahydrated Double Selenates containing Thallium.—W. H. J. Childs: The Distribution of Intensity in the Band Spectrum of Helium: the band λ4650.—M. C. Johnson: Studies in the Behaviour of Hydrogen and Mercury at the Electrode Surfaces of Spectrum Tubes.—*Papers to be read in title only*:—Prof. W. E. Curtis: The Structure of the Band Spectrum of Helium.—Prof. H. A. Wilson: The Saha Theory and the Conductivity of Flames containing Alkali Metal Vapours.—R. G. Lunnon: Fluid Resistance to Moving Spheres.—Prof. S. Chapman: On the Brownian Displacements and Thermal Diffusion of Grains Suspended in a Non-Uniform Fluid.—N. F. Mott: The Solution of the Wave Equation for the Scattering of Particles by a Coulombian Centre of Force.—G. H. Biggs: A Redetermination of the Velocities of α-Particles from Radium C, Thorium C and C'.

LINNEAN SOCIETY OF LONDON, at 5.—A. M. Smith: The Algæ of a Bog, Five Years' Observations.—Dr. C. Crossland: Coral Reefs of Tahiti, Moorea, and Rarotonga.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. F. A. E. Crew: Individual, Familial, and Racial Differences in Respect of Immunities and Disease Resistance (Milroy Lectures) (I.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. F. Ll. Griffith: Nubia in Antiquity and in the Middle Ages (II.).

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Dr. S. Z. de Ferranti: Electricity in the Service of Man (Faraday Lecture).

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Wing Comdr. R. M. Hill: Experiences with the Baghdad Air Mail.

INSTITUTE OF METALS (Birmingham Local Section) (at Engineers' Club, Birmingham), at 7.—Prof. C. A. Edwards: Gases in Metals.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (Jointly with Bristol Section of Society) (at Bristol), at 7.30.—T. Penny: The Art of Soap Manufacture.

CHEMICAL SOCIETY, at 8.—F. G. Mann: The Complex Salts of Divalent Platinum with αβγ-triaminopropane.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch).—W. Watson: The Spinning of a Cotton Thread and the Machinery Used.

FRIDAY, MARCH 2.

ROYAL ASTRONOMICAL SOCIETY, at 4.30.—Geophysical Discussion: Periodicities. Chairman: Dr. G. C. Simpson. Speakers: Sir Gilbert Walker, Prof. Turner, Mr. Yule, Mr. Brunt.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at Engineers' Club, Manchester), at 7.—Dr. T. Callan and S. Horobin: Some Industrial Applications of the Potentiometric and Conductometric Method of Analysis.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—Annual General Meeting.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—A. Abbey: Some Notes on a Recent Visit to the United States of America.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Prof. E. J. Garwood: River Meanders (Lecture).

PHILOLOGICAL SOCIETY (at University College), at 8.—L. C. Wharton: Universal Language of late Dr. Mason.—Report of the Copenhagen Conference on Transcription and Transliteration.

OXFORD UNIVERSITY JUNIOR SCIENTIFIC CLUB (in Department of Biochemistry and Physiology, Oxford), at 8.15.—H. T. Tizard: Careers for Scientific Men.

ROYAL SOCIETY OF MEDICINE (Anæsthetics and Obstetrics Sections), at 8.30.—Discussion on Anæsthesia in Obstetrics. Speakers: Dr. J. Blomfield and H. A. Richards (Anæsthetics); E. Holland and W. Gilliatt (Obstetrics); also H. E. G. Boyle and Dr. H. R. Spencer.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Farquhar Buzzard: The Psychology of the Sick.

SATURDAY, MARCH 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—C. Dodgson: The Life and Work of Albrecht Dürer (II.).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 25.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. Edith Durham: Primitive Life in South-East Europe.

MONDAY, FEBRUARY 27.

GRESHAM COLLEGE, at 6.—G. P. Bailey: Modern Science and Daily Life: Chemistry in Industry.

LEEDS UNIVERSITY, at 8.—Dr. Ll. Wynn Jones: Recent Advances in Experimental Psychology: Applications to Education and Industry.

WEDNESDAY, FEBRUARY 29.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.30.—Sir Robert Armstrong-Jones: The Present Legal Aspect of the Treatment of the Insane and the Mentally Defective.

BIRKBECK COLLEGE, at 5.30.—Dr. F. A. E. Crew: Heredity. (Succeeding Lectures on Mar. 7 and 9.)

THURSDAY, MARCH 1.

LEEDS UNIVERSITY, at 8.—Air Vice-Marshal Sir Sefton Brancker: Some Recent Developments in Aviation.—A. N. Shimmin: Economics in Everyday Life: The Getting of Money.

FRIDAY, MARCH 2.

KING'S COLLEGE, at 5.30.—S. Gaselee: Greek Culture in Egypt at the Time of the Arab Invasion.

SATURDAY, MARCH 3.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—J. E. S. Dallas: A Naturalist at Land's End.

CONFERENCE.

FEBRUARY 24 AND 25.

ASSOCIATION OF TECHNICAL INSTITUTIONS (Annual Meeting) (at Stationers Hall).

Principal G. H. Austin: Commercial Education.

Principal S. Carter: Suitable Courses in Commerce for Small Institutions.

T. P. Bennett: The Technical Training of the Architect.

Principal F. E. Drury: Technical Education for the Building Trades.

F. W. Roberts: Technical Education for the Boot and Shoe Industry.

SATURDAY, MARCH 3, 1928.

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The Science of Scenery.

THE study of scenery as land form has long been the subject of scientific inquiry. The slow but ever acting processes of earth sculpture have been observed, and the everlasting hills of our experience have become in mental vision but shadows of a changing earth flowing from form to form. Mountain and vale, river and coast, each can be explained from the texture of the rock and the character of the tools used by Nature in the shaping of the earth. What man naturally sees, however, is not land form but landscape, and his sympathetic appreciation of the latter rests on entirely different principles from his intellectual understanding of the former.

Landscape is too elusive in its composition, too fickle in its ever-changing form, to be bound by rigid laws of science, and yet it is obviously subject to certain laws of harmony. "Every landscape," states Prof. Alexander, "has to be composed. He who finds Nature beautiful does not manipulate with chisel or brush or voice the material he uses; he makes it beautiful by selection and composition, and, if need be, by imaginative addition. The fact is that the Nature we find beautiful is not bare Nature as she exists apart from us, but Nature as seen by the artistic eye." The laws of scenery may be compared with those of music. They are the laws of harmony.

It is to find a scientific foundation for the æsthetic study of scenery that Dr. Vaughan Cornish has of recent years turned his careful observation. Some of his results have formed the subject matter of many publications, and from these the following examples of his methods have been drawn.[1] The tones and colours of every landscape go through a cycle of change with the daily and annual revolution of the sun, and it is evident, therefore, that an æsthetic science of scenery must give an account of all these changes. They are exactly recurrent, and the results would be precise were it not that the atmosphere interposes a screen or veil of varying density according to the weather.

Dr. Vaughan Cornish is of the opinion, however, that, taking account both of the position of the sun and the state of the atmosphere, the effects observed are sufficiently definable to admit of a systematic and fairly simple description and explanation of the variation of tone and colour in the landscape. As an example he describes three varieties of atmospheric condition

[1] Presidential Address, Geographical Association, Jan. 1928. See also *Geographical Journal*, Nov. 1925; June and Nov. 1926.

as they affect an extensive view of lowland. On fine days, with the exceptionally clear air which often precedes rain, there is a broad foreground of lights, shadows, and local colours. In the far distance the landscape is richly dyed with atmospheric shades of purple and of blue. The middle band of relatively unattractive tone and colour is less noticeable and perhaps is actually narrowed. This constitutes the richest daylight harmony of light and landscape on the English plain. On a misty day the farthest parts of such extensive prospects are shut out and the foreground loses in stereoscopic strength and in contrast of light and shadow. The undulations of the middle distances are then revealed in unwonted emphasis by the increased rate of atmospheric absorption and with an attractive tint of silver grey.

During spells of fine summer weather of anticyclonic type there is no broad harmony of light and landscape in the English plain. The diffusion of the sun's rays in the upper air deprives the foreground of much of the vitality of tone and colour which are its proper charm and the means whereby it acts as a *distancer* for the rest of the landscape; the farthest undulations of the land lack atmospheric blue, and thin cloud, reflecting a crude white light from the sun, usually makes the sky near the horizon too garish to be viewed together with the distant land. These factors in tone and colour in relation to distance enter also into questions of apparent magnitude with its effect on landscape. Thus it is pointed out that distance affects the tone of clouds and mountains in opposite ways. Mountains physically compact look less massive from a distance, being then merely the opaque background of a translucent coloured medium. Cloud, on the contrary, being a sparse collection of small particles, is misty near at hand, but in its piled-up or cumulus form, appears compact and massive at a distance of a few miles. At close quarters, where clouds appear vaporous and mountains massive, the relation between them is altogether desirable.

From this example of natural scenery we turn to one in which man's work is superimposed on Nature. In his 'scenery of civilisation' Dr. Vaughan Cornish strikes a note of great practical significance. In its largest sense, Nature includes humanity, and the works of man may or may not blend with Nature to form harmonious groupings of æsthetic landscapes. The charm of old towns and places lies not solely in their age, but in the degree with which they conform to the laws of æsthetic geography. The city is the greatest expression of man's regional activity, and the stately avenues of a well-planned city are the crowning examples of one of the most characteristic contributions made by man to the scenery of the world—the vista—that pleasant path of converging lines which leads the eye to a point of rest in the far distance. The towering effect of buildings in the foreground, always considerable from the effect of vertical planes, is enhanced by columnar relief, which being imperceptible at a distance, does not interfere with the perspective of regular and strongly marked cornices reinforcing recessional effect in the remoter view.

Delight in the vista led men long since to plant trees in avenues of approach to lordly mansions, and later occurrences of a somewhat accidental character brought in the boulevard. Here we have not only the simultaneous pleasure of a vista of buildings and a vista of trees, with pleasant combination of colour in the season of the leaf, but also an enhancement of architecture, which, though appreciable at all seasons, is especially remarkable when the boughs are bare. The plane tree, which is mostly chosen for boulevard planting, is unsurpassed in winter for the combined delicacy and magnitude of the three-dimensioned lattice, which, as a foreground, makes space itself stereoscopic, distancing and magnifying the architectural background, to which, moreover, it imparts an atmospheric tone. The constructional lines of the dome, the crescent, and the archways of a stone-built bridge, are a monotonous repetition of balanced curves, but seen near by as they are in cities, perspective transforms monotony to rhythm, and the rhythm changes with every step of our approach, the curve of each element of the structure changing, the change different for each element according to its position, the change from form to form so subtle, so continuous in its flow, that it imparts the sense of infinity.

These two examples, culled from the records of Dr. Vaughan Cornish, illustrate the range of his inquiries and the principles upon which he is working. Investigation into the laws which govern scenery is of course valuable in itself. It points, however, to a practical maxim of great worth in view of man's increasing energy to change the surface of the earth. We are to-day great city builders, and even the countryside we tend to urbanise. The townward drift of men is everywhere observable, swelling to inordinate size our cities and city agglomerations. The evidence appears incontrovertible that, for good or ill, cities and culture go together. The higher men rise in

the social scale, the more they appear to desire to be within the circle of civic life.

No greater example of the national danger which comes from the absence of such institutions may be found than in the report which was issued some ten years ago by the Commission of Inquiry into Industrial Unrest in South Wales (Cd. 8668, 1917). Physical conditions in the narrow valleys of the coalfield have resulted in great populations being crowded in long rows of congested villages set in the shadow of slopes falling steeply to the stream bed where roads and railway and colliery workings are placed. The beauty of Nature has been destroyed and no 'scenery of civilisation' has taken its place. Cities and civic life are absent in these valleys, and to the present dismal surroundings the report traces the prime cause of social unrest there.

It is a characteristic of the industrial age that it has been one in which humanity has been crowded together round mill and factory. We have reached a stage in the evolution of cities, however, when the vulgar ugliness of industrial towns no longer satisfies. Town planning is the order of the day, but on what principles shall we develop constructive civic art or shape the countryside? Patrick Geddes notes that Aristotle wisely insisted upon the importance not only of comparing city institutions, but also of seeing our city with our own eyes. He urged that our view be truly *synoptic*, a word which had not then become abstract, but was vividly concrete as its make-up shows. It meant the seeing of the city as a whole, like Athens from the Acropolis, or rather of Athens and Acropolis together—the real Athens—from Lycabettos and from Piræus, from hill-top and from sea. Large views in the abstract depend on large views in the concrete.

The appreciation of scenery, in this fullest sense, is, like the quality of mercy, twice blessed. To the individual it gives a new pleasure in the world around him. To a community educated in scenery appreciation, it reveals principles which should guide constructive art in Nature, principles which will influence for abiding good the resettlement of England and of other countries consequent on a vigorous development of the economic resources of the earth with new means of transport and communication. The diagnosis of scenic beauty made by Dr. Cornish in his addresses should appeal particularly to all who are concerned in regional surveys and the preservation of rural scenery or the relation of architecture to landscape.

Palæometrology.

(1) *Glass Stamps and Weights: Illustrated from the Egyptian Collection in University College, London.* By Sir Flinders Petrie. Pp. vi + 28 + 26 plates. (London: British School of Archæology in Egypt, 1926.) n.p.

(2) *Ancient Weights and Measures: Illustrated by the Egyptian Collection in University College, London.* By Sir Flinders Petrie. Pp. vi + 51 + 54 plates. (London: Department of Egyptology, University College, 1926.) n.p.

FIFTY years ago there was published in London a small book with an ambitious title, "Inductive Metrology." It was an account of the author's attempts to discover from ancient structures, by an analysis of their ascertainable dimensions, the basic units of linear measurement that must have been employed by their builders. The adjective served to direct attention to the contrast between the author's method and the prevalent practice of spinning unverifiable hypotheses out of the vague data furnished by remains of a purely literary character. The method was not new, even in relation to the investigation of ancient metrology—it had been used by Newton in his endeavour to ascertain the length of the sacred cubit from certain dimensions of the Great Pyramid—but it had never hitherto been exercised upon so large a scale.

Now the applicability of the inductive method depends greatly upon the extent to which trustworthy observational data are envisaged, and this again depends upon the degree to which relevant material is available for observation. These considerations were clearly appreciated by the author of "Inductive Metrology," and, seeing that the supply of material or of observational data were deplorably lacking, such trivialities having been almost completely ignored alike by writer and excavator, he set himself with a will to remedy the deficiency. As a consequence the name of Flinders Petrie has become inseparable from mention not only of ancient metrology but also of scientific Egyptology in general.

Within a few years of the publication of his initial essay he was excavating, on behalf of the newly formed Egyptian Exploration Fund, the ancient cities of the Delta, whence, especially from Naucratis, Tanis, and Defenneh, he recovered *inter alia* great quantities of weights of various ages, shapes, sizes, materials, and states of preservation. To the data obtained from this material, carefully corrected for estimated losses and accretions, he applied the method of statistical analysis which had

proved so effective in his study of linear measurements, and arrived at certain conclusions with regard to ancient units of weight, duly publishing his results in the reports of his excavations. Since that time the store of Egyptian weights recovered has been periodically augmented through the labours of the British School, and now amounts to about six thousand specimens, of which number two-thirds are preserved in the collection at University College, London, together with a smaller but still important assemblage of measures of capacity and of length, and a few examples, mostly of late periods, of balances and steelyards.

The present volumes are primarily of the nature of a catalogue of all objects of a metrological character contained in that collection, and as such they have a value proportional to the importance and uniqueness of the collection; but they are considerably more than mere descriptive enumerations: they are studies in the art of scientific classification. In the introduction to the larger work, Sir Flinders Petrie modestly disclaims any attempt to deal with the whole field of ancient metrology. "This," he says, "is only a publication of material, and in the necessary classification of it we may reach some solid foundation for the whole subject." Whether the foundation that has been reached is solid enough to support a permanent edifice time will no doubt show, but if the prodigious industry, meticulous care, unwearying patience, and searching breadth of view to which these two books bear witness are insufficient for the purpose, we may have long to wait for the provision of a sounder basis.

All who have at any time been led by circumstance to seek for authentic information regarding ancient units of weights and measure, and have found themselves floundering amongst competing theories of derivation and inter-relationship, or staggering through mazes of pseudo-scientific hierophantics, must surely turn with grateful relief to the findings of one who restricts himself to the consideration of actual facts. We have here no airy speculations, no arguing from questionable premises or gratuitous assumptions, but the results of a prolonged and patient examination, at every practicable angle, of a vast amount of material evidence.

Naturally these results can scarcely be expressed in the form of pocket-book tables, nor do they readily lend themselves to popular presentation, though it must be admitted that they are set forth with as much clearness as the complexity of the subject will permit. In order to form some idea of that complexity, it should be realised that as regards the weights alone the objects dealt with are from periods ranging from an early prehistoric (Amratian) age to the thirteenth century A.D.; that several systems, often with overlapping multiples and submultiples, were in simultaneous use; that individual weights might vary considerably from the standards they were intended to represent; that the mean values of the basic units fluctuated throughout the ages; that some systems were confused by the existence of single and double (or 'light' and 'heavy') varieties of the same unit; that in any given system binary, ternary, decimal, and other series of multiples might exist side by side; that most of the specimens bear no markings, and that where markings are found they are frequently of an ambiguous or misleading character; that in many instances elaborate tests and calculations have been necessary in order to allow for injury or corrosion, or both, in estimating the original weight.

With these considerations in mind, one may without difficulty credit the statement made in the larger volume that "a large amount of tentative tabulating had to be done, on various lines, before a conclusive method of handling each part of the material could be reached."

It would, of course, have been impracticable to burden the catalogue with details of all this experimental work; all the 'scaffolding,' to use the author's own expression, has been removed and the extent of it might not be realised from a mere perusal of the stated conclusions.

With regard to the weights, excluding the Arabic series, it would appear that eight fundamental units emerge from the investigation, each forming the basis of a system. The specimens are catalogued in 'registers' and grouped under their respective systems, the serial number, material, form, ascertained weight, numercial relationship to basic unit, the value of that unit and details of markings, etc., in respect of each specimen being compactly tabulated. The ancient names of the basic units were not in every instance easy to determine; indeed, but for the clues furnished by the results of recent progress as regards Palestinian weights, it is doubtful whether it would have been possible to discover the names of certain of the units or to disentangle completely the corresponding systems.

In this connexion it is to be noted that the weights are very rarely marked, like modern weights, with their value in terms of a stated denomination. When they are marked at all it is

often with some numeral which may refer to their equivalence in some system other than that to which they belong; it is as if a kilogram weight were to be marked '35' because it is roughly equivalent to 35 ounces. Even where a denomination is marked, it is apt to be nothing more than the designation of some sort of a multiple common to more than one system, the term *teben* or *deben*, for example, being used for a weight of 10 qedets or one of 10 peyems (cf. *mina*, *shekel*, etc.). Fortunately, however, the names of three standards of weight, *Necef*, *Peyem*, and *Beqa*, have been found marked on weights from Palestine belonging respectively to hitherto unnamed series which occur also in Egypt, and others were discovered which bore, in common with one Egyptian example, a sign construed as a monogram of the letters X and O, and hence, having regard to the fact that some syenite weights of apparently the same series are shaped like the shell of the cowry, to be an abbreviation for the Greek name for that mollusc, χοιρίνη. The ancient names of the four remaining basic units having been already established on abundant evidence, these Palestinian sidelights afforded a very convenient key to the solution of the nomenclature problem and to the elucidation of all the Egyptian weights hitherto unclassified.

Lest the argument outlined above for the adoption of the name *khoirine* be criticised as far-fetched, it is only fair to add that it appears to receive no small support from the information contributed by competent zoological authorities, whose observations are appended to the text; it is hard to resist the conclusion that the standard derived its name and form from the Mediterranean *Cypræa lurida*.

The eight standards recognised, then, are: (1) the *peyem*, varying from about 112 to 125 grains; (2) the *daric*, a very early Mesopotamian unit, from 124 to 133 gr.; (3) the *stater*, so called after the famous gold coinage of Philip of Macedon though of much earlier origin, 132 to 138 gr.; (4) the typically Egyptian *qedet*, 137 to 152 gr.; (5) the Syrian *necef*, 152 to 169 gr.; (6) the *khoirine*, 170 to 189 gr.; (7) the *beqa*, also known as the 'gold' standard on account of the frequent occurrence of the 'nub' sign on its examples, 187 to 214 gr.; and (8) the *sela*, or Phœnician standard, 209 to 227 gr. By reason of the variation exhibited in their different examples, these units form a continuous overlapping series, but there are no grounds for concluding that they have diverged from a common predecessor. In an interesting appendix it is shown that, with the exception of the peyem and stater, the same standards must have been used in the weighing of the precious metals at a very early time in western Europe. A remarkable comparison is drawn between the widely spread system which connected Egypt with Babylonia, Assyria, etc., and those of India, China, and Etruria, leading to some curious speculations regarding the Etruscan migration.

Although, as already stated, the work is primarily a catalogue of the Gower Street collection, the very useful step has been taken of appending in brief outline an account of various other collections of weights to which reference is made in the main text, including a hitherto unpublished list of the weights in the Græco-Roman Department of the British Museum compiled by the author forty years ago and used by him in preparing his well-known article in the "Encyclopædia Britannica." No reference, however, is made to the Egyptian weights mentioned by Chisholm in his report on various ancient weights in the British Museum in 1873 (Annual Report of Warden of the Standards, 1874–5, Appendix XI.), though the data there given would appear to be not altogether devoid of interest.

In a chapter devoted to the steelyards, a very detailed account is given of the two large and elaborate specimens of Arabic date, the remaining sixteen examples being of Roman times, and a highly ingenious method is explained for arriving at the weight unit on which the graduations are based, notwithstanding mutilations and the absence of counterpoises. The balances, including the wonderfully preserved set in a combination 'pocket' case reminiscent of those in use in Great Britain a few centuries ago, are considered not with the steelyards but separately, after the measures. Only one example is pre-Roman, and that is apparently prehistoric, a red limestone scalebeam about 3½ in. long. The inclusion of a George III. coin balance, a Chinese balance, an eighteenth-century nest of avoirdupois weights, and similar oddments in this section, strikes a note of incongruity.

The basic units deduced from the study of the measures of capacity are: (1) the Syrian standard, of 20·8 or 21·4 ± 0·3 cub. in.; (2) the native Egyptian *hen*, 29·0 ± 0·3 cub. in.; (3) the Syrian *log*, 33·1 ± 0·2 cub. in.; (4) the Attic *kotyle*, 17·2 ± 0·2 cub. in.; and (5) the Persian *kapetis*, 74·9 ± 0·3 cub. in. Most of the vessels in this section, like many of the weights, have nothing to show that they are intended as measures (or weights) except the fact that they are found to stand in more or less definite relationships to one another as regards capacity. One, however, is graduated internally and another is marked as "1/8th"; these prove to be respectively a 2-*hen* subdivided into ½-*hen* and a 1/8th

hen. The weight of water-content of the measures shows some slight agreement with the systems of weight units so far as the *hen* and the Syrian standard are concerned, but practically none otherwise. The theory of a primitive connexion between units of weight and of lineal measure receives no support whatever; indeed, such a connexion is shown to be *prima facie* improbable.

The lineal measures in the collection include eight wooden cubits, some as old as the 12th dynasty, showing the royal cubit of about 20·6 inches divided into seven palms; four rods showing the Assyrian and Jewish cubit of 21·4 inches divided into six palms; and a limestone standard measure showing a 7-palm cubit of 26·8 inches, besides various fragmentary specimens. The description of this material is followed by a discussion of the relationship between the last-named standard and those of northern countries, some striking parallels being set forth.

The smaller volume is concerned solely with the glass stamps and weights characteristic of the Arabic period. Its range of interest is accordingly more circumscribed, though even here the non-specialist may find food for reflection in the evidence afforded of the astounding degree of precision to which the medieval craftsmen were able to adjust their weights. We know from other sources that the Arab scientists bestowed great attention on the development of the balance, both for weighings in air and for the Archimedean determination of specific gravities; but even so, it is rather startling to learn that they were in fact able, during their best period (during the caliphate of El Mahdy, *circ.* A.D. 775–785), to turn out weights agreeing with the standard and with one another to within a few thousandths of a grain, or about 0·01 per cent. of their nominal weight!

To the collector this catalogue should be of the highest value, for not only is the series dealt with larger than either of those previously listed (Brit. Mus. Coll., *catal.*, Lane-Poole, 1891, and the Fouquet Coll. at Cairo, *catal.*, Casanova, 1893), but also greater attention has been bestowed on exactitude of the weights and fuller use has been made of photographic illustration, every specimen except duplicates from the same die being portrayed. As the inscriptions are not always sufficiently clear in the photographs, they are all reproduced opposite the plates. The average error and the variation of the average standard of the *dinar* and the *dirhem* over the whole period are shown graphically. Of these two standards, the former varies from about 62 to 66 gr., the latter from 44 to 48 gr. The principal multiples appear to be the *wuqiyeh* of 10 dirhems (av. 443·4 gr. in glass weights and 445·6 in metal) and the *rotl* of 12 *wuqiyehs* (av. 5814 gr.), but many of the earlier weights are marked as a *fels* of so many *kharrubehs*. The *kharrubeh* or *carob* (also = *qirat*; Gr. *keration*) is about 3 grains. Our own *carat*, legalised in 1913 as the 'Metric Carat,' is 0·2 gramme = 3·086 gr. In addition to the registers of weights there is given a chronological scheme of caliphs, governors, and other officials, also a transliteration of the curious monograms on the Byzantine *solidus* weights.

In conclusion, it certainly seems no extravagance to state of these two volumes that not only do they constitute a worthy record of a unique collection, but that they may also be regarded, especially the major work, as forming a most valuable contribution to the foundation of a rational system of palæometrology. W. H. MATTHEWS.

The Study of Living Machinery.

(1) *Muscular Movement in Man: the Factors governing Speed and Recovery from Fatigue.* By Prof. A. V. Hill. (The George Fisher Baker Non-resident Lectureship in Chemistry at Cornell University, Vol. 3.) Pp. vi + 104 + 5 plates. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1927.) 12*s.* 6*d.* net.

(2) *Living Machinery: Six Lectures delivered before a 'Juvenile Auditory' at the Royal Institution, Christmas 1926.* By Prof. A. V. Hill. Pp. xiv + 256 + 24 plates. (London: G. Bell and Sons, Ltd., 1927.) 7*s.* 6*d.* net.

(3) *Basal Metabolism in Health and Disease.* By Prof. Eugene F. Du Bois. Second edition, thoroughly revised. Pp. viii + 17-431. (London: Baillière, Tindall and Cox, 1927.) 22*s.* 6*d.* net.

(1) IT is not many years since critics of academic physiological research work were accustomed to illustrate their arguments by referring to the uselessness of the investigations which were being made on muscle function. It has now become clear that these investigations laid down basic knowledge which to-day underlies the scientific study of muscular activity in athletics, medical science, and industrial problems. In the preface of his book, "Muscular Movement in Man," Prof. A. V. Hill recounts an experience in America when, on being challenged by a member of the audience at the conclusion of a lecture to prove the value of his work, he replied that he performed experiments

because they were amusing. While it is apparent that Prof. Hill finds great amusement in his investigations, yet few physiologists are able to demonstrate the application of their work to the elucidation of practical problems as Prof. Hill has done in his recent publications.

The present-day views of muscular contraction have their origin in the investigations of Fletcher and Hopkins (1907) on the lactic acid content of muscle. These observers studied the lactic acid content of muscle under a variety of conditions, and showed that when a fatigued muscle was placed in oxygen the muscle regained its excitability and the lactic acid fell in value. These experiments suggested that lactic acid was formed by the breakdown of a carbohydrate substance (glucose) on contraction of muscle, and that the lactic acid played an important rôle in the initiation of the contraction. These investigations have, in recent years, been extended and confirmed. In the contraction of muscle, lactic acid is the most important known intermediary. It is probable, however, that the lactic acid is not further oxidised, but is re-transformed through hexosephosphate and glucose to glycogen, the energy for the process being supplied by the oxidation of a further supply of sugar; carbon dioxide, which is increased by the contraction, being formed from this later product.

The investigation of heat changes during muscular activity have confirmed the chemical findings. Recently attention has been directed by Prof. Hill and his co-workers to the viscosity of the muscle, and they have shown that during contraction the viscosity of the frog's muscle appears to rise about twenty times. The effects of viscosity changes are clearly seen in investigating the speed of shortening and the energy of contraction, for, on contraction of the muscle, the viscous elements act as a resistance to the movement. Therefore the greater the speed of shortening, the larger the proportion of energy wasted; on the other hand, if the muscle shortens too slowly, the energy is not utilised for work but is converted into heat. At some intermediate point an optimum speed may be obtained where the maximum work is done in a given time.

In "Muscular Movement in Man," which is based on a series of lectures delivered at Cornell University in 1926–27 under the non-resident lectureship in chemistry, Prof. Hill has applied the knowledge gained by investigations on the isolated frog's muscle to the problems of muscular movement in man with particular reference to athletics. The author shows how, from measurements of the oxygen consumption, information may be obtained of the change taking place in the muscle during exertion. The resting oxygen consumption is accurately measured and compared with the oxygen used during the period of exercise and period of rest following the exercise. During the period of exertion the oxygen which can be inspired is not sufficiently large to prevent the accumulation of lactic acid, and excess of oxygen must therefore be taken in during the recovery period to restore the muscles to their previous condition. The amount of oxygen used, in excess of the resting level, during the period commencing at the moment exercise ends and ending when recovery is complete, is called the 'oxygen debt.' The greatest speed which can be maintained during exercise is therefore determined by considerations of the energy expenditure. An example is given on p. 23, where the author estimates that a fit man might climb the Woolworth Building (792 ft.) in New York in eight seconds, finishing with an oxygen debt of fifteen litres, which is about all a man can tolerate. A footnote adds that the newspapers reported that the feat had actually been accomplished in nine seconds.

By an ingenious electric timing method the speed of a runner has been measured for varying distances. Plane coils of wire connected with a galvanometer were arranged parallel to the track. The runner carrying a magnet induced a current in the coil as he approached, which was recorded by the galvanometer. The author's experiments show that the slowing up during a maximal effort depends not only on the extent of the oxygen debt, but also on the increased viscosity of the fatigued muscle. The best athlete investigated took a longer time than other runners to attain his maximal speed in a 200 yards sprint, but this is due to the fact that his speed was considerably greater. It is suggested that his success in attaining so high a speed, while partly due to his skill in running, is mainly dependent on the low viscosity of his muscles. The important rôle played by the muscles in aiding the circulation during exercise is emphasised in the tables where a comparison of the oxygen consumption per kilogramme per minute is made between oarsmen and runners. The runner, by virtue of the pumping action of the muscles increasing the circulation rate, can consume per kilogramme of body weight considerably more oxygen than an oarsman.

"Muscular Movement in Man" is a book of exceptional interest. It gives the reader a clear and interesting account of muscular activity in relation to exercise, and Prof. Hill may feel assured

that his lectures will stimulate others to investigate the problems.

(2) In "Living Machinery," Prof. A. V. Hill has written in simple language a description not only of the muscles and functions of the body and how they work, but also of the body functions as a whole. The book is undoubtedly one of the best popular scientific expositions of physiology which has been published. It will be read with benefit by all those who are interested in their own machinery or the progress of physiology. Boys and girls of a mechanical and scientific turn of mind will be stimulated by the description of experiments carried out by Prof. Hill and his staff of four, whose ages ranged from six to eleven years. The book will also serve to demonstrate how the principles of chemistry and physics enter into our own daily life and regulate the activities of the tissues of the body.

(3) The metabolism of the body at rest has been recently dealt with by E. E. Du Bois, Medical Director of the Russell Sage Institute of Pathology. The work of Du Bois on the measurement of body surface in man and on the metabolism in diabetes and fever is of fundamental importance, while his figures for calories per square metre per hour in normal individuals of different age and sex are generally used as the standard from which the percentage increases or decreases in metabolism occurring in disease are calculated. The book, less condensed than the monographs of King and McCann, and containing less detailed description of technique than that of Boothby and Sandiford, is admirably written and covers the ground in a manner which leaves little to be desired. The book, though written for those "engaged in the practice of medicine and surgery, for medical students, for physiologists and for dietetians," should also be of value to general biologists interested in the problems of respiration and metabolism.

The schools of nutrition in America, founded by Benedict and Lusk, of whom Prof. Du Bois is a distinguished pupil, have for some years been applying the results obtained on studies of normal human basal metabolism to the problems of clinical medicine. The success of these methods may be judged by the wealth of information which has been accumulated on disorders of nutrition, disease of the thyroid gland, blood, and fevers. This book affords an excellent example of the extent to which quantitative methods of measurement may be applied to the study of the normal and disordered functions of man.

Modern Physics.

Lehrbuch der Physik. Von Theodor Wulf, S.J. Pp. xiv + 512. (Freiburg im Breisgau: Herder und Co., G.m.b.H., 1926.) 17·50 gold marks.

WULF'S "Lehrbuch" is the most recent edition of P. Ludwig Dressel's "Elementares Lehrbuch der Physik," which first appeared more than thirty years ago. It is not a rehash of the original or later editions, but an entirely new book. That this should be so is self-evident in view of the fundamental advances and far-reaching discoveries of the last few decades. During last century the main object of the science consisted in the observation and description of natural phenomena, and in the formulation of 'laws' embodying the results obtained. Now we seek to 'explain' them in terms of the smallest constituent bricks of the material world. From gross matter we have passed by way of the atom and molecule to the electron and the proton.

During recent years there have been many books, both for the layman and for the specialist, dealing with the newer physics. Here we have a book which deals with the fundamental results of the whole of physics, and is written from the modern point of view. Of mathematics, the book contains just that amount necessary, in the author's opinion, to stimulate a fuller appreciation and understanding of the subject. But it is not a text-book in the usual sense, that is, for students studying for examinations, though all who read it must derive much benefit and a keener and more enlightened grasp of the subject. It is not intended for the 'man in the street,' but for the young physicist, the engineer, the chemist, the schoolmaster, and in fact for anyone who would welcome an authoritative and trustworthy account of the present-day structure of physics, without all its finer detail.

The distribution of the subject matter is somewhat off the usual lines, and possesses many advantages over the pigeon-holed system of most text-books of physics, ancient and modern. Thus, instead of subdividing the subject into mechanics, heat, light, sound, magnetism, and electricity, the author has presented his subject under four main heads.

In Part I., "Die Körperwelt," perhaps best rendered as "The Material World," the author deals with bodies as they are directly revealed to our visual sense, and includes sections on the fundamental ideas of motion, the motion of bodies, the force of gravitation and general attraction of

masses, elasticity, impact, general wave theory, and sound. Now we have ample evidence that matter is composed of small particles—atoms—and although we cannot see them, we recognise their existence and know some of their properties. This aspect of physics is dealt with in Part II. on the atomic structure of the material world, which contains sections on the system of the elements, the three states of aggregation of matter, temperature, specific heat, heat and change of state, the three principles of thermodynamics, and the atom. Not content with the knowledge of the atomic constitution of matter, the physicist has probed in turn into the structure of the atom and its consequences, with which Part III. is concerned. In this, the sections deal respectively with magnetism, electrostatics, electric currents, 'interactions' between electricity and magnetism, electrolysis, ions and electrons, radioactivity, electro-magnetic rays, and atomic constitution. Finally, there are numerous phenomena which, apart from ponderable matter, require a medium—the so-called ether—for their explanation. Part IV. is devoted to such etherial phenomena, and contains sections on 'disturbed' (reflection, refraction, etc.) and 'undisturbed' propagation of light, interference and diffraction, polarisation, light and colour, and the ether—treated also from the relativistic viewpoint.

After a careful perusal of this book, one feels that the author has departed from the traditional 'dry as dust' presentation of physics which is the bugbear of so many young students. For this it is to be feared our examination system is largely to blame, for it has tended to foster the grouping of the branches of physics into somewhat disinterested watertight compartments. A treatment of physics on the lines of Prof. Wulf's "Lehrbuch" would, we believe, be of inestimable value to the junior classes in our universities, and serve to give them some of the enthusiasm for their subject that one usually meets with only amongst more advanced students.

Our Bookshelf.

A Dictionary of Applied Chemistry. By Sir Edward Thorpe, assisted by eminent Contributors. Revised and enlarged edition. Vol. 7: Thalenite to Z. With an Index to the whole work by Frances M. G. Micklethwait. Pp. viii + 765. (London: Longmans, Green and Co., Ltd., 1927.) 60*s*. net.

THE first duty of a reviewer of the seventh and final volume of "Thorpe's Dictionary" is to congratulate those who have been responsible for the enterprise on the successful completion of their arduous task. As the first volume appeared in 1921, the publication of a fresh volume has become almost an annual event; but only five volumes had been completed when Sir Edward Thorpe died in February 1925. The work on the two remaining volumes has therefore been completed by Dr. Forster Morley, whilst Dr. Micklethwait has prepared an index to the whole work, which occupies more than 150 pages of the text of the last volume.

As in the earlier volumes, the emendation and enlargement has been so well distributed that it is not easy to discover where the new material has been incorporated, but the present volume is noteworthy for the addition of two articles on toluene and xylene by Prof. Rowe and Dr. Davies, which account for nearly 120 extra pages, and for an article by Prof. Briscoe on the physical and chemical properties of water, which covers rather more than 40 pages, compensation being provided by an expansion of about 4 pages in the article on wine. Prof. Hopkins has also contributed a new article on vitamins. These additions provide evidence of the thoroughness of the revision, and justify the expectation of a long lease of life for a work of reference which first appeared in 1890–1893.

Katalyse mit kolloiden Metallen. Von Walter Hückel. (Kolloidforschung in Einzeldarstellungen, herausgegeben von Richard Zsigmondy, Band 6.) Pp. viii + 86. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1927.) 6 gold marks.

IN presenting this account of laboratory methods of using colloidal metals as catalysts, attention is directed mainly to the work of Paal and of Skita on the application of metals of the platinum group to the hydrogenation of different types of organic compounds. The earlier investigations of the phenomena accompanying the decomposition of hydrogen peroxide are only introduced to elucidate the theory of the kinetics of colloidal catalysis, since they form the subject matter of a separate volume in the same series. The use of colloidal metals has greatly simplified the important process of hydrogenation, since many reductions can be carried out in solution at ordinary temperatures.

Paal's method has given very valuable results, particularly in the terpene series, but it is much more limited in scope than that of Skita, which appears to be applicable to most unsaturated compounds. Since, however, the latter method requires special apparatus in which a pressure of 2-3 atmospheres can be developed, it has received much less attention. Much less is known about the application of colloidal catalysts to the reduction of inorganic compounds or to oxidation processes. The volume ends with a chapter on the mechanism of catalytic hydrogenation, in which theories of hydrogen activation are discussed.

Evolution of the Drama in Hull and District. By Thomas Sheppard. Pp. xii + 254. (Hull: A. Brown and Sons, Ltd., 1927.) n.p.

IN this volume the versatile curator of the Hull Museum has published, with some expansion and numerous illustrations, an address delivered by

him in his office of president of the Hull Playgoers' Society. Properly speaking, theatrical history in Hull does not begin until 1767, except for an ordinance of the Mayor and Corporation forbidding burgesses to attend performances of the players in 1599. Nor does Hull itself contribute much to the history of the drama, although Beverley, which comes within Mr. Sheppard's area, celebrated Corpus Christi with the usual plays and gild processions, and is also credited with the first mention of miracle plays. Mr. Sheppard has drawn liberally on the material available from York, Chester, and elsewhere in elucidating the early stages of his subject. No Corpus Christi plays are recorded in Hull; but it is interesting to note that there was a performance of the Noah play on Plough Monday in medieval and later times, when a large ship which hung suspended in the transept of Holy Trinity Church was taken down, dragged round the town, and then served as the ark of the play in front of the church. Mr. Sheppard describes a Ploughboys' Monday celebration which he himself saw in his early youth, when a group of rustic players went from house to house and acted a play which seems to have been of the usual folk drama type, culminating in the killing of one of the characters.

The Mathematics of Engineering. By Prof. Ralph E. Root. Pp. xiii + 540. (London: Baillière, Tindall and Cox, 1927.) 34*s*. net.

AMERICAN text-books of mathematics rarely find favour in Great Britain, and this work, written by a professor of the U.S. Naval Academy to meet the requirements of student officers, is scarcely likely to prove an exception. The tendency throughout is to give an empirical and mechanical knowledge of the subject, so that the engineer uses his mathematics merely as a tool. This is typified by the fact that a student is encouraged at an early stage in his mathematical career to rely on a table of integrals, rather than to acquire the facility for evaluating them independently. The degree to which the subject has been condensed may be judged from the fact that the theory of errors, method of least squares, and curve fitting have been dismissed in 42 pages.

The printing is marred by the rendering of all letters used as symbols in ordinary Roman characters instead of in the customary italics. In these days of monotype setting such an innovation cannot be defended on the grounds of economy, and, as it increases the difficulty of reading, it is to be hoped that other publishers will not follow suit.

L. J. C.

Spherical Harmonics: an Elementary Treatise on Harmonic Functions, with Applications. By Prof. T. M. MacRobert. Pp. xii + 302. (London: Methuen and Co., Ltd., 1927.) 15*s*. net.

THE object of this work is to provide a text-book on the elements of the theory of spherical harmonics with applications to mathematical physics so far as this can be done without employing contour integration. Within these limitations the author has certainly provided a useful book. The actual treatment of spherical harmonics occupies ten chapters with gravitational, electric, and magnetic applications. There is also a treatment of spheroids. No applications to hydrodynamics are mentioned. Chap. i. contains an account of Fourier expansions subject to Dirichlet's conditions, which should prove useful. Chap. ii. deals with the conduction of heat, and in Chap. iii. an interesting discussion of the vibrations of harp, violin, and piano strings is given, which offers a striking contrast in the effect of initial conditions. The last three chapters of the book give a valuable account of Bessel functions and their applications to the vibrations of a circular membrane and the flow of heat.

L. M. M.-T.

Mathematical Statistics. By Prof. Henry Lewis Rietz. (The Carus Mathematical Monographs, No. 3.) Published for the Mathematical Association of America. Pp. xi + 181. (Chicago and London: The Open Court Publishing Co., 1927.) 10*s*. net.

PROF. RIETZ aims at explaining the mathematical theory underlying modern statistical analysis, and in particular to correct misleading impressions as to the place and importance of probability theory. He has succeeded in giving an admirable and connected survey of the more important methods, including an account of the Lexis theory. The mathematics used are elementary and the style elegant, but the language is that of the mathematician, and it is doubtful whether the author will succeed in reaching those whose knowledge is confined to the elements of the infinitesimal calculus. From the point of view of readers of this class, the book would have been improved by a list of definitions of the terms employed. To those of mathematical tastes the book can be recommended as offering a convenient conspectus of an important field of thought. L. M. M.-T.

Studies in Psychology: Memory, Emotion, Consciousness, Sleep, Dreams, and allied Mental Phenomena. By Dr. William Elder. Pp. xv + 212. (London: William Heinemann (Medical Books), Ltd., 1927.) 8*s*. 6*d*. net.

DR. ELDER writes very sincerely as a neurologist who is much interested in psychological theory but is quite unable to think of a mind without a brain. He has no sympathy with modern psycho-analytic theory and writes as a whole-hearted behaviourist. He looks on sleep as an instinct which has become a habit. Dreams are to him easily explained on old-fashioned lines without any need to invoke the aid of the censor, the symbol, manifest or latent contents, or any other Freudian concept. The author very sensibly points out that the interpretation of dreams must by their very nature be largely a matter of guess-work and far removed from any claim to scientific accuracy. Altogether a most refreshing book in an age where one has almost forgotten the existence of any other dream theories than those of Freud, Jung, Adler, and Rivers.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Nebulium Spectrum.

IN an interesting note by C. T. Elvey (NATURE, **121**, p. 12, Jan. 7, 1928) a calculation has been given of the "density necessary to produce the nebulium spectrum," the example considered being the nebulosity originating in the new star Nova Aquilæ, 1918. The outburst of this star was observed early in June 1918; by October a bright nebulous envelope had appeared around the star; it continued to spread as long as the star was under spectroscopic observation (August 1926). The outward flying gases had an average velocity of some 2000 km./sec. The N_1 and N_2 lines (5007 A. and 4959 A.) were recognised in the spectrum about 19 days after the outburst. At that time the density of the envelope would be of about 10^{-17} grams/c.c. In the first years of the existence of the envelope the light of the gas consisted mainly of the nebulium lines N_1 and N_2; in 1926, however, these were extremely faint, and most of the light came from the Balmer lines of hydrogen and 4686 A. He^+ (E. Hubble and J. C. Duncan, *Astrophys. J.*, **66**, p. 60; 1927; and Plate IV.). Nine other novæ give similar density, 10^{-19} to 10^{-20} grams/c.c., that is, about 50 molecules/c.c.

This constancy was taken as indicating that "there is a limiting density above which the conditions are unfavourable for the production of the nebular spectrum" (10^{-17} grams/c.c.). This corresponds to some millions of H atoms/c.c., the free path being of the order of hundreds of kilometres. Forbidden lines, however, have been actually obtained at higher pressures, and without denying that the density is of great importance, it seems to us that another factor has been unduly neglected: the temperature. It is evident that the expansion of the star was accompanied by changes in temperature or at least by changes in the composition of the spreading matter. It is generally recognised at present that the light observed in nebulæ is in some way caused by neighbouring stars (in the diffuse galactic nebulæ) or where the luminosity is arranged around a brighter nucleus (planetary nebulæ) by the light from the central star. The nebulous material must be in a physical state sensitive to stellar radiation and close enough for the density of radiation to be effective.

An attempt has been made (Zanstra, *Astrophys. J.*, **65**, p. 50; 1927) to show that the light emitted by the diffuse nebulæ is, in the case of the Balmer lines, at least, due to the recombination of positive ions and electrons. The total number p_n of electrons which is captured by the nth level of the H atom is, according to Kramers, about

$$p_n = \frac{\dfrac{1}{n + Cn^3}}{\sum\limits_{n=1}^{\infty} \dfrac{1}{n + Cn^3}} \text{ where } C = \frac{\frac{1}{2}mv^2}{W_1}$$

(W_1 the ionising energy of the first excited level, m and v the mass and the velocity respectively of the electron). If $\frac{1}{2}mv^2$ of the electron is comparable with W_1, an appreciable fraction of electrons will be captured by the first levels. Although the Balmer series and the associated continuum have been observed in many nebulæ, it is by no means clear how recombination phenomena can account for the majority of these clouds. The density of the gas itself is usually smaller than the concentration of charges obtainable in the positive column of a (rare) gas discharge, and in this case recombination is negligible.

Any theory of nebulæ emission has to account for the wide differences in the spectra of nebulæ. In this respect Hubble's results as to the type of stars associated with the gaseous matter are important (*Astrophys. J.*, **56**, pp. 162 and 400; 1922). The light emitted by the nebulæ is very often different from the spectra of these centres. There is, however, a close correspondence in that nebulæ giving bright lines are always connected with stars of earlier than B1 type, whereas when later types are involved the nebular spectrum is continuous, with or without dark absorption lines. B1 type stars correspond to a temperature of about 20,000°.

The typical nebular lines N_1 and N_2, the forbidden lines between the low-lying metastable levels of O^{++}, are as a rule much stronger in the planetaries than in the diffuse nebulæ. In the diffuse case H_β is about as strong as N_1, in the planetaries the ratio is $N_1 : N_2 : H_\beta = 10 : 3 : 1$. The strengthening of the nebulium lines in the planetaries is not accompanied by a corresponding increase of the continuous spectrum of the nuclei in this region; but the maximum of the continuous nuclear spectrum is shifted to the violet as compared with that of the stars associated with diffuse nebulæ. Thus the planetary nuclei have an extraordinary intensity in the ultraviolet, the maximum being certainly at a wavelength less than 3300 A. There are now two points to which we should like to direct attention. The first is that the energy to excite the nebulium lines would be very small if the material (oxygen) were already in an ionised state, so that the connexion between strong ultra-violet spectra and nebulium lines is difficult to understand on that basis. The second point is that the lines are essentially emission lines and have as yet no importance in absorption spectra. Both facts lead to the conclusion that the oxygen which is responsible for the nebular lines cannot be in an ionised state, but must be present as a molecule or molecular ion. As a molecular ion it ought to show absorption bands situated in the visible spectrum.

That forbidden lines between low metastable states of an atom may be expected from dissociating molecules was first pointed out by the authors in a paper published more than half a year ago (*Proc. Roy. Can. Soc.*, vol. 21, p. 27; 1927: cf. the discussion of the low metastable levels of I_2). We should like to add that not only the emission of forbidden lines must occur, but also their absorption. In the case of mercury vapour, for example, the heat of dissociation of the molecules is low; under the conditions of the experiment it is of the order of the energy of the faster molecules, so that a large number of molecules break up into atoms, while other atoms recombine to maintain the equilibrium. So long as in this process one mercury atom remains under the influence of the field of its companion of late, it may absorb forbidden lines. That forbidden lines are absorbed has indeed been strikingly demonstrated by Lord Rayleigh (*Proc. Roy. Soc.*, vol. 117, p. 294; 1927).

These relations will be more closely analysed in connexion with other work; their importance for our knowledge of the constitution of stars is evident.

J. C. MCLENNAN.
RICHARD RUEDY.

The Physical Laboratory,
University of Toronto, Jan. 27.

The Hydrogen Molecule.

In his very interesting letter on this subject to Nature of Jan. 28, Prof. Birge has decided that the first of the two alternatives which I proposed for the structure of the spectrum of H_2 is correct. I should have been very much pleased to obtain the support of so eminent and experienced a band spectroscopist for either view; but at the present time there is no material divergence between us. The last of the two or perhaps three papers [1] which Prof. Birge traverses was written nearly a year ago. At that time it was obvious that there was a misfit somewhere, and I indicated two alternative positions for it. Since then much information about the extreme ultra-violet, as well as the visible spectrum, has come to light. There are also the results of the calculated structure of the hydrogen molecule which have been obtained by the new quantum mechanics. It now seems fairly certain that the suspected coincidence of my 2^3P level with Dieke and Hopfield's C level is an accident. The case for the coincidence of my 2^1S level with their B level is much more convincing.

If this coincidence is correct the following fact is very curious. On Werner's plates taken in the visible, which he has kindly allowed me to inspect, I find the violet bands $2^1S - 3^1P$ and $2^1S - 4^1P$ strongly developed. On plates taken in the far ultra-violet under the same discharge conditions Werner finds his own bands, $A - C$ ($1^1S - C$), strongly developed, but if the Lyman bands, $A - B$ ($1^1S - B$), are present, they are very weak. The presence of the violet bands shows that the 2^1S states are formed; the weakness of the Lyman bands shows that they pass with difficulty into the 1^1S state, which is the only known deeper state. It looks as though they must get rid of their excitation energy by dissociating the hydrogen molecules with which they collide. The Lyman bands are present in the absorption spectrum of H_2, but they can only be excited efficiently in emission in presence of a large excess of argon. This will greatly reduce the opportunity of the excited hydrogen molecules to collide with other hydrogen molecules.

As regards the method by which I calculated B_0 (the band constant which is inversely proportional to the moment of inertia) for the 2^1S and 3^1P states, I used it because there was no other method available. I expressly stated that it was inaccurate in the data to which it had to be applied, and that the value obtained for the 2^1S state was likely to be too high. I now think that this error is due to some of the weaker lines being probably the wrong lines. Accepting Prof. Birge's value of about 28 for $2B_0$ for the 2^1S state, the second differences of the strong ${}_0A_0$ band in which the lines are probably trustworthy, show that the value 41 got by the same method for 3^1P was about right.

It is, at any rate, a cause for great satisfaction that there exists at the present time a complete harmony between the interpretation of the spectroscopic data for the molecule H_2 on one hand and the results of the theory of its structure according to the new quantum mechanics, as well as the theory of the specific heat of hydrogen, on the other. However, the last chapter of this story is not yet written. There are even now many important lines in the secondary hydrogen spectrum which are not understood and there may be room for some surprises still.

O. W. Richardson.

King's College,
University of London.

[1] *Proc. Roy. Soc.*, A, vol. 111, p. 714; vol. 113, p. 368 (1926); vol. 115, p. 528 (1927).

The Dominant Species of Ostrea.

In reviewing the characters of the dominant species of oysters, Ostrea, of which something is known of the life-history as well as the shell-characters, two distinct types are recognisable.

Type I. consists at present of

O. edulis, Linn., the European oyster (see Hoek [1] and Dean [2]).

O. lurida, Carpenter, the British Columbian oyster (see Stafford [3]).

O. Angasi, Sowerby, the south-west Australian oyster (see Roughley [4]).

In this type the shell is sub-circular; the egg is large; the adult larviparous; the individual is hermaphrodite; spawning occurs at medium temperatures, round about 15° C.; and the species flourish in temperate regions.

Type II. consists at present of

O. virginica (≡*elongata*), Gmelin, the American-Canadian oyster (see Stafford [3]).

O. angulata, Lamarck, the Portuguese oyster (see Dean [2]).

O. cucullata, Born, of world-wide distribution in sub-tropical and tropical parts (see Dean [5] and Roughley [6]).

In this type the shell is elongated in an antero-dorsal and postero-ventral direction; the egg is small; the adult non-larviparous; the individual of one sex only; spawning occurs at moderately high temperatures (round about 20° C.); and the species flourish in sub-tropical or tropical regions.

Although the species noted above are among the most abundant and most successful of the genus, a large number of other supposed species have been described (Sowerby [7])—from shell characters—at various times. Shell-characters are, however, now known to exhibit great range of variation within the species in the genus Ostrea, and it may be anticipated that in the—probably distant—future many supposed species will be found to be mere varieties. At present we are therefore confronted with a supposed large genus containing at least two well-defined groups of species amongst the best known and the most successful forms in the genus. These successful forms are, however, of such world-wide distribution that it is difficult for one individual to summarise into an accurate technical description the assemblage of characters occurring in the two types noted above.

It seems clear, nevertheless, that there is justification for recognising two groups of species, whether the groups be regarded as differing generically or only sub-generically. Type I. is clearly Ostrea, of generic, or type sub-generic value, while type II. may be regarded as Ostrea, sub-genus Gryphæa, or a separate genus, for which the name Gryphæa may be suggested, or a new generic name may be preferable, and Dioeciostrea is a suitable one.

In a question of this kind international co-operation would be highly desirable in order to avoid over-weighting of the literature with names. On the other hand, a decision must be made by someone, and if sufficient care be devoted to the matter it should be possible to avoid complications in the literature and at the same time give a better expression to the relationships of known forms than exists at present.

[1] Hoek, P. P. C., *Tijd. Nederl. Dierk. Ver.*, Supp. Deel 1., 1883–4.
[2] Dean, B., *Bull. U.S.F.C.*, 10; 1890 (1892).
[3] Stafford, J., "The Canadian Oyster," 1913, Ottawa.
[4] Roughley, T. C., *Australian Museum Magazine*, 2, 1925.
[5] Dean, B., *Bull. U.S.F.C.*, 22; 1902 (1904).
[6] Roughley, T. C., *Proc. Linn. Soc. N.S.W.*, 2, 4; 1926.
[7] Sowerby, G. B., in Reeve's *Conchologia Iconica*, Part 288, 1871.

Similar cases do no doubt occur in all groups of plants and animals where international co-operation might be of value, if the machinery to effect it could be devised. But there is a danger, in such a method, of problems being shelved. For example, in 1912, attention was directed to the fact that the species of Cucumaria at Plymouth could be divided into two groups on such fundamental characters as the gross morphology of the gonad and presence or absence of radial symmetry, but the author forebore to establish a separate genus or sub-genus for one of these groups on the ground that such a proceeding would be better performed by a specialist reviewing the whole genus. That work is still waiting to be performed, and may not be done for several decades, whereas if the sub-genera had been created, the species of the genus would have been allotted to their proper place when revised locally or regionally.

Ideally, species of sub-genera should be phylogenetically related, but such relationships can rarely be established and are usually intelligent assumptions with a great probable error. There is always a possibility of convergence in evolution, especially in closely related forms, so that groups with certain characters in common may frequently comprise members which have not arisen unilaterally from a single common species or stock. Nevertheless, until the contrary is proved, the current method of grouping species with common characters into a sub-genus or genus—or even larger groups—will give a maximum first approximation value to phylogenetic relationships. Thus the practice of grouping similar species is defensible. One might in a case like the facies, Ostrea, go farther, and in an ideal scheme scrap the old names for new and more useful ones, such as, Monoeciostrea for Ostrea, type sub-genus, and Dioeciostrea for all such forms as conform with the characters of type II. noted above; at the same time, more useful names for the species might be obtained by latinising the now well-known common names, to give, for example:

O. edulis ≡ *Monoeciostrea europa*
O. lurida ≡ *Monoeciostrea vancouverensis*
O. Angasi ≡ *Monoeciostrea sud-australis*
O. virginica ≡ *Dioeciostrea americana*
O. angulata ≡ *Dioeciostrea hispaniola*
O. cucullata ≡ *Dioeciostrea subtropica*

A glance at the suggested new names is sufficient to show their superiority in descriptiveness.

The more the names of organisms describe their fundamental characters, the greater their value, and the nearer the approach to a simplified biology. The chief objection to descriptive names is, however, the constant inadequacy of extant knowledge. We never know that we know enough to describe organisms accurately for all time. For example, many animals are known to be functionally bisexual, or diœcious, but specifically hermaphrodite, or monœcious; and no doubt many other forms now supposed to be bisexual will be found in the future to be specifically hermaphrodite. Therefore, as we cannot expect to describe organisms for all time, we must expect and submit to change, but to avoid excess of change it is desirable that any effected change should be supported by either adequately proved individual or collective experience.

In the case of the two types of living species in Ostrea noted above, it is considered advisable to postpone the creation of new genera (with new or modified generic names) until more detailed information is available of their correlated morphological and biological characters. The names Monoeciostrea and Dioeciostrea are therefore mentioned merely as suitable types of names, and are not intended to be adopted in the literature until definition can be made, founded on adequate information. In the meantime, this discussion may stimulate inquiries into the characters of other less well-known species of the genus.

J. H. ORTON.

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Soft X-ray Emission and Absorption Spectra with Tangential Grating.

SINCE 1925 I have endeavoured to apply, for spectrographic work in the domain of the X-rays, the ruled glass grating, used with very high glancing angle, approaching 90°, which is particularly suited to give a high resolving power. Successively, I obtained direct diffraction and absolute measurement of wave-length for an X-ray beam of $K\alpha$ and $K\beta$ of copper and iron (*C. R. Acad. Sci.*, Dec. 21, 1925), and showed that the same arrangement could be utilised for extreme ultra-violet spectra (copper condensed spark spectrum between 140 A. and 3500 A.) by adjusting the 'tangential grating' in vacuum (*Revue d'Optique*, **5**, 97; 1926: *C. R.*, **182**, 1141; 1926: *Journal de Physique*, Jan. 1927). Afterwards, using as the source of rays for the vacuum spectrograph a water-cooled metal X-ray tube and a glass grating with 30,000 lines to the inch from Prof. R. W. Wood. I have been able to obtain line spectra of soft X-rays (10 A.-100 A.) upon an ordinary photographic plate. The grating method seems, therefore, the most suitable to bridge the gap between the ultra-violet and X-rays (*C. R. Acad. Sci.*, **185**, 62; 1927: *Journal de Physique*, Nov. 1927) (Fig. 1). Soltan and I

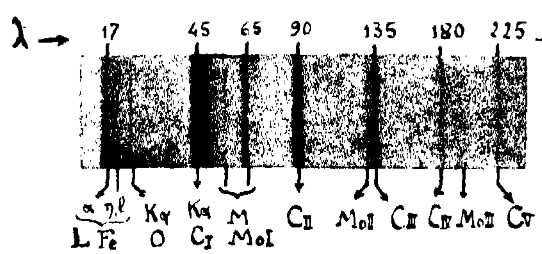

FIG. 1.—Line spectrum.

have registered and measured the $K\alpha$ lines of boron (68·0 A.), carbon (44·9 A.), nitrogen (31·8 A.), oxygen (23·8 A.), the L spectrum of iron, the M lines of molybdenum (65·0 A., 54·9 A.), and a regular doublet ($\Delta\lambda = 3$ A.) from N series of heavier elements (for tantalum, tungsten, platinum, gold; lying between 46·8 A. and 61·4 A.) (*C. R. Acad. Sci.*, **185**, 642; 1927: *Journal de Physique*, Dec. 1927, in which there are numerous reproductions of spectra).

In these earlier line spectra I have never noted the emission of a continuous radiation. Recently, however, using elements of high atomic weight as anticathode and intense electronic current in the tube (100 milliamp., 1000 volts), I have been able to demonstrate the emission of a continuous spectrum from solid bodies between 15 A. and 250 A. with similar properties to the independent background of a Coolidge tube.

The continuous background registered in my spectra is not uniform, but divided by a succession of fine bands with abrupt edges on the short wave-length

sides (Figs. 2, 3). The absorption of soft X-rays, then, varies discontinuously whenever the frequency of the independent radiation reaches a discontinuity of atomic absorption of elements present in the path of the rays. The elements present in the vacuum

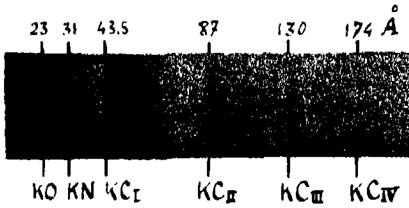

Fig. 2.—Absorption spectrum.

spectrograph, at a pressure much less than a barye, are carbon (vapour from grease used in joints), nitrogen, and oxygen, and, in fact, we observe the intense K band of carbon (in five orders), and also of nitrogen and oxygen. It is hence a very sensitive method for revealing minute quantities of gaseous matter. The three absorption edges (carbon, nitrogen,

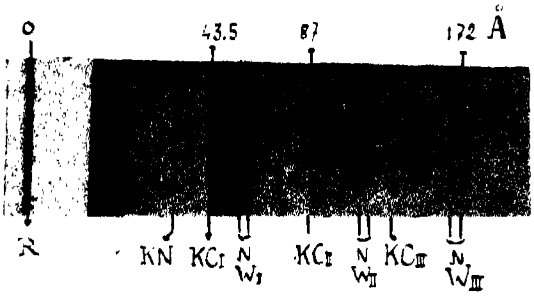

Fig. 3.—Emission and absorption spectrum.

and oxygen) are without structure, but seems limited by a 'white' absorption line similar to those observed close to the L edges of heavier elements (Nishina, Coster).

The wave-lengths of the K edges are as follows:

	λ(A.).	V (volts).	ν/R.
Carbon (C) . .	43·5	284	21·0
Nitrogen (N_2) .	31·1	397	29·3
Oxygen (O_2) .	23·5	524	38·7

in good accordance with Holweck's results from the ionisation method.

The absorption spectra reproduced herewith are the first to be recorded by a photographic method in the gap between the ultra-violet and X-rays.

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The Highly Penetrating Cosmic Rays.

In their interesting account of new results on cosmic rays, published in the supplement to Nature of Jan. 7, Prof. Millikan and Dr. Cameron direct attention to the statement made by Dr. E. Steinke (*Zeitschr. f. Physik*, **42**, 570; 1927) that the very careful measurements on highly-penetrating rays at sea-level performed by him do not show any real variations as to the intensity of these rays. I wish, however, to point out, as a matter of fact, that when the values of Dr. Steinke's measurements are arranged directly *according to sidereal time*, and when small systematic differences between the values of the different registering films are eliminated, these measurements show variations which are completely in accordance with those found by W. Kolhörster and G. von Salis (*Sitz. Ber. Preuss. Akad. d. Wiss.*, **11**; 1927) and by K. Büttner (*Zeitschr. f. Physik*, **45**, 588; 1927), but are only in percentage smaller.

Although sidereal time shifts 50 minutes with respect to civil time during the thirteen days of Dr. Steinke's measurements, he has only computed the means and the mean errors for every hour of *civil* time (MEZ), and he regards these as valid also for sidereal hours. This may be excused in a careful experimental investigator who is not an astronomer, nevertheless it is evident that if we are seeking a possible correlation with respect to the sidereal time, the measurements must be arranged *from the beginning* according to this time. If we arrange the values in Steinke's Table 3 (where they are corrected for barometric effect) according to sidereal hours ($0^h = 23^h\ 30^m - 0^h\ 30^m$, *etc.*), and also according to the different registering films, we may first compute the means for every sidereal hour. Comparing, then, all values of a certain film with the corresponding last-mentioned means, we find the following systematic corrections for the films:

1926 Nov.	13-14:	− 0·022 volt/58^m
„	15-16:	+ 0·027 „
„	16-17:	+ 0·008 „
„	17-18:	− 0·022 „
„	18-19:	+ 0·012 „
„	19-20:	− 0·004 „
„	20-21:	+ 0·012 „
„	21-22:	− 0·014 „
„	22-23:	− 0·004 „
„	23-24:	+ 0·020 „
„	24-25:	− 0·015 „

When we apply these corrections to the values of the corresponding films and then compute anew the mean, the mean error of every value, and the mean error of the mean for every sidereal hour, we find primarily that the means are very little affected by the systematic corrections. The weighted mean error of a single value is, however, here $\pm 0{\cdot}0226\ V/58^m$ instead of $\pm 0{\cdot}0295\ V/58^m$ as given by Steinke, and the weighted mean error of a point on the curve of the means is $\pm 0{\cdot}0074\ V/58^m$ instead of $\pm 0{\cdot}010\ V/58^m$ as given by Steinke. The curve shows the same maxima at 0^h, 5^h-7^h, 13^h-16^h, and 20^h (and in addition one maximum at 3^h), and the same minima at 4^h, 8^h-12^h, and 19^h sidereal time that were found by Kolhörster and Büttner (*loc. cit.*), and these extremes deviate about $0{\cdot}016\ V/58^m$, or more than twice the mean error from the general mean ($= 1{\cdot}961\ V/58^m = 1{\cdot}765\ J$ cm.$^{-2}$ sec.$^{-1}$). Steinke's curve of the means for each hour of *civil* time agrees in some features with those of Kolhörster and Büttner, as was remarked by Büttner in his paper cited above.

As the curves of three authors, who have not only made their measurements at different times and places, and in different ways, but also hold different views, thus agree in the fundamental point of showing maxima and minima for the same sidereal times, and, moreover, greater percentage variations for increasing height over the sea-level, I think we must now consider the existence of these variations to be confirmed. The failure of Prof. Millikan's and Dr. Cameron's experiments to detect variations is puzzling and may have some unknown physical cause. I should like to suggest the possibility of the variations being caused mainly by somewhat softer cosmic rays (coming from the 'heated vacuum' of the Mira stars ?—see *Astr. Nachr.*, **5529**) than those found by Prof. Millikan and Dr. Cameron when their apparatus was sunk deep below the

levels of the lakes used by them. In fact, the greater absorption coefficients (of Kolhörster) are found by such apparatus and experiments, which have also revealed great variations, whereas the smallest absorption coefficients are related to those experiments (of Millikan, Cameron, and Steinke), which show only small variations or none. In the mountain, or balloon, experiments, a mixture of both kinds of rays may have been measured. For full consideration of the lack of agreement of the measurements, it would, however, be most valuable if Prof. Millikan would, like the German workers, publish also the particulars of his measurements.

AXEL CORLIN.

Observatory, Lund,
Jan. 26.

The Relation of Specific Heat to Ferromagnetism.

FERROMAGNETIC substances, in addition to their purely magnetic qualities, have other properties which are distinctive. For example, the temperature coefficient of resistance and the thermo-electric power behave abnormally up to the critical temperature, and become approximately normal above this point. But notably the true specific heat shows abnormal behaviour with rise of temperature. It increases to a high value (C_θ) at the critical temperature, and then immediately above this temperature there is an abrupt change (ΔC) to a much lower value.

An equation connecting C_θ and ΔC, which is derived from observations on iron, cobalt, and nickel, is

$$m.a.C_\theta = 5n.a.\ \Delta C \quad . \quad . \quad . \quad . \quad (1)$$

where $m.a$ and $n.a$ are the molecular weights below and above the critical temperature, m and n being the number of atoms of atomic weight a in the molecule. Thus the molecular heat at the critical temperature is five times the molecular heat of the discontinuity, a result which is of significance. The discontinuity (ΔC) is intimately connected with two magnetic constants, the maximum intensity of magnetisation (I_0) and the reciprocal of Curie's constant (R') as follows:

$$n.\Delta C.J.\rho = 278\ R'\ I^2_0 \quad . \quad . \quad . \quad . \quad (2)$$

J and ρ being Joule's equivalent and the density of the material respectively.

Both equations are satisfied by the numerical values derived from experiments on iron, cobalt, nickel, and magnetite, and it is of interest and importance to inquire if the abnormal behaviour of the specific heat is always to be found with ferromagnetism, and if the magnetic constants have always a definite relation to the specific heat.

There is, fortunately, one other ferromagnetic substance on which experiments may be made for the answering of this question, namely, Heusler's alloy.

I am indebted to Prof. F. C. Thompson for a sample of this alloy with an analysis of it, and I have made a number of experiments on its properties. Briefly, it may be said that Heusler's alloy shows the same kind of abnormality with temperature in its thermo-electric power and electrical resistance as do other ferromagnetics. Further, the true specific heat increases rapidly up to the critical temperature and then exhibits a discontinuity such that the equation first given is satisfied, and also the maximum magnetic intensity and Curie's constant are related to the discontinuity of the true specific heat according to the second equation.

The specimen I have of Heusler's alloy has magnetic qualities which are similar to those of nickel. Its maximum intensity is 420, and its absolute critical temperature (θ) is $360° + 273$, so that it conforms to the equation,

$$\frac{\theta}{I_0} = 8/27 \times q \quad . \quad . \quad . \quad . \quad (3)$$

where q is a whole number—the number 5—and it forms one of the whole number series 2, 3, 4, and 6, which are the q-values for iron, cobalt, nickel, and magnetite respectively. With Heusler's alloy, both C_θ and ΔC are, as with nickel, about half the values found in the other ferromagnetics.

Lastly, the alloy satisfies the general equation

$$\rho \cdot R_{an} = R'\ I^2_0 \quad . \quad . \quad . \quad . \quad (4)$$

in which R_{an} is the gas constant, if this is taken to be that of manganese with two atoms to the molecule.

Thus Heusler's alloy, like other ferromagnetics, conforms to the four equations given above which are characteristic of ferromagnetism, and the conclusion is that abnormal electric and thermal properties are necessarily associated with ferromagnetism, all of them being connected together by energy considerations.

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Rochdale.

Bird Feathers and the Antirachitic Vitamin D.

ON reading the article entitled "The Antirachitic Vitamin D" in NATURE of Dec. 31, which has just come to hand, it struck me that it might be worth while to record the following. In my student days I at one time kept various hawks and owls as pets. Many of these were taken from the nest and hand-reared, their food being in the main 'lights'—in the broadest sense—including liver. The majority died of rickets before attaining maturity. Among the exceptions were two favoured young tawny owls, which were fed almost exclusively on mice and sparrows. Success with these led me to add chicken heads complete with feathers and an occasional sparrow, also feathered, to the commissariat of the others. The only essential difference between the new diet and the old was the inclusion of feathers. The birds ceased to be troubled with rickets.

That feathers may be a source of vitamin D seems questionable in view of the general nature of a feather, yet birds possess nothing comparable with the sebaceous glands of mammals, and the so-called preen gland, practically the only skin gland known to occur in birds, is not present in all species. Many birds are entirely cereal eaters, except at such times as they are rearing young, which suggests that they may get their supply of vitamin D mainly from the solar radiation via their external covering of feathers. This need not necessarily mean through the substance of the feather, for most feathers have an oily coating. How much of this owes its origin to the preen gland is highly problematical, but so far as the gland itself is concerned, Prof. J. B. Collip tells me that he has found it to be rich in colesterol in the domestic fowl; and this may apply, and probably does, to feather oil generally, whatever its origin.

However, in view of these things, the following episode from the life-history of the merlin (*Falco columbarius æsalon*) seems worthy of note. As recorded in Pt. III. of my observations on this species in *British Birds* (Mar. 1922), another aspect of which drew comment in these columns (NATURE, Dec. 8, 1921, p. 478), the hen fed her chicks entirely on birds. These were nearly always brought to the eyrie plucked, the young being given the meat and less frequently the entrails, the bones as a rule being swallowed by the parent. The diet thus far compared excellently with the rickets-encouraging lights fed to

my pet birds. But the growing merlins did not develop rickets, and it appears that the mother was 'aware' of the remedy, for from time to time she would bring in a victim entirely or partially feathered and feed mouthfuls of *feathers only* to all her offspring in turn. They quite evidently objected to it and regarded it as 'medicine,' for the mouthful invariably had to be thrust well down into the maw, and even then proved very difficult to swallow. Possibly it is true that there is nothing new under the sun, and we may here be witnessing a crude method of administering the antirachitic vitamin D that has, no doubt, been in practice for countless centuries.

Wm. Rowan.

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Edmonton, Canada.

The Cause of Fishiness in Dairy Products.

The action of Fenton's reagent (hydrogen peroxide in the presence of small amounts of ferrous salt) on lecithins in alcoholic solution causes the oxidation of the choline and amino-ethyl alcohol portions to trimethylamine and methylamine respectively (together with some ammonia).

The olein of butterfat, owing to its unsaturation, easily absorbs oxygen to form a labile peroxide, the absorption being strongly catalysed by compounds of heavy metals, especially those of copper. The peroxide thus formed is an active oxidising agent in fatty media and is also a catalyst to more advanced oxidation. Lecithin is intimately associated with the fat peroxide in the fat phase of dairy products, and its nitrogenous base portion is oxidised through the agencies of the fat peroxide and the catalytic activity of the metallic (copper) compounds present, forming volatile bases possessing a fishy odour. That is, the reaction involved is a modified Fenton reaction in the fat phase. These volatile bases (trimethylamine mostly), together with the easily hydrolysable salts of these bases with free fatty acids (butyric and oleic), are the causes of fishy flavours and smells in dairy products.

The importance of small amounts of metallic compounds, copper especially, in strongly catalysing the oxidation must be realised, since, without metallic contamination, the formation of labile peroxide would be slow, and, since rancidity is a precursor to fishiness, that degree of rancidity necessary for fishiness to develop would not have been reached during the normal storage of products free from metallic contamination. In the examination of all products which were fishy, copper in appreciable quantity has been found to be present.

That such oxidation is possible in butterfat also demonstrates the need of inquiry into the fate of fat-soluble vitamins during the development of rancidity.

W. L. Davies.
A. T. R. Mattick.

The National Institute for Research in Dairying,
University of Reading.
Feb. 7.

Nomenclature of Eruptive Rocks.

The reviewer of my book "Eruptive Rocks" (Nature, Dec. 17, 1927) says that I have not accomplished my expressed purpose of cleaning up "the jungle of rock names." The *wisdom* of my procedure is open to question, but the *facts* can be ascertained by simple enumeration. Prof. Arthur Holmes collected about 470 names of eruptive rocks in his "Nomenclature of Petrology," and the total number in use at the present time is certainly not less than 500. Of these I have used only 56 in my system, a reduction of about 88 per cent. This seems to me to be a fairly thorough 'cleaning-up,' and I wonder what more the reviewer wants? Of course, I use some qualifying terms in conjunction with these names, but so does every petrologist, no matter what system he follows.

S. J. Shand.

University of Stellenbosch,
Jan. 11.

Prof. Shand has been led astray by his metaphor. He imagines that petrographic nomenclature is to be cleaned up by the simple process of chopping down names to the extent of 88 per cent. (as he claims), just as a jungle would be cleaned up by chopping down trees and clearing undergrowth. In denying that he has cleaned up the jungle of rock names I merely meant to imply, following his metaphor, that he has not, in my opinion, succeeded in his task of reforming petrographic nomenclature. I do not deny that he has eliminated, or attempted to eliminate, a large number of rock names, some desirable, others undesirable; but he has also added a number of fungoid growths such as per-, sub-, meta-, -oid, to the names he has spared, a procedure which, in my opinion, neither lessens the confusion nor contributes to the beauty of the nomenclatorial jungle.

It may further be questioned whether Prof. Shand has really cleaned up the jungle to the extent of 88 per cent. Of the 470 igneous rock names given in Holmes's "Nomenclature of Petrology," probably at least half have never been used more than once, and are, therefore, seeds that never took root.

The Reviewer.

Mammoths and Man in the Transvaal.

In the supplement to Nature of Dec. 10 is an interesting contribution by Prof. Dart on "Mammoths and Man in the Transvaal." The paper is valuable in directing attention to the importance of the Vaal River diamond gravel terraces, and the light which they will probably throw on early man in South Africa, and possibly on the wild animals associated with him. Whether Prof. Dart's conclusions are confirmed or not, the paper will result in more intensive work being done. Some of us who for years have been interested in the matter, have come to conclusions which differ from those of Prof. Dart.

Two years ago Miss Wilman, director of the Kimberley Museum, sent to Prof. Osborn, at my suggestion, two elephant teeth from the gravels of Barkly West. These Prof. Osborn determined as two species of Archidiskodon, one of which he regarded as a Middle Pliocene type and the other as an Upper Pliocene or Lower Pleistocene type. Three years ago I described the molar of an extinct giant pig from another gravel deposit. At present I have on hand four specimens collected by diggers, evidences of a huge extinct horse, and of a second type of large pig. All these teeth show some signs of being water worn, and if Prof. Osborn is right in regarding the elephant teeth as of Pliocene or Lower Pleistocene type, we must conclude, I think, that the teeth have been carried into the deposit from a much earlier one. If, as seems probable, Prof. Dart's Archidiskodon teeth are similar to those examined by Prof. Osborn, then it may be regarded as almost certain that they are very much older than the lowest gravels of the Vaal, which cannot be of great geological antiquity.

R. Broom.

Douglas, S. Africa.

The Influence of Diet upon the Teeth.

OWING to the prevalence of dental caries under our present conditions of living and dieting, knowledge of its cause, and the means by which it may be prevented or its ravages mitigated, is of great importance not only to the individual but also to the nation. During the last decade, attention has been directed by a number of observers to the influence which various types of diet may exert upon the structure of the teeth, often in conjunction with their effects upon other tissues of the body, especially the skeleton. This work has demonstrated that diet plays an important part in producing abnormalities of the teeth of experimental animals: the relationship of these abnormalities to dental caries is not so clear, since animals comparatively rarely suffer from this type of dental disease. Some evidence has been produced that there is a definite relationship between the structure of the teeth and caries, but it has not met with universal acceptance. In this article the influence of diet upon the structure of the teeth will be more especially considered, and the problem of dental caries only mentioned incidentally, where it appears to throw light upon the manner in which diet may affect the teeth. To illustrate the points raised, reference will be made to a few of the more recent papers dealing with the subject: further details will be found in these papers and also in those mentioned in their bibliographies.

There appear to be three ways in which diet can affect the teeth: food lodged in their crevices may undergo changes which lead to alterations in the enamel and other structures of the tooth; the diet may alter the composition of the saliva and thereby affect the teeth indirectly; or it may alter the structure of the tooth directly, in a comparable manner to its effect upon other tissues of the body. In the first two cases the agent acting upon the teeth attacks them, so to speak, from their outer or superficial surface; in the last, the changes depend upon an alteration in the composition of the blood and lymph reaching the tooth, and are thus initiated from the pulp or from within the tooth itself.

There is probably general agreement that caries is initiated by the fermentation of carbohydrate food stagnating between the cusps of the molar teeth, between the teeth themselves, and round their necks. According to J. Sim Wallace (*Med. Press and Circ.*, vol. 124, p. 487; 1927), diet cleanses the teeth mechanically, by initiating the secretion of ptyalin and by controlling the bacterial flora which digests remnants of food remaining between them. Efficient mastication is necessary both for keeping them clean and for ensuring their proper development together with that of the jaws. Inefficient mastication, leaving stagnating mucus on and around the teeth, encourages the development of tartar, since bacterial decomposition of the mucus leads to the production of alkali and the consequent precipitation of certain salts. On the other hand, the consumption of soft, sticky carbohydrate food leads to the production of acid, from the bacterial decomposition of the masses adhering to the crevices of the teeth, and this acid attacks the interprismatic areas of the enamel, initiating caries. Thus starchy or sugary foods favour the development of caries, whilst the more fibrous foods, such as fruits or raw vegetables, and fish and meats, tend to cleanse the teeth both mechanically and by increasing the secretion of saliva which washes away adhering remnants, and thus hinder or prevent dental decay. Experiments have shown that acid-forming bacteria can initiate caries when grown *in vitro* in the presence of teeth, the acid attacking the enamel: at least two organisms have been found in or on carious teeth which can form acid from carbohydrate, but whether either of them is specific for this disease is not yet certain. Penetration of the enamel is very slow unless the acidity is of the order of pH 5·0 (I. H. Maclean, *Proc. Roy. Soc. Med.*, vol. 20 (Sect. Odont.), p. 873; 1927).

Little is known about the possibility of altering the composition of the saliva by changes in the diet. Although saliva is a secretion, it is possible that certain changes in the composition of the blood may be reflected in this secretion: in health, the variations in the different constituents of the blood lie within very narrow limits, but they are more marked in disease, and variations from the average normal might then be observed in the composition of the saliva. In fact, C. L. Pattison has found definite changes in the calcium with variations in the diet (*Brit. Med. Jour.*, vol. 2, p. 6; 1926). The work was carried out on children suffering from tuberculosis of the bones and joints. On admission to hospital the average salivary calcium was 4·77 mgm. per 100 c.c. On the ordinary hospital diet this rose to 7·79 mgm.; on a diet containing little milk, no cod-liver oil or eggs, but oatmeal and olive oil, the figure was almost unchanged (4·68 mgm.); but when plenty of milk and cod-liver oil and an egg, but no oatmeal, were given daily, the salivary calcium rose to 10·68 mgm. per 100 c.c. In the light of our present knowledge, there is little doubt that these results are to be explained by the improvement in absorption and retention of calcium which occurs on the administration of adequate amounts of vitamin D, following a relative or absolute deficiency in the intake of this compound. Addition of a calcium salt to the diet for a short period was without effect on the salivary calcium. Whether changes in the composition of the saliva can influence the teeth is not known: a possible indirect effect might be suggested by means of subsequent alterations in the bacterial flora of the mouth.

It is now known that the structure and composition of the teeth can be affected by changes in the amounts of calcium and phosphorus and of vitamins C or D in the diet: in general, it may be said that the proper development of the teeth usually shows a close relationship to the proper development of the bony skeleton. In producing imperfect calcification and structure of the teeth, deficient intake of calcium or phosphorus, or an improper ratio between these two elements in the diet, has most often been associated with a deficiency of vitamin D.

also. J. A. Marshall, however, found that pups exposed to sunlight and kept on a diet containing an adequate amount of vitamins, but with improper quantities of calcium and phosphorus, developed gross changes in their teeth, including imperfect calcification of the enamel and relative absence of the dentine: there was marked delay in dentition, and the deciduous teeth were not shed (*Jour. Amer. Med. Ass.*, vol. 81, p. 1665; 1923). G. Toverud also observed that in white rats maintained on a diet deficient in calcium the teeth contained less mineral ash than normal teeth (*Jour. Biol. Chem.*, vol. 58, p. 583; 1923); whilst M. R. Jones and F. V. Simonton found that the addition of alkali (sodium carbonate) to a diet complete in every other respect produced changes in the teeth and jaws of puppies (*Proc. Soc. Exper. Biol. and Med.*, vol. 23, p. 734; 1926). It is known that the absorption of calcium and phosphorus is influenced by the hydrogen ion concentration of the contents of the intestine, alkali interfering with this absorption and acid increasing it. C. J. Grieves (*Jour. Amer. Med. Ass.*, vol. 79, p. 1567; 1922) also found that a deficiency of calcium in the diet increased the amount of dental caries in the teeth of rats. Decay also occurred when the calcium was increased above the optimal amount: thus the effective factor appeared to be an improper calcium-phosphorus ratio rather than a simple change in the amount of calcium alone.

Among the symptoms of scurvy, due to deficiency of vitamin C in the diet, are hæmorrhages in various parts of the body, including the gums, in which situation they are accompanied by a loosening of the teeth in the jaws. Experimentally, changes in the teeth have been described by several authors: P. R. Howe (*Jour. Amer. Med. Ass.*, vol. 79, p. 1565; 1922), has observed decalcification of guinea-pigs' teeth, when the animals were kept on a scorbutic diet, with recalcification when a source of vitamin C, such as orange juice, was added to the food. Dental caries was present in the animals on the faulty diet. F. M. Wells (*Proc. Roy. Soc. Med.*, vol. 12 (Sect. Odont.), p. 22; 1919) and Toverud (*loc. cit.*) have described changes in the pulp of the teeth of scorbutic guinea-pigs with replacement of the orthodentine by osteodentine: the degeneration of the pulp may occur before other clinical signs of scurvy are present.

Probably the most important factor in producing alterations in the teeth is a shortage of vitamin D, or the antirachitic vitamin, with or without accompanying defects in the diet, such as variations in the calcium-phosphorus ratio. E. V. McCollum and his collaborators described changes in the teeth of rats maintained on diets low in protein, calcium, and fat-soluble vitamins (*Bull. Johns Hopkins Hosp.*, vol. 33, p. 202; 1922), and Grieves (*loc. cit.*) found that caries was worse in rats when the diet was deficient in fat-soluble vitamin as well as calcium than when it was deficient in calcium alone. In puppies, May Mellanby has shown that the most important variables affecting the formation of the teeth are variations in the amount and type of cereal in the food, in the amount of fat-soluble vitamin present, and in the degree of exposure of the animals to ultra-violet light (M. Mellanby, *Proc. Roy. Soc. Med.*, vol. 16 (Sect. Odont.), p. 74; 1923, etc., summarised by E. Mellanby, *Brit. Med. Jour.*, vol. 1, p. 515; 1926). The less vitamin and the more cereal present in the diet, the worse was the structure of the teeth. When the bitch was fed on the deficient diet during pregnancy and lactation, the deciduous teeth of the pups were affected; if the latter were given the diet after weaning, the defects were disclosed in the permanent teeth. It thus seems possible that the influence of carbohydrates upon dental caries is not only due to their fermentation in the mouth, but also to their effect, in association with the fat-soluble vitamin, and after their digestion and absorption, upon the structure of the teeth.

How far are these results applicable to human beings? It is beyond the scope of this article to discuss the relationship between the structure of human teeth and dental caries, but it may be mentioned that May Mellanby has adduced evidence of a close relationship between defective structure and caries, based on the microscopic examination of a large number of teeth. Discrepancies are explained as due to alterations in the structure of the teeth after they have erupted. That the defective structure is due to deficiencies in the diet is possible but unproven, since the diets of the patients from whom the teeth were obtained were not known or regulated; but where it has been possible to control the diet, a definite relationship between it and the spread of caries has been observed. About thirty children in an institution were divided into three groups, and each group given a carefully selected diet (May Mellanby, C. L. Pattison, and J. M. Proud, *Brit. Med. Jour.*, vol. 2, p. 354; 1924). Careful examination of the teeth was made at the beginning and end of the experimental period of seven to eight months, and the general condition as regards defective structure and the position and extent of caries noted. One of the diets was the ordinary hospital diet: on this the average number of teeth per child in which caries had spread was 2·9; on a diet containing less milk and no butter, but more oatmeal, *i.e.* low in calcifying vitamin (vitamin D) and calcium, the spread of caries was represented by 5·1 teeth becoming more affected in each child; whilst on a diet containing more milk and no oatmeal, *i.e.* abundant vitamin D and calcium, the figure was 1·4 only. Thus there appears to be a close relationship between the diet and the spread of dental caries in human beings.

More recently, May Mellanby has published some work on the structure of human teeth, the results of which suggest that diet plays an important part in producing defects of structure (*Brit. Dental Jour.*, July 1, 1927). More than 1000 deciduous and more than 250 permanent teeth were examined both macroscopically and microscopically: in many cases the first examination was made whilst they were still in the mouth. The results obtained depend, of course, upon the definitions of the terms 'normal' and 'abnormal' as regards tooth structure. Descriptions are given of the naked-eye

appearance of the enamel in various degrees of hypoplasia, and of the microscopic picture of the dentine: any uncalcified areas in the dentine are considered to be abnormal, but are so common that it is possible some authorities would consider them normal. Close agreement between the macroscopic and microscopic appearances was obtained in more than 85 per cent. of the examinations. Of the deciduous teeth, 14 per cent. were found to be perfectly calcified, 21 per cent. were slightly, and 64 per cent. definitely, hypoplastic. The incisors were the best calcified, 49 per cent. being normal: 8 per cent. of the canines, 7 per cent. of the first molars, and only 1 per cent. of the second molars could be so classed. Slighter defects appeared among the remaining incisors and canines, and the more severe degrees of hypoplasia were observed in the majority of the defective molars. The teeth obtained from private sources, as opposed to those from dental clinics, were less defective in structure. Of the permanent teeth examined, none was normal, and 92 per cent. showed definite hypoplasia; but these figures give no indication of the condition of permanent teeth in Great Britain, since all those examined had been extracted for caries, or to help in the adjustment of irregularities.

These results also indicate that there is less chance of interference with calcification before birth than afterwards, and that the more rapid the development of the tooth, the more defective is its structure likely to be. The defects in structure are probably to be correlated with the diet during the time the teeth are developing in the jaws: thus before birth, even if the mother is on a deficient diet, the fœtus can obtain its requirements of salts and vitamins by the sacrifice of the maternal stores. After weaning, the child has to depend entirely on its food and on its own stores, which are likely to be low if the mother's diet has been poor, for its supply of the substances necessary for the proper development and calcification of the teeth. At the same time, the diet frequently contains a large amount of cereal products, the influence of which is exerted against proper calcification. The incisors are the most advanced in development at birth, and are also the best developed structurally. The second molars are the least developed at birth; they grow rapidly after birth, and have the worst structure of any of the teeth.

In conclusion, it may be said that diet affects the teeth as it affects the other tissues of the body, and that the teeth, like the other tissues, respond more easily to some defects in the diet than to others, but that the same defect rarely affects more than a few of the tissues to a marked degree. In addition, the diet can affect the teeth locally by causing alterations in their environment, the changes in the teeth then starting from their oral surfaces.

The degree to which diet directly affects the structure of the teeth depends in part on the definition of the terms 'normal' and 'abnormal' as regards this structure: and on this depends again the relationship between abnormality of structure and dental decay. In any case, caries will not be initiated unless acid is present on the oral surfaces of the tooth. It may be pointed out that it is difficult to produce caries in animals unless at the same time the conditions are such as to lead to defective structure also.

The Enhancement Principle in X-ray Photographs.

By Sir WILLIAM BRAGG, K.B.E., F.R.S.

AN interesting phenomenon is often shown in the X-ray rotation photographs of crystals. Photographs of this kind are obtained by causing a crystal to revolve steadily about an axis perpendicular to the direction of a fine pencil of homogeneous X-rays. As the crystal revolves, one set of planes after another comes to a favourable condition for reflecting the pencil and a corresponding spot appears upon the plate. The crystal is usually very small indeed, and the shape of the crystal largely determines the form of the spot. The complete photograph shows an array of spots which displays certain regularities of arrangement as exemplified in Figs. 1, 2, and 3. When the photographic plate is flat, the spots arrange themselves on hyperbolæ as in Fig. 1; if a circular film is used the hyperbolæ are replaced by straight lines as in Figs. 2 and 3. The phenomenon to which attention is now directed consists in the enhancement, sometimes a very great enhancement, of certain groups of the spots. The explanation is more readily understood if consideration is first given to an analogous case of greater simplicity.

An ordinary optical grating gives a series of spectra: if the incident light is homogeneous, each spectrum is limited to a line. If now every fifth line in the grating were intensified or altered in some way, there would be added to the series already referred to a second series consisting of lines five times as close-packed, and every fifth line of the new spectrum would coincide with one of the old. For the sake of what follows, this may be put in another way.

If, in the first place, the grating had contained only lines corresponding to those which we have spoken of above as being intensified in some way, the more numerous series of spectra also referred to above would have appeared upon the plate. If, now, four other lines were intercalated uniformly between the lines already drawn upon the grating, every fifth line of the series of spectra would be enhanced.

From this simple case we may now proceed to the more complicated three-dimensional case of the crystal. A first example may be taken from the work on the structure of the silicates which has been carried out by Prof. W. L. Bragg and his colleagues at Manchester. They have shown that a silicate may be regarded in the first instance as a compilation of close-packed spherical oxygen atoms: the other atoms belonging to the silicate are to be thought of as inserted in the interstices in the

close-packed structure. Sometimes the inserted atoms, for example, when they are beryllium or silicon, do not strain the structure, and again larger atoms such as calcium or magnesium distort it more or less. But in all cases the silicate structure may be described as consisting of a basis of close-packed oxygens on which a larger pattern of other atoms has been superimposed. This is the very condition which was exemplified in simpler form in the optical case already described. When the rotation photographs are considered, the parallel consequences are also to be found. Certain spots are strongly enhanced; these are the spots which would be given by the oxygens acting alone in close-packed structure. The multiplicity of other spots which fill the photograph, including those which have been enhanced, are such as would appear if the structure consisted only of all the atoms except the oxygens. An example of these photographs was given in NATURE, Sept. 17, 1927, and is reproduced here (Fig. 1). This one picture is sufficient to show the exceedingly interesting and beautiful structure of the silicate family.

A second example may be taken from the work of Dr. Müller on the long chain compounds (*Proc. Roy. Soc.*, vol. 114, p. 542). In this case also there are two periodicities in the structure. There is that which depends on the length of the chain, which in stearic acid is 48·84 A. Along the axis of the chain there is a second and finer periodicity due to the regular arrangement of the carbon atoms. The repetition takes place every second atom and its length is 2·52: the one periodicity is approximately nineteen times that of the other. A rotation photograph of stearic acid shows a multiplicity of spots due to the many sets of planes which are capable of reflecting the homogeneous X-rays usually employed. Some of these spots are very strongly enhanced for similar reasons to those already given. For example, the sets of planes denoted by (2, 0, 19), (2, 0, 38), (0, 1, 20), (0, 2, 19), (0, 3, 19), (0, 0, 18), (0, 0, 20), all show up on the plate, and indeed are almost the only high indices planes to appear. Such sets divide the c-axis into 18, 19, 20 . . . equal parts, as their designation implies. Consequently, their periodicities nearly coincide with that of the carbons of the chain. It is not necessary that the one periodicity should be an exact submultiple of the other.

A third example may be taken from the photographs of naphthalene and anthracene about the c-axis. It will be seen from a comparison of the two accompanying illustrations (Figs. 2 and 3) that whole rows of spots are here enhanced. Proceeding upwards or downwards from the central horizontal row, which is called the equator, the first row in each case is still strong; but in naphthalene the second row almost fails, and in anthracene the second and third. There is, in fact, a maximum between the third and fourth rows in naphthalene and the fourth and fifth rows in anthracene. The succeeding minima of intensity of rows are not shown in these pictures, because it is somewhat inconvenient to obtain photographs sufficiently extended upwards and downwards to include them, but it is easy to find out from other observations, which need not be given here, that minima do follow and are succeeded again by maxima. Thus, for example, the eighth and ninth rows of anthracene are strong. This enhancement of whole rows means that there is a certain repetition along the c-axis of a distribution of matter which, in the case of naphthalene divides it into between three and four

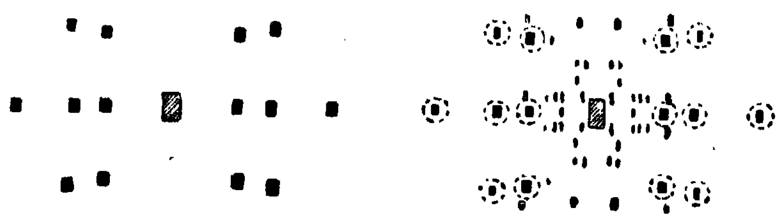

FIG. 1.—Rotation photograph around b-axis of disthene (right) compared with ideal rotation photograph around cube edge for close-packed atoms (left). Spots in the right-hand diagram corresponding to spots in the left-hand diagram are contained in circles.

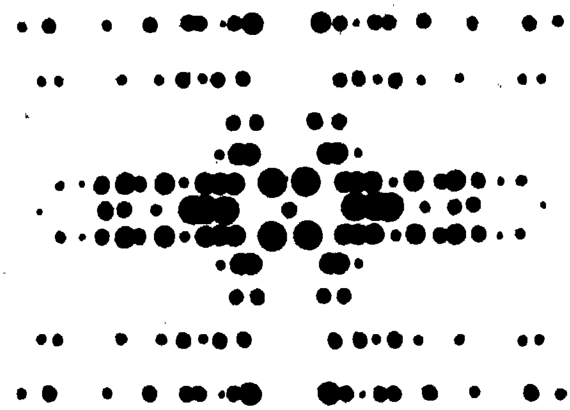

FIG. 2.—Rotation photograph about the c-axis of anthracene. The size of a spot is intended to represent its strength on the photographic film.

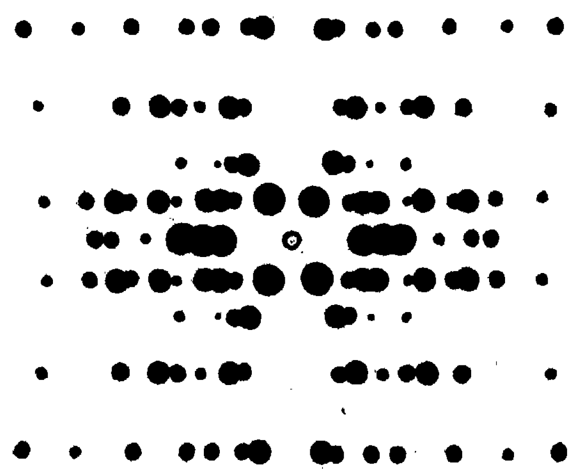

FIG. 3.—Rotation photograph about the c-axis of naphthalene.

parts; in the case of anthracene, between four and five. This is just what is to be expected if the structure of these crystals is that which was given by the author some years ago. The axis of a crystal in each case lies along the c-axis and the repetition is of the width of a benzene ring, namely, 2·52. The length of the c-axis of naphthalene is 8·69 and of anthracene 11·18. The axis of the former case is $3\frac{1}{2}$ times the width of the ring, and of the latter case about $4\frac{1}{2}$ times. The enhancement of the ninth row is due to the fact that the diameter of the ring divides it into two equal halves; there are periodicities of both 1·26 and 2·52 along the c-axis. The distribution of the intensities of the various lines in these figures is, in fact, an index of the distribution of matter or electrons along the axis about which the crystal was rotated.

There is one further point of interest in these last photographs. It will be observed that the distribution of spots on the equator is exactly the same for the two crystals. Even in the next row there is very little difference for the two, though the difference increases with the distance of the rows from the equator. Assuming the structure of the crystals to be that already referred to, to an eye looking along the c-axis the crystals would seem exactly alike. To what may be called to an X-ray eye looking in the same direction the crystals would look very nearly alike, but there would be a small difference because such an eye would see in depth as well as in plan. The eye would not observe, and the X-ray eye would, that certain atoms were hiding behind one another. The spots on the equator are due to planes which pass through the c-axis. The very close correspondence between the positions and intensities of the equator spots in the two crystals shows that to an eye, supposed capable of looking along the c-axis and observing the disposition of the atoms, the two crystals would appear exactly the same. This is confirmatory evidence of the structures assigned to them.

A somewhat different use of the same principle has been made by W. T. Astbury in his work on the acetyl-acetones (*Proc. Roy. Soc.*, **112**, p. 457). From a consideration of the relative intensities of the rows, he has drawn conclusions as to the relative positions of the molecules in the unit cell of the crystal.

Obituary.

MR. ALEXANDER SIEMENS.

ALEXANDER SIEMENS was born in Hanover in January 1847. He belonged to the second generation of the four brothers Siemens whose names are so well known. He used to tell how his parents owed allegiance to the King of England until 1837, when, under the Salic Law, Hanover was separated from England and given to the Duke of Cumberland, the fifth son of George III. In 1866 Hanover was annexed by Prussia, and Siemens automatically became a Prussian. He was educated at Hanover and Berlin, and in 1867 entered the telegraph workshops of Siemens' Brothers at Woolwich, of which Sir William Siemens, the first president of the Institution of Electrical Engineers, was a director. He was then employed in the erection of the Indo-European telegraph line in Persia and in laying cables in the Black Sea. He also worked in the cable ship *Faraday*. He served in the German Army during the Franco-Prussian War and was awarded the Iron Cross. In 1878 he became a naturalised British subject.

After his release from the German Army, Siemens came to England and assisted Sir William Siemens in developing the regenerative furnace. About 1879 he developed a system of lighting public halls by means of arc lamps. The systems adopted at the Albert Hall and in the British Museum Reading Room were done under his direction. He also carried out the electric lighting of Godalming, the first town in England to have an electric light supply.

Siemens had the greatest faith in science, in scientific training, and especially in scientific management. He considered that scientific management was quite as important as either capital or labour in developing the industry of the country. He was enthusiastically in favour of the decimal system, and in 1902 strongly advocated its universal adoption in a discussion held at the Institution of Electrical Engineers. His great protagonist was the late Sir Frederick Bramwell. The sympathies of most of the auditors were in favour of the decimal system, but the older generation of engineers seemed to think that engineering in Great Britain would be hopelessly handicapped internationally were we to abolish the inch and the pound. There was one thing said at this meeting which the writer never saw contradicted, and that was that without the decimal system it would not be possible to extract square roots. It is quite easy, however, to turn the square root of any number or fraction into a continued fraction and then find its value to any required degree of accuracy as a vulgar fraction.

Siemens was president of the Institution of Electrical Engineers in 1894 and 1904, and of the Institution of Civil Engineers in 1910. In his presidential address in 1894 he discussed, among other subjects, the possibility of trebling the speed of our trains. Although he considered it rash to say that such a speed could not be obtained, yet the necessity of strengthening the permanent way, etc., made it very unlikely that it would be adopted commercially. He contributed many papers and gave many lectures to scientific bodies. One of his most interesting papers was an account of experiments carried out by German engineers on the military railway connecting Marienfelde and Zossen. In these experiments, train speeds up to 125 miles per hour were obtained. The A.E.G. Co. insured the lives of their engineers before the experiments. After the tests, the front of the engine was coated with dead insects, and amongst them a dead swallow. The speeds

attained seem small now, but twenty-six years ago they excited the greatest interest. The writer remembers also how Siemens showed that the empirical formula found by the German engineers for the air resistance was in almost exact agreement with that obtained by Sir Isaac Newton.

Alexander Siemens was a member of the committee which in 1897 discussed the desirability of establishing a National Physical Laboratory in Great Britain. Later on he served on the executive council. He married in 1881 Frances Dodwell, of Campden, Gloucestershire, and had three daughters, the eldest of whom married the late Prof. Bertram Hopkinson, of Cambridge. For many years Siemens used to attend the Council dinners and meetings of the Institution of Electrical Engineers, and his kindly nature and interesting conversation made him many friends.

A. R.

COL. S. W. H. RAWLINS.

COL.-COMMANDANT STUART WILLIAM HUGHES RAWLINS died on Dec. 16 last, from acute pneumonia, near Aldershot, where he commanded the artillery of the 2nd Division. Born in 1880, Rawlins' name was on the list of successful competitors at the 1893 election of scholars at Eton. His family tradition was closely bound up both with Eton and with academic life. His father, William Donaldson Rawlins, was a life fellow of Trinity College, Cambridge. His uncle, Francis Hay Rawlins, became lower master and ultimately vice-provost at Eton, and was one of the last fellows of King's under the statutes by which a fellowship was retained for life. Leaving Eton rather sooner than many boys, Rawlins went into the Royal Marines, in which he saw five years' service and from which he transferred to the Army.

During the years before the War, apart from fighting in South Africa, Rawlins saw much foreign service, chiefly in India and Central Africa, an experience which gave him every opportunity of indulging his naturally great linguistic powers. He could converse in numerous dialects, chiefly of Swahili. His taste for languages was coupled with an active interest in ethnology and archæology, add to these considerable musical sympathy, and it is clear that Rawlins, even outside his professional skill, was no common person.

To the scientific reader, the feature of greatest interest in Col. Rawlins' career is no doubt his association with the chemical warfare organisation in Great Britain as Commandant of the Experimental Station at Porton. Porton, from consisting of two or three huts at the commencement of 1917, underwent remarkable development under the direction of the late Dr. (Lieut.-Col.) A. W. Crossley, so that before the date of the Armistice it consisted of numerous departments and employed more than six hundred persons. Its activities then were chiefly on the offensive side. Parallel with Porton, the late Lieut.-Col. E. F. Harrison developed, first at Millbank and later at University College, London, the extensive organisation which in the first three months of 1918 manufactured three million respirators. The Navy had its own organisation. With the Armistice, the activities of these stations were suspended, and remained so until the Cabinet was able to define its international obligations.

Towards the end of 1920, the present Chemical Warfare Committee was formed, and at the start the whole of its experimental work, focused on defence, was concentrated at Porton, to the command of which Col. Rawlins was appointed on Aug. 29, 1921. From that date until he left to become Director of Artillery in November 1924, Rawlins with untiring energy bent his great mental powers to the development of the station. Many a soldier in his place would have regarded the appointment as a purely military one and would have left the scientific side entirely to his technical experts. Not so Rawlins. He made up his mind to understand the activities of each department and to be able to contribute intelligent constructive criticism to the scientific reports over which his name appeared. So successful was he that when ill-health overtook the director of experiments, Rawlins himself largely filled the gap. Porton having become the Experimental Station not only of the Army but also of the Navy, Rawlins' early years of training in the Royal Marines gave him a practical knowledge of the naval point of view which was of great value. On the technical side, Rawlins had the unique qualification of having served in the War as right-hand man to Sir Noel Birch, who was chief artillery adviser at G.H.Q. during the latter years of the War. Rawlins therefore had complete knowledge of the requirements of the Army in all that pertained to smoke and gas.

Of Rawlins, Sir Noel writes: "He was a master organiser, as proved by his work at the War Office," that is, during his tenure of the office of Director of Artillery.

Rawlins' high intellectual equipment, his varied experience, and his untiring power of work would not by themselves have sufficed for the solution of many of the problems which beset Porton. His success was in great measure due to his personality. Full of vigour, full of hope, full of cheerfulness, full of generosity, full of helpfulness, Rawlins attached friends to himself from all walks of life, and, aided in full measure by his wife, he has left a community in every locality in which he has been stationed who cherish a thousand memories of his devotion.

WE regret to announce the following deaths:

Mr. Martin J. Cole, part author of "Modern Microscopy" (Cross and Cole) and an expert on the preparation of microscope specimens, on Feb. 8, aged eighty-one years.

Prof. Willis L. Moore, professor of applied meteorology at George Washington University and an honorary member of the Royal Meteorological Society, on Dec. 18, aged seventy-one years.

Sir Dawson Williams, who retired in January last from the editorship of the *British Medical Journal* after thirty years of distinguished service in that office, on Feb. 27, aged seventy-three years.

News and Views.

CHAULMOOGRA oil is an old drug in the treatment of leprosy, but it is only in comparatively recent years that a really useful remedy has been evolved from it. Long trials and experiments by Manson, Roux, Heiser, Rogers, and others have culminated in 'alepol,' a preparation of sodium hydnocarpate suitable for injection, and from the account given by Sir Leonard Rogers at the annual meeting of the British Empire Leprosy Relief Association on Feb. 24, it seems that it is possible with this to achieve a cure or something very near a cure in a sensible proportion of cases, especially if treatment is commenced at an early stage. Renewed interest in leprosy and its intensive investigation has also shown that the disease is more prevalent in Great Britain and elsewhere than had been supposed, and the Association has a considerable task before it. Besides surveying the problem, it has distributed the remedy on a large scale, and has provided seeds of the plant (*Taraxtogenos kurzii*) from which the oil and ultimately the separated gynocardic acid is prepared, so that the drug may be grown locally in the various foci where it is needed. No one should imagine that a certain cure for all cases of leprosy has been discovered, but there is no doubt that the new remedy represents a very important advance in that direction.

FEW of the many claims for the discovery in America of human remains of high antiquity have withstood the test of rigorous examination on strictly scientific lines. Even when, as in a number of recent discoveries, a *prima facie* case appears to have been made out, the verdict still must be regarded as in suspense. Especial interest, therefore, attaches to an expedition of the Smithsonian Institution to Florida under the leadership of Dr. J. W. Gidley, of the National Museum, of which the object is to test the evidence for pleistocene man on sites in the neighbourhood of Vero and Melbourne on the east coast, where human skeletal remains have been found in association with pleistocene fauna. In the latest of three geological strata which have been examined by previous expeditions, there is clear evidence of disturbance in the presence of modern remains; but the question has to be decided whether the second stratum, in which human remains are associated with an undoubted pleistocene fauna, is to be regarded as undisturbed throughout or can be shown to be partly the result of a redeposit which has brought recent remains into association with the material of a pleistocene stratum.

THE lure of the treasure hunt is eternal. The latest venture, which is to be financed by a limited company formed recently, has as its object the discovery of a treasure hidden by Jesuits in Bolivia, when they were deported from the country by the Spanish authorities in 1778. For eleven years they had resisted the Government, and had been blockaded. During that time they had been unable to export any of the gold and silver derived from their mines or their precious stones. Two of these mines were known to be very rich, but they have never been located. It was agreed finally, that the Jesuits were to be allowed to depart, provided that they gave up this accumulation of treasure to the authorities. Rather than do this, they concealed it, and it has never been recovered, although a number of expeditions have looked for it. One of the Jesuits, Father Gregorio San Román, left with his brother, the Prefect of Callao, a description of the hiding place. This was handed down in the family until the beginning of the present century, when it came into the hands of Mr. Cecil Prodgers, who in 1920 passed it to Mr. Edgar Sandars, the organiser of the expedition which will proceed to Bolivia in the present year. Mr. Sandars believes that in excavations carried out in 1925 and 1926, he has discovered one of the entrances to the treasure chamber which the Jesuits constructed with the help of 500 Indians, some, and perhaps all, of whom they killed. He has, at any rate, found in a shaft which he partially cleared, a silver crucifix and a parchment warning intruders to withdraw from a spot dedicated to God Almighty in which 'a dolorous death' awaits him who dares to enter. Father San Román's document also suggested caution, as "enough poison to kill a regiment of the king has been laid about." The value of the treasure in present currency is estimated as £12,000,000.

MR. WOOLLEY'S report on the excavations at Ur in the *Times* of Feb. 22, while adding further discoveries of human victims sacrificed in the royal tombs to those mentioned in his special interim report, records the discovery of the body of Queen Shub-ad, with the jewels which once covered her garments, and jewelled head-dresses, and suggests how and when the tomb of the king was rifled. As further discoveries are made, the more remarkable this revelation of the funerary customs of Ur and the beliefs they connote appears to be. One of the most important recent discoveries, though by no means so spectacular as some, is the form of the tomb itself. In the stone wall there was a doorway crowned by a true arch of brick, the tomb chamber was vaulted with arches, and the end was brought round to apsidal form and roofed with a half dome which was a cross between corbel work and a true dome building. A crudely fashioned arch had been found roofing a drain at Nippur belonging to the third millennium B.C. The present discovery makes it clear that the arch, corbel work, and the dome were familiar to Sumerian builders so early as the fourth millennium B.C.—a discovery of the greatest importance in the history of architecture.

THE original Wright biplane of 1903, the first power-driven man-carrying aeroplane to make a free and sustained flight, has been received at the Science Museum, South Kensington, on loan from Mr. Orville Wright, and will shortly be exhibited for the first time in Europe. Mr. Orville Wright and his brother, the late Mr. Wilbur Wright, began the

study of aeronautics in 1896 subsequent to the death of Otto Lilienthal, whose gliding experiments had aroused their interest, and they made and conducted experiments with man-carrying gliders, utilising such knowledge as was then available. In 1901 they turned their attention to the application of power, and their research led to the production of this, the first successful aeroplane. The first flight was made by Orville Wright on the morning of Dec. 17, 1903, at Kitty Hawk, North Carolina, in the presence of several witnesses; and it lasted twelve seconds. It was followed by three other flights, the last being one of 59 seconds, when the distance covered was 852 feet; the machine was then overturned by a gust of wind while left unattended, and the damage resulting prevented further experiments at that time. Since the first flights were made, the aeroplane has been preserved in the Wright laboratory, and certain parts which were damaged beyond repair have been replaced by Mr. Wright himself.

FLYING in an Avro-Avian biplane with a 30-80 h.p. Cirrus engine, Mr. B. Hinkler reached Darwin, in northern Australia, on Feb. 22, sixteen days after leaving Croydon. This compares with the 28 days taken by Sir Keith Smith and Sir Ross Smith on the first flight to Australia in 1919. The *Times* gives the total distance flown as 10,400 miles, measured from point to point of the flight, but points out that the actual distance flown was probably more than 12,000 miles. Mr. Hinkler covered the distance in fifteen stages, of which the last was the longest, involving 950 miles from Bima, in the Dutch East Indies, to Darwin. Another long flight was the 870 miles from Croydon to Rome, which occupied nearly thirteen hours. No second person was carried, and the passenger space was used for an extra petrol tank. A collapsible rubber raft was carried but was not required. There was no engine trouble at any point of the flight, and the only forced landing was in northern Africa and due to darkness. The weather was favourable throughout, but the flight was nevertheless a remarkable one, and brings nearer the day when the projected air-mail route to Australia will be accomplished. Mr. Hinkler has since continued his flight to Bundaberg, Queensland.

SIR SAMUEL HOARE, Secretary for Air, replying to a question in the House of Commons on Feb. 27 relating to Mr. Hinkler's flight, summarised excellently the main facts of the achievement. He said that the flight established several 'records.' "Mr. Hinkler achieved the fastest flight to date between England and Australia, shortening the time taken by Sir Ross Smith in 1919 by between 12 and 13 days; the longest solo and the longest light aeroplane flights yet made; and the first non-stop flight to Rome; whilst all places beyond India were reached in a shorter time than has been achieved by any other form of transport. The total flying time was 134 hours, so that the flight would have taken five days 14 hours if it had been made continuously, flying by day and night. Taking the total time spent on the flight, including nights and halts in the daytime on the ground, the average speed per hour throughout was well over 30 miles; whilst taking the time spent in the air only, it works out at an average of about 89 miles per hour. Further, 12,000 miles were covered without any repairs, a striking testimony to the reliability of machine and engine. One of the most striking features of the flight is that the machine employed was a standard Avro 'Avian,' with a Cirrus engine, which has been in use since 1926, and the only alteration made prior to the flight was the incorporation of extra tankage. A machine of this type costs, complete, apart from the extra tanks, only some £730, and an approximate estimate of the cost of the flight in terms of the petrol and oil consumed—as I have already said, no repairs were carr'ed out—is £50. These figures are a striking indication of the great potentialities of aircraft for improving communications in the vast stretches of the Empire in which other means of communication are as yet non-existent or relatively undeveloped."

THE Air Ministry has sent us a copy of the log of the Royal Air Force flight from Felixstowe to Karachi last autumn. This was the first part of the flight which was afterwards continued to the Far East. The machines were four metal supermarine Southampton flying boats, under the command of Captain H. M. Cave-Brown-Cave. The flight left Felixstowe on Oct. 14 and took a course via Plymouth, Bordeaux, Marseilles, Naples, and Athens to Aboukir. From there the course continued via Alexandretta, Ramadi, Basra, Bushire, Henjam, and Gwadar to Karachi. Stops were made at these and other places, but the log contains no mention of any accident or forced landing. All went well on the journey. The total flying distance was 4834 miles, and the average flying time of each aircraft at 67 knots was a few minutes under 72 hours.

BRITISH chemists will this year be afforded a unique opportunity of intercourse, both professional and social, with their colleagues in the United States of America and in Canada. Arrangements for the annual general meeting of the Society of Chemical Industry, which is to be held in New York, and for participation with the American Institute of Chemical Engineers and the (British) Institution of Chemical Engineers in visits in the United States and Canada are already nearing completion. The provisional itinerary commences on Aug. 11 at Southampton, and embraces Quebec, Shawinigan Falls, Montreal and Ottawa, Kirtland Lake, Niagara Falls, Akron (Ohio), Pittsburgh, Washington, Edgewood Arsenal, Wilmington, and New York, Great Britain being reached about Sept. 17. A number of 'tourist third cabin' berths have been reserved, and special facilities are being accorded by the White Star Line to members making their arrangements through the Society. It is believed that the total expenses of the complete trip need not exceed £150. The Society has allocated from the Messel fund ten grants of £50 each

to members of the Society who wish to participate in the round trip and travel 'tourist third cabin,' and members wishing to take advantage of this offer are asked to apply promptly to the secretary. Those desiring to participate in the visit are urged to make early application to Mr. J. P. Longstaff, the secretary of the Society of Chemical Industry, or to Prof. J. W. Hinchley, the honorary secretary of the Institution of Chemical Engineers. Recent events in the political arena have shown how much good may accrue from opportunities of personal contact; it is to be hoped that the facilities which these arrangements afford may be largely used by chemists and chemical industrialists in Great Britain in the promotion of her own legitimate interests and in attaining a closer understanding of and regard for her friends and competitors.

ELECTRICAL engineers are watching with keen interest the development in Great Britain of the interlinking schemes which form an integral part of the Electricity Act of 1926. These schemes will ultimately tie together the power stations of the country. A beginning has already been made in connexion with the 132 kilovolt lines of the Central Scotland area. By linking the power stations together a more steady load is attained, and so a reduction in the amount of spare plant is effected. In other countries interlinking is also being effected, and power can be interchanged over distances of hundreds of miles. From a purely economic view, the heavier the load the greater the advantage of using high pressure. It is possible that in a few years' time pressures of 380 kilovolts may be employed. Progress in the design of electrical apparatus has been very rapid, and there seems to be no limit either to the output or the voltage of machines. By suitable coverings corona losses can be suppressed and the dielectric losses at very high pressures, whilst appreciable, are far from prohibitive. Probably the smallest-sized link between two networks will consist of two three-phase lines with suitable transformers. For economical reasons these transformers must be very large, and so the difficulties of transportation by road and rail limit their size. In the *English Electric Journal* for January, the total power loss at full load for a 100,000 kilowatt transformer is given as 850 kilowatts. This is converted into heat in the transformer, so very special arrangements have to be made for keeping it cool. As a rule the transformers are immersed in oil, which is kept circulating through pipes passing through external water coolers. A considerable supply of water is necessary. The rise of temperature of the oil at full load is about 30° C., and for a 50,000 kilowatt transformer working at this load, 15,000 gallons of water per hour are required.

RAILWAY electrification in India is making steady progress. On Jan. 5 the electrified suburban lines of the Bombay, Baroda, and Central India Railway, from Colaba in the south to Borivli in the north, a distance of 57 miles of track, was opened. Two lines of rails are electrified for the whole distance, and four for part of the distance. The power for the operation of the railway is purchased from the Tata Company's hydro-electric power stations, situated some fifty miles from Bombay on the Western Ghats. Power is transmitted to a receiving station at a pressure of 100,000 volts, and from thence is retransmitted to the substations situated along the line at 22,000 volts. At the substations the pressure is reduced and then converted into direct current at the working pressure of 1500 volts. The motor coaches are equipped with four motors each of 275 horse-power. The overhead high-tension wires are supported by lattice steel structures, which when necessary span eight tracks. The pantographs which collect the current from the overhead wires are operated by a vacuum pump, which also works the vacuum brakes. The sanding gear is of the gravity type and is controlled by electrically operated valves. In the event of mechanical failure, each mile of the equipment can be at once isolated. Each section also can be rapidly isolated by air break switches. Special care has been taken to prevent birds causing short circuits accidentally. All the cross-arms and beams are carefully insulated, so that it is practically impossible for the legs and the beak of the bird to be each in contact with separate conductors having a great difference of potential between them. In the overhead equipment alone, approximately 2000 tons of steel and 500 tons of copper were used.

A RECENT addition to the Department of Zoology of the British Museum (Natural History) is a mounted specimen of an immature Snow leopard from the north-west Himalayas; owing probably to the commercial value of the fur, museum specimens of this animal are rare. Mr. J. J. Joicey has presented to the Department of Entomology his complete series of Lymantriidæ, consisting of nearly 6000 specimens from all parts of the world. The Department has also received a valuable series of fleas from Manchurian ground squirrels; these fleas include species of practical importance, on account of the possibility that, like the tropical rat-flea, they may be concerned in the spread of plague. Recent acquisitions for the Department of Mineralogy include a series of fluorspars from the iron mines of west Cumberland, showing colourless, blue, and yellow cubes on the hæmatite ore. These are small, and as a rule quite inconspicuous, and very little is as yet known about them; but they must be taken into account in any theories dealing with the origin of the iron ores, and this of course has an important bearing on the finding of new ore-bodies. Various minerals, including willemite (zinc silicate), native silver, silver iodide, mimetite, scheelite, and copper ores from Northern Rhodesia, have been presented by Mr. R. Murray-Hughes. A sample of the meteoric dust ('red rain') that fell at Melbourne, Victoria, on Jan. 1, 1928, has been sent by Mr. E. J. Dunn. The trustees have authorised the purchase of a magnificent crystal of topaz from Madagascar. As an exhibition specimen this far surpasses any topaz previously in the collection, and it forms a companion crystal to the fine beryl purchased last year. It measures 12 cm. × 11 cm. × 10 cm., and weighs 2290 grams (11,450 carats, or just over 5 lb.). It is water-clear with a pale blue tinge and of gem quality.

The well-developed and brilliant crystal-faces are marked by complex and intricate pyramids and lines of growth, and the specimen is an instructive example of a crystal in which the process of growth has been abruptly arrested.

A NEW egg grading and marketing scheme has recently been brought out by the Poultry Advisory Committee, by which it is hoped to stabilise prices throughout the year. The National Poultry Council and two important associations of retail distributors in Great Britain have already assented to the principles of the scheme, and it is understood that the Government may provide time for the necessary legislation. At present there is no large, recognised market for English eggs, and transactions are made with comparatively small consignments, the organisation being insufficient for the development of the industry. Foreign eggs, however, are properly graded and packed, and it was only owing to the risk of their obtaining a better market on this account that an order as to the labelling of imported eggs was not recommended by the committee under the Merchandise Marks Act, 1926, until improvements in the grading and packing of British produce had been secured. The present scheme is to be voluntary, and available to all country and town packers provided they deal with a stated minimum quantity of eggs, registration under the scheme permitting the use of a 'national mark.' It is suggested that the Minister should be given power by act of parliament to define grades of eggs, the terms 'Specials,' 'Standards,' 'Mediums,' and 'Smalls' being recommended, and that only first quality eggs should be dealt with, sale being by weight. In addition, the scheme provides that all preserved British eggs should be marked as such, and imported eggs afterwards stored in Great Britain should also be appropriately labelled. It is hoped that all large egg producers will see the wisdom of coming under the scheme. It may well be the means of developing the egg industry in Great Britain.

DR. R. A. MILLIKAN, Director of the Norman Bridge Laboratory of Physics in the California Institute of Technology, Pasadena, has been awarded the Messel Medal of the Society of Chemical Industry.

AT the meeting of the London Mathematical Society at 5 P.M. on Thursday, Mar. 8, Prof. A. E. H. Love will deliver a lecture on "Biharmonic Analysis, especially in a Rectangle, and its Applications to the Theory of Elasticity." Members of other scientific societies are invited to attend.

THE Council of the Institution of Naval Architects has invited Admiral of the Fleet the Right Hon. Lord Wester Wemyss to succeed His Grace the Duke of Northumberland as President of the Institution. The election will take place at the opening of the annual general meeting at the Royal Society of Arts on Mar. 28 at 11 A.M. The Council of the Institution has awarded two premiums for the year 1927, one to Mr. H. J. R. Biles, for his paper on the "Effect of Wind Resistance on Superstructures and Ship Resistance," and the other to Mr. W. C. S. Wigley, for his paper on "Ship Wave Resistance—A Comparison of Mathematical Theory with Experimental Results—Part 2."

THE two Boyle Medals awarded by the Council of the Royal Dublin Society to Dr. W. R. G. Atkins (Pure Science) and to Prof. W. E. Adeney (Applied Science) were presented at a special scientific meeting of the Society on Feb. 15. The statements setting forth the grounds of these awards referred in Dr. Adeney's case to the valuable work he has accomplished during the last twenty years with respect to river pollution; this work has done much to elucidate the biological and chemical factors involved and had been generally recognised as of fundamental importance. In the case of Dr. Atkins, emphasis was laid on his work on the cryoscopic examination of physiological fluids: his researches on the osmotic pressures occurring in plants: his work on the relation of the *p*H value of the soil to plant distribution; on the photosynthetic changes in sea water; and on the significance of the phosphate content as a limiting factor in plant and animal production in the sea.

THE Carnegie Institute of Technology has issued a preliminary announcement of a second International Conference on Bituminous Coal, to be held at Pittsburgh on Nov. 19-24. The purpose of this Congress is again to present the results of recent studies of coal bearing on improved methods of utilisation and combustion. The programme will include the discussion of the fixation of nitrogen, the manufacture of substitutes for gasoline from coal, complete gasification of coal, high temperature distillation, low temperature distillation, coal-tar products, power, smokeless fuel, etc. An invitation is extended to scientific workers of all countries to take part in this conference. The president of the Carnegie Institute of Technology, Thomas S. Baker, will visit Europe during March and April to confer with fuel technologists who may consider the possibility of presenting papers or taking part in the congress in any other way. President Baker's address will be c/o Guaranty Trust Company, 1 rue des Italiens, Paris, where he will be glad to receive correspondence in regard to the meeting.

WE have received the annual report of the Society for the Provision of Birth Control Clinics for 1926–27. Two new clinics at Oxford and at Birmingham have been opened, making a total of nine clinics in operation in Great Britain. An increasing number of poor women is attending, and it is believed that much valuable assistance is rendered. The Society is entirely dependent upon private donations.

THE annual report of the South African Institute for Medical Research for 1926 has been issued. Sir Spencer Lister is now Director in succession to Dr. Watkins-Pitchford, who has resigned on account of ill-health. A summary of the work of the Institute is given; much of it has been devoted to plague research. A mosquito survey of the Union and a tuberculosis survey of the Native Territories are being undertaken.

THE secretary of the Royal Horticultural Society reminds us that "Index Londinensis" has been prepared under the auspices of that Society. This was not mentioned in our note in the issue of Feb. 25, p. 296, referring to the publication. Messrs. Dulau and Co., Ltd., are now accepting subscriptions for the work.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A chemist for research work for the improvement of mine rescue breathing apparatus, a physiologist to assist in investigations regarding mine rescue breathing apparatus and methods of resuscitation, and an investigator for research work on mechanical appliances for use in mines, each under the Safety in Mines Research Board —The Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (Mar. 10). An assistant to the lecturer in systematic forest botany, and a herbarium assistant, at the Imperial Forestry Institute, University of Oxford—The Secretary, Imperial Forestry Institute, Oxford (Mar. 12). A research student for work on bulb-growing problems at the Royal Horticultural Society's Experimental Gardens — The Director, R.H.S. Gardens, Wisley, Ripley, Surrey (Mar. 13). A bio-chemist at the Forest Research Institute, Dehra Dun, India—The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (Mar. 15). A reader in geography and education at Raffles College, Singapore—C.A. [T.], the Secretary, Board of Education, Whitehall, S.W.1 ; Scottish candidates, [T.], the Secretary, Scottish Education Department, Whitehall, S.W.1 (Mar. 17). Junior assistants at the National Physical Laboratory—The Director, National Physical Laboratory, Teddington (Mar. 17). A full-time lecturer in chemistry at the Chelsea Polytechnic—The Secretary, Chelsea Polytechnic, Manresa Road, S.W.3 (Mar. 24). A lecturer in geography in the Durham Colleges, University of Durham—The Secretary to the Council of the Durham Colleges, 38 North Bailey, Durham (Mar. 31). A lecturer or an assistant lecturer in zoology in the University of Bristol—The Registrar, The University, Bristol (April 14). A principal of Chelsea Polytechnic—The Secretary, Chelsea Polytechnic, Manresa Road, S.W.3 (April 30). A handicraft teacher for woodwork and light metal work under the Leicestershire County Council Education Committee—The Director of Education, County Education Offices, Grey Friars, Leicester.

Our Astronomical Column.

NEW COMET.—The first comet of 1928 was discovered photographically by Herr K. Reinmuth, assistant at Königstuhl Observatory, Heidelberg. Herr Reinmuth is well known as a discoverer of minor planets, having found more than a hundred of them, but this is his first comet ; as the new comet is near the ecliptic, it was doubtless found in the course of the routine search for minor planets. Its magnitude is 12½. The following positions have been obtained at Königstuhl and circulated by the I.A.U. Bureau, Copenhagen :

U.T.		R.A. (1928.0).	N.Decl.(1928.0).
Feb. 22.	96160	$9^h\ 15^m\ 4^s$	21° 44′ 0″
,, 23.	96368	9 14 54·93	21 52 39
,, 24.	95736	9 14 42·20	22 0 6
,, 25.	93181	9 14 33·93	22 6 57

The motion is getting slower ; an estimated prediction for Mar. 4.0 is $9^h\ 15^m\ 36^s$, N. Decl. 22° 43′ ; the full moon will, however, prevent observation for a few days. There has not been time as yet to compute an orbit ; in any case, the above arc is too short to determine reliable elements. The slow motion probably implies that the object is at a considerable distance.

There is occasionally a double solution to the problem of finding an orbit from three observations ; an interesting case of this arose last year in the orbit of Galé's comet ; the observations of the first six weeks could be satisfied with periods of either 11 or 13 years, the former being found to be correct when a longer series of observations was available. Prof. T. Banachiewicz discusses this question in *Acta Astronomica* for Feb. 7, and gives the discriminating rules in a simple form ; the case to which he applies them (Orkisz's comet) has only a single solution ; an example with a double solution would have been more instructive.

A LARGE SUNSPOT.—A large sunspot, nearest the centre of the sun's disc on Feb. 21, was seen in London by many people through the screen of mist or fog prevailing about that time. A small telescope showed that the group consisted of a principal spot accompanied by an aggregation of irregular spots or penumbral markings to the south. The latter decreased considerably as the group crossed the disc. No unusual disturbance of the earth's magnetic elements has been reported. In NATURE of Feb. 11, p. 220, a short account was given of a large prominence which was observed near a spot when at the sun's west limb. The recent group is either a return or a revival in the place of this earlier spot. Other particulars of the later and larger spot are given below, and it may be added that this is the first one this year to be recorded generally as a naked-eye object, although several other large spots are mentioned in NATURE of Feb. 11.

No.	Date on Disc.	Central Meridian Passage.	Latitude.	Maximum Area.
1	Feb. 15-28	Feb. 21·6	6° N.	1/700 of hemisphere

THE GREGORIAN CALENDAR IN EGYPT.—The 'Old Style' or Julian Calendar has now become practically obsolete, having taken nearly three and a half centuries to do so. The Orthodox Church in Greece adopted some years ago a modified form of the Gregorian Calendar ; instead of the 400-year cycle of the Gregorian calendar, it uses a 900-year one ; but as the two calendars are exactly the same for about seven centuries from the present time, the difference is not of immediate importance. The *Times* of Feb. 15 announces that the Synod of the Patriarchate of Alexandria, representing the Orthodox Church in Egypt, has decided to adopt the Gregorian calendar from Oct. 1, 1928 (Sept. 18, Old Style). Presumably it is following the same form of it as the Greek Orthodox Church ; the latter body also differs from western usage in the manner of computing Easter, which is made to depend on the actual moon, instead of using the simplified 'ecclesiastical moon.' The day used is that of the meridian of Jerusalem, thus getting rid of difficulties of longitude.

Research Items.

THE EVOLUTION OF MAN AND APES.—In volume I. of the new journal *Palæobiologica*, edited by Prof. Othenio Abel and published in Vienna and Leipzig (Emil Haim and Co.), there appears a paper by Prof. H. F. Osborn entitled "Recent Discoveries relating to the Origin and Antiquity of Man." This paper is less a review of recent discovery than a statement of Prof. Osborn's own opinion on the course that the evolution of man has taken. This differs from that usually held by the majority of investigators, in that it denies any close connexion between ape and man and places the ancestor common to the two stocks back to a period so remote as the Oligocene. While admitting that there are some anatomical resemblances, Prof. Osborn lays more stress on the difference in 'behaviourism' between man and the ape, and thinks that "scientific mythology has accumulated around the anthropoid apes, falsifying and exaggerating their human resemblances, minimising and ignoring their profound differences from man in habit and gait and in the anatomy and functions of the brain. . . ." Some resemblances, moreover, are to be attributed to convergence. There are two diagrams, both dated 1927, which express graphically Prof. Osborn's views on primate evolution. Propliopithecus at the base of the Oligocene is the common meeting ground of the two stocks. Dryopithecus and Pliopithecus are Miocene representatives of the Simian division, but with the exception of Hesperopithecus, on whose primate nature very great doubt has been cast (*v.* NATURE, Jan. 28, p. 148), there is no human representative actually known until towards the top of the Pliocene. This emphasises how much palæontological exploration has yet to do before there is enough evidence to form a clear opinion on this great problem of our own ancestry.

CARNIVOROUS HABIT OF AMERICAN MAGPIES.—In view of the well-known change of feeding habit in the New Zealand kea, a parrot of vegetarian tastes, which has developed a liking for the kidneys of living sheep, and has caused very serious damage to flocks in certain areas of the South Island, the description by E. R. Kalmbach of a similar development in the American magpie is of great interest (*U.S. Dept. Agr. Tech. Bull.*, No. 24, Oct. 1927). During the past ten years the magpie has begun to attack live stock on the western ranches, and since the first reports came to hand in 1917, its depredations have extended from Utah to Colorado, Wyoming, and Montana. Sheep, cattle, and horses have been attacked so severely that many have succumbed: recent reports mention that in one area several hundreds of cattle are destroyed each winter, and in another the magpie has become one of the greatest problems with which the ranchers have to deal. The magpies generally attack the animals about the loins, sometimes penetrating to the body cavity, sometimes reaching and devouring the kidneys. The origin of this habit in the States may throw some light on the predisposing causes which gave rise to the kea's depredations in New Zealand. It has been found that sheep were first attacked when they showed fresh wounds caused during shearing, cattle on fresh brand marks, and horses on unhealed saddle-sores. But the habit having been formed, the magpies learned to begin an attack without any direct incentive such as exposed raw flesh. The magpie concerned is the black-billed magpie (*Pica pica hudsonia*), a geographical race of the British magpie, and in normal circumstances the feeding habits of the two are similar.

DIURNAL VARIATION OF OXYGEN IN RIVER WATER.—The degree of saturation of river water with oxygen is an important criterion in forming a judgment as to the suitability of a river for maintaining fish life. This property is one frequently determined in work dealing with the pollution of rivers, as the proportion of dissolved oxygen falls in the presence of oxidisable organic matter. It has recently been found, however (Butcher, Pentelow, and Woodley, *Biochem. Jour.*, **21**, 945, and 1423-1435; 1927), that there are both diurnal and seasonable variations in the proportions of dissolved oxygen and ammoniacal nitrogen in river waters. This has been established by making hourly determinations over periods of 24 hours both on a contaminated stream in Suffolk and on a pure and unpolluted Hampshire trout stream. The diurnal variations in the oxygen dissolved were greater in the case of the River Lark in Suffolk, although quite distinct in the pure River Itchen. The ammoniacal nitrogen, which varies in a sense opposite to that of the dissolved oxygen, also showed a diurnal variation in the Lark, but was constant in the Itchen. The variations, especially in dissolved oxygen, are very large, ranging in some cases from 60 per cent. of saturation shortly after midnight, to 150 per cent. shortly after midday. The rise is attributed to the photochemical evolution of oxygen from organisms, and the fall to the absorption of this oxygen by organic matter, and by processes of respiration. It has thus become clear that in conducting a field survey of a river, the value of a single determination of the dissolved oxygen is of little value. Investigations over a period of 24 hours are necessary, and consideration must be given to such factors as time of year, actinic conditions, nature of plant and animal life present, as well as to the character of the river bed and its history with regard to past pollution. It is probable also that the diurnal variation in the supply of oxygen available for the needs of fish may have a bearing on their movements, a subject of constant interest to the fisher.

THE WHEAT BULB FLY.—The late Prof. J. F. Gemmill's observations on the life-history and bionomics of this fly, *Leptohylemyia coarctata*, have recently been published in *Proc. R. Phys. Soc. Edin.*, vol. 21, part 3, 1927. The fertilised eggs are laid during July, August, and early September in bare, loose soil, preferably among early potatoes and scarcely ever among cereals or in pasture. The egg develops slowly and the larva does not hatch until towards the end of January or in February. The newly hatched larvæ seek out, and by means of their mouth hooks bore into, young wheat plants, entering just above the so-called bulb. Reaching the centre of the plant they ascend for one to three inches, and the infected wheat plant soon shows withering of the central blade, and in early or poorly growing wheat the whole plant withers and dies. The larva makes its way to a second plant, which it affects in the same way, and it may destroy a third or even a fourth plant. If, however, the wheat plant is so far advanced when attacked as to show good lateral buds, the larva completes its growth in one of these and the plant saves itself by sending out additional lateral buds. The larvæ, which undergo two or three moults, are fully grown by the beginning of May; they then leave the plant and pupate in the soil half an inch or more below the surface. The flies emerge in late June and early July and, after having laid eggs, die off by the end of September.

The larvæ can infect barley, rye, and couch grass, and in these can complete their life-history. Couch grass appears to be the natural wild host in the area investigated. Prof. Gemmill recommended that in an infected area wheat should not be sown after potatoes or other root crop or fallow, and stated that if this were done in a single year he believed the numbers of the fly would be so reduced that it would not be a menace for many years to come. Short of this drastic action, he recommended to avoid sowing wheat after early potatoes, or to sow it after the middle of February, to arrange that potato fields shall not adjoin wheat fields in any one year, to get rid of couch grass, and to avoid deep burial of the wheat seed, for shallow-rooted plants form lateral shoots earlier. A field may be regarded as being badly infected in which during November the soil contains half a million to one million eggs of the fly per acre.

TEXTILE PROPERTIES OF INDIAN COTTONS.—Progress in research work on the textile properties of standard Indian cottons is reported by A. J. Turner in *Bulletin 11*, issued by the Technological Laboratory of the Indian Central Cotton Committee. The foundation of the work lies in the annual testing of the fibre characteristics and spinning properties of some eighteen pure strains, the objects being generally, to accumulate data for the investigation of the methods of determining the intrinsic value of a cotton, and specifically: (1) to prepare a series of standards by which to judge other cottons, particularly new cottons produced by cotton breeders; (2) to determine the extent to which these standard cottons are affected by seasonal variations; (3) to determine the minimum weight on which a spinning test can be carried out satisfactorily; and (4) to assist in the marketing of these cottons by providing the cotton trade with detailed information concerning them. These objects have been achieved by submitting, year by year, typical samples of each variety to spinning tests which, though carried out on full-size machines, require only small quantities of material. The significance of small-scale tests has been investigated in accordance with object (3) above, and it has been shown that trustworthy results can be obtained by spinning duplicate lots weighing 5 lb. each. In addition, efforts have been made to determine the relationship between the physical properties of the fibres with spinning value, and while no conclusions of a positive character have been arrived at, the way seems to have been cleared for a more definite attack. Among the supplementary problems that have arisen in the course of work are those of the effect of temperature and humidity on cotton spinning, and the effect of subjecting cotton to repeated blow-room treatment. These are the subjects of *Bulletin 9* and *Bulletin 10* respectively. The latter has perhaps more of a technical than a general scientific appeal, but the former is interesting inasmuch as it embraces a very lucid résumé and criticism of previous work on the subject, and shows that Lancashire is by no means unique in the suitability of its climate for the manufacture of cotton goods.

THE ANTHRAXOLITE OF SUDBURY.—The so-called 'coal' occurring in the pre-Cambrian rocks of Chelmsford, near Sudbury, has given rise to the suggestion "that terrestrial floras had a long pre-Devonian history." In the *Amer. Jour. Sci.*, Jan. 1928, Prof. A. P. Coleman shows conclusively that there is no need to assume pre-Cambrian land plants to account for the deposits in question. He finds that the veins of supposed coal cut across the stratification of a black slate, and reaches the conclusion that the slate was originally an oil-shale, and that the coal-like material must have reached its present position while it was plastic and still retained its original volatile hydrocarbons. The latter were probably driven off by the heat of the nickel-bearing eruptive of the Sudbury basin, residual carbon being left behind. Since the material differs both in origin and properties from *anthracite*, it is important that this name, with its inevitable implications, should not be applied. The term *anthraxolite*, used for coal-like deposits forming the end-products of the metamorphism of petroleum, is clearly more fitting. There remains the problem of the formation of oil-shales in the pre-Cambrian. At least one can conclude that the waters of the time were thronged with lowly types of plants and animals.

APPARATUS FOR THE INVESTIGATION OF FLUORESCENCE.—A new and simplified apparatus designed for the investigation of fluorescence is described in the *Chemiker Zeitung* of Jan. 11, by Dr. F. W. Müller, of Essen, from whom it may be obtained. Instead of the quartz mercury lamp, the source of ultra-violet light is a carbon arc lamp fitted with carbons containing iron and tungsten, which provide an almost completely continuous spectrum. The apparatus can be used even in daylight, and the ultra-violet light, filtered from visible rays, may be directed either from above or in a horizontal direction. A suitable resistance is provided with the apparatus, which can be used for direct or alternating current.

A MICRO-METHOD FOR THE DETERMINATION OF SURFACE TENSION AND DENSITY.—A method for the determination of surface tension and density, using only one piece of apparatus and a very small sample of liquid, down to 0·1 c.c., is described by V. R. Damerell in the *Journal of the American Chemical Society* for December. This apparatus is very simple in design and operation and may readily be constructed from the materials available in any laboratory. The results obtained were satisfactory for all except the most volatile liquids, such as ether, and the method has an accuracy of between 1 part in 100 and 1 part in 300.

THE INTERACTION BETWEEN RADIATION AND ELECTRONS.—The main problems presented by the absorption and scattering of X-rays are discussed by Prof. A. H. Compton in the January number of the *Physical Review*. In his opinion the two phenomena are essentially similar, in that the whole momentum lost by the radiation is transferred to the electron, indicating that the action is sensibly instantaneous, but they differ in the extent to which they conform to classical electron theory. Experiment shows that the direction of emission of photoelectrons is given, at least statistically, by the Lorentz equations, whereas the preferred direction of motion of recoil electrons is perpendicular to the electric vector of the incident rays. Prof. Compton points out that conservation of angular momentum has also to be taken into account when dealing with circularly polarised waves. The point of view which he has adopted throughout is that of the older quantum theory, only one reference being made to the wave mechanics, in connexion with Wentzel's analysis of the angular distribution of photoelectrons.

AN IMPROVED APPARATUS FOR THE REMOVAL OF DISSOLVED GASES FROM WATER.—The various forms of apparatus used for removing dissolved gases from water depend upon the use of heat and a vacuum, either separately or both at once. Those employing both heat and a vacuum are the most efficient, and a new apparatus of this type is described by Lorch, Williams, and Thompson in the *Journal of the American*

Chemical Society for December 1927. This apparatus is of simple construction and is adaptable to any amount of liquid or gas.

THE ESTIMATION OF GOLD AND SILVER IN SEA WATERS.—It is well known that sea water contains traces of gold and silver, and a new method for their estimation is described by M. Yasuda in the *Bulletin of the Chemical Society of Japan*, vol. 2, No. 12. Mercuric chloride is added to the sea water and then reduced to a fine suspension of metallic mercury, which removes the gold and silver (with the exception of that present in organic colloids) as it settles down. The amalgam thus obtained is absorbed in a bead of pure lead and, finally, the gold is obtained free by dissolving the other metals in nitric acid.

COLOURING MATTERS OF CARAJURA.—Carajura (or crajura or chica red) is a rare colouring material prepared from certain leaves and bark and used by various American Indian tribes. The main colouring matter is a crystallisable substance known as *carajurin*, and an interesting investigation of its constitution by E. Chapman, A. G. Perkin, and R. Robinson is described in the issue for December last of the *Journal of the Chemical Society*. Perkin (1914) considered carajurin to have the empirical formula $C_{18}H_{16}O_5$, but it is now shown to be $C_{17}H_{14}O_5$. Carajurin on demethylation yields salts of *carajuretin*, and these have been shown to be identical with certain flavylium salts prepared synthetically, thus enabling a provisional formula to be advanced for the constitution of carajurin. The synthesis of this substance is now being attempted and a second colouring matter, *carajurone*, has been isolated from carajura. The investigation involved a large amount of experimental work, including the synthesis of a number of new compounds.

YIELD-POINT IN IRON AT VARIOUS TEMPERATURES.—The *Journal of the Royal Technical College, Glasgow*, for December 1927 contains several papers of considerable importance, not the least interesting of which is one on the yield-point in iron by Prof. J. Muir. The work was carried out on some hard-drawn wrought-iron wire, 0·024 in. in diameter and of composition: carbon, 0·05 per cent.; manganese, 0·30 per cent.; phosphorus, 0·016 per cent.; sulphur, 0·032 per cent. Before use the material was annealed in nitrogen at a temperature of approximately 800° C. The stress at the yield-point, the extension taking place there, and the time required for that extension were all measured at temperatures ranging from 17° C. to 250° C. Excluding two results at 185° C. and 215° C., which were doubtful, the amount of the extension at the yield-point shows a progressive drop from 4·65 per cent. at 17° C. until at the highest temperature used (250° C.) the yield-point so characteristic of iron at ordinary temperatures has practically disappeared (0·5 per cent.), a stress-strain curve similar to that, for example, of a non-ferrous metal being obtained. Another interesting observation was concerned with the rapidity with which these extensions took place. At 17° C., 150 minutes were required for the extension to complete itself. At 52° C. the extension took place very much more rapidly and was complete in about 8 minutes. At 210° C. and 215° C. the yielding took place with startling rapidity in about a second, and was characterised by a number of very rapid jerks, a phenomenon which had entirely disappeared at 250° C. The loads at which the yield-point occurred varied from 19·4 lb. at 17° C. to 20·25 lb. at 195° C. to 14 lb. at 250° C. A load of 1 lb. corresponded very nearly to a stress of 1 ton per square inch.

DOMESTIC APPLICATIONS OF ELECTRICITY.—Two papers were read on the domestic applications of electricity on Feb. 16 to the Institution of Electrical Engineers. The load on the various power stations has been rapidly increasing in Great Britain for a number of years owing to the extensive use of labour-saving appliances. The importance of standardising the systems of wiring in use and of making provision during the building of houses for the installing of the electric wires was emphasised. An experiment carried out recently at Birmingham showed that the saving in the cost of building an 'all electric' as compared with an ordinary house is about fifteen per cent. In the Weir system of houses for working classes the cost of wiring is reduced to a minimum. The parts of the houses are all duly wired in the factory, so that when the house is erected by ordinary workmen, an electrician can make all the requisite connexions in about two hours. The total cost comes to about £5 per house. Electric cooking is successful commercially, there being very few dissatisfied consumers. The standard rate of consumption for cooking is one unit per day per person. The radiant system of cooking is becoming popular. In this system the oven elements consist of two vertical radiators which radiate heat directly on to the food. As the food is grilled on both sides simultaneously, much time is saved, and it is claimed that the quality and flavour are greatly improved. The time required to cook a 5 lb. joint of beef is 40 minutes and the energy consumption is only half a unit. An ordinary electric oven takes more than twice as long and takes four times as much energy.

STRESSES ON HIGH TENSION CABLES.—A progress report by the Research Department of the Detroit Edison Company, which was presented at a meeting of the Association of Edison Illuminating Companies, held at Colorado Springs on Sept. 26, gives a very interesting study of the mechanism of the actions which cause the failure of high tension electric cables. In experiments with a new three-core lead-covered cable of modern type, it was found that internal pressures as high as 85 lb. per square inch were sometimes developed after the current had been flowing for several hours. If the current is kept flowing for many hours the pressure begins gradually to diminish, due largely to the stretching of the lead. When the current is now diminished to half its value, vacuous spaces develop in isolated regions along its length; the pressure falling to about 15 inches of mercury below atmospheric pressure. The vacuum in these spaces may exist for days if the cable is left unloaded. These vacuous spaces are subjected to a high electric stress, and cumulative ionisation ensues, an electric discharge taking place through them. The shape of these spaces being unknown, it is impossible to compute the electric stresses to which the insulating material is subjected. The experimental results prove the novel result that the cable insulation produces a definite rectifying action on the current flowing through it. The direct current component of the voltage thus produced was found to be of the order of eight per cent. of the peak value of the alternating current voltage. It is stated that this is detrimental to the cable and that the relative magnitude of this effect increases with the length of time the cable has been in use. Resin oil evolves large quantities of gas under electrical bombardment. From this point of view its use is deleterious. On the other hand, its conductivity improves with temperature, and this generally has the beneficial effect of relieving the electric stress on the air cavities.

The Seventh Congress of the Far Eastern Association of Tropical Medicine.

THE seventh Congress of the Far Eastern Association of Tropical Medicine was held in Calcutta on Dec. 5–24 last. The Association was founded at Manila in 1908, where the first congress was held in 1910. Since that date congresses have been held at intervals, usually of two years (except during and for a short interval after the War), at Hongkong, Saigon, Weltevreden, Singapore, and Tokyo. The Calcutta Congress was the largest that has so far been held, and was attended by about 900 members. The headquarters were in the School of Tropical Medicine and the adjacent Medical College.

The scientific business of the Congress was conducted in six sections: (i) Clinical medicine and surgery, ophthalmology, dermatology, etc. (apparently all that is not specifically included in the titles of the other sections); (ii) State medicine and hygiene, child welfare; (iii) plague, cholera, dysentery, sprue, intestinal infections, bacteriophage, leprosy, tuberculosis, and bacteriology; (iv) malaria, kala-azar, protozoology, typhus-like diseases, leptospiræ, medical entomology, and helminthology; (v) nutrition, deficiency and endocrine diseases, immunology, chemicotherapeutics, rabies, and pharmacology; (vi) veterinary. Several of these were divided into subsections.

A total of 228 papers was read; abstracts of these were published beforehand [1] and were available for all members. Judging from these abstracts, the meetings of the sections must have been packed with interest. It is impossible to mention even a tithe of the titles that attract attention on turning over the pages of the handbook; and the following notes on a few of the papers are really only in the nature of a random sampling.

Dr. Gian Singh considered the incidence of pulmonary tuberculosis in Multan City, according to sex, religion, age, occupation, and residence in different parts of the city. His study leads him to recommend that Government should oblige municipalities to take housing schemes in hand, to open up congested areas, and to enforce building by-laws prohibiting high houses in narrow lanes; that municipalities should employ health visitors to carry on propaganda among the women against certain customs observed by them in the puerperal period; that the people themselves should form anti-purdah and anti-child marriage societies, and that the working and economic conditions of low-paid Government servants should be improved by Government.

Lieut.-Colonel Russell, considering population and public health in India, finds that the population is outrunning the means of subsistence, hence unemployment, rising prices, and reductions in the standard of living of agricultural and industrial workers. As to the possibility of these phenomena being countered by improved agricultural methods and the production of much larger quantities of food, the author considers it unlikely that the situation can be thus influenced to any extent in the long run. In the Madras Presidency the population is within a million of the upper asymptotic limit, and even now considerable quantities of rice are being imported from Burma and Ceylon.

Dr. d'Herelle has three papers on bacteriophage, a subject with which his name is especially connected, and which has attracted much interest in recent years. Bacteriophage is a 'principle' which effects the dissolution of bacteria, reproducing itself as it does so. According to d'Herelle, it is a filter-passing parasite (*Protobios bacteriophagus* d'Herelle 1918) of the bacteria. It is present in the intestine of every man and animal, and in normal individuals develops upon the saprophytic flora there present; by a process of adaptation (demonstrable *in vitro*), which is more or less rapid according to circumstances, it becomes able to parasitise any invading bacteria. The end result, recovery or death, in the bacterial intestinal diseases of man and animals, depends on the power of the bacteriophage to attack and destroy the pathogenic organisms. Bacteriophagy is thus the result of an infectious disease prevailing amongst bacteria. Bacteriophage treatment has been eminently successful in bacillary dysentery, and in cholera has been fully efficient in the great majority of cases.

Lieut.-Colonel Acton and Major Chopra, investigating the action of quinine on the malarial parasites, found that by increasing the degree of alkalinity in the intestines they obtained a greater diffusion of quinine into the circulating blood; hence the blood concentration of quinine was higher when alkalis were administered at the same time. Still, the concentration attained in the circulating blood is considered to be insufficient directly to kill the parasites; but sublethal concentrations are able to paralyse their movements to a certain extent, and the parasites fail to penetrate the envelope of the red blood corpuscle and so to reach their food. These sluggish parasites are swept off the corpuscles by the friction of the blood stream and die of starvation.

Lieut.-Colonel Christophers and Dr. I. M. Puri ("Why do Anopheles Larvæ feed at the Surface, and How?") show that the Anopheles larva is morphologically adapted to feed at the surface, and point out the advantages it obtains by doing so. (Most waters have a special bacterial and flagellate surface film; there is also a subsurface layer of organisms that aggregate below the surface film, either because they are lighter than water, or because they actively seek this position.) The feeding process is described.

Lieut.-Colonel S. P. James and Drs. Nicol and Shute consider the habits of Anopheles in relation to their rôle in the spread of malaria—an interesting paper, since the work was done in England, in connexion with the provision of supplies of infected mosquitoes for transmitting malaria to certain mental patients. The same authors have a paper on experiments on the treatment of malaria in England. Lieut.-Colonel James contributes some remarks on anti-malarial measures for poverty-stricken regions; no one doubts, he says, the efficacy of the established methods of malaria control, but they are difficult and expensive, and it is important to discover a method which can be applied in poorer countries, such as those of south-eastern Europe. In spite of the Commission appointed by the League of Nations Health Committee, such a method is not yet forthcoming; but the first aim should be to reduce the severity rather than the incidence, to combat the disease itself on its appearance in the human or insect hosts; the disease then soon ceases to be of importance. Besides doing this by direct methods, it is essential to improve the economic and social conditions of the people and their general well-being and standard of life; Dutch and Italian schemes for such purposes are already in existence.

Lieut.-Colonel Knowles considers the kala-azar transmission problem and the factor of resistance; he tells the interesting story of recent research into this problem, the arguments which led to the incrimination of the sandfly *Phlebotomus argentipes* as the trans-

[1] Guide to the Seventh Congress of the Far Eastern Association of Tropical Medicine, Calcutta, December 5th to 24th, 1927. Pp. vi+115. Abstracts of Papers and Programme of Scientific Sessions. Pp. iv+176. The Indian Empire: being a Brief Description of the Chief Features of India and its Medical and Sanitary Problems. Pp. vii+346 +20 plates+4 maps. (Calcutta: Far Eastern Association of Tropical Medicine.)

mitter, feeding experiments and their results, the working out of the history of the parasite in the fly (the whole life-cycle of the parasite is fully considered in a paper by Major Shortt), and refers to the parallel work of Patton and Hindle in China. The final link in the chain of proof, namely, transmission from man to a human volunteer by means of the sandfly, is still lacking, probably owing to the fact that man, instead of being very susceptible, is extremely resistant to infection by kala-azar.

There are numerous papers on helminthology and on medical entomology; but these notes must close with a mention of Mr. Senior-White's paper on progress towards the realisation of the biological control of mosquito breeding, in which, after recounting the older methods, the author considers the connexion between the hydrogen-ion concentration of the water and the species of mosquitoes that breed in it. Acidity other than that due to carbon dioxide is definitely inhibitory to anophelines; but only extremes of 'natural' pH have any such effect. The presence of very small amounts of ammonia, however, are destructive to larvæ; and the probability that bacteriophages (*v. sup.*) can be isolated by which the nitrifying bacteria can be destroyed, and hence the conversion of ammonia into nitrites and nitrates delayed, gives a hope that practical measures may be devised on these lines.

Perhaps it is scarcely necessary to add that all the activities of the Congress were not on these strenuous lines. The programme specifies such things as an evening reception by H.E. the Governor of Bengal at Government House, another by the Trustees of the Indian Museum at the Museum, a conversazione by the Asiatic Society of Bengal, a garden party at Government House, river trips and 'bus tours, visits to works, scientific cinema films, a play in an Indian theatre, as well as other diversions. The scientific meetings concluded on Dec. 11, after which three tours were arranged, one through northern India, one through southern India (these lasting a fortnight), and one through Bihar and Orissa (lasting a week). The "Souvenir—The Indian Empire," presented to all members, is "a brief description of the chief features of India and its medical and sanitary problems"; it fulfils a similar function to the Local Handbook of the meetings of the British Association. Among its 18 chapters are included a résumé of Indian history, and accounts of the history of European medicine in India, of indigenous systems of medicine, of Indian archæology, zoology, botany, geology, weather, and art. Its 340 pages are illustrated by 20 plates of photographic reproductions, several—including the frontispiece, a magnificent peak in the Sikkim Himalayas—of great beauty. Everything seems to have been done to make the Congress a success; and the members can scarcely fail to have enjoyed an intensely interesting as well as a very profitable visit to Calcutta.

J. Stephenson.

The Origin of the Japanese Earthquake of 1923.

Dr. N. Yamasaki, professor of geography in the Imperial University, Tokyo, contributed to the official report some valuable physiographic studies on the Japanese earthquake of 1923, which he has recently brought to the knowledge of western readers by translating them into English (*Jour. Fac. Sci.*, Imp. Univ., Tokyo, vol. 2, pp. 77-119; 1926). They are of great interest, chiefly on account of the light which they throw on the origin of this remarkable earthquake.

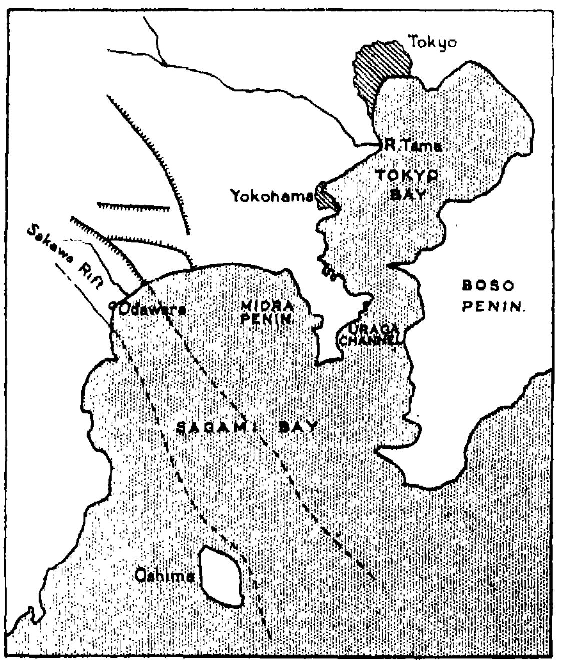

Fig. 1.

The principal features of Prof. Yamasaki's map are here reproduced (Fig. 1). The river Sakawa runs into the Bay of Sagami on its north-west side. The valley is part of a remarkable rift valley, bounded on the north-east side by a fault-scarp from 200 to 300 metres in height. It was formed by blocking movements of comparatively recent date. Earthquakes, indeed, still occur in the district, one of the latest being the strong Odawara earthquake of 1633. The earthquake of 1923 was very severe in this part. Many villages at the foot of the scarp were totally ruined and the level surface of the fields was thrown into gentle undulations. Still more remarkable than the rift valley on land is its continuation into Sagami Bay. A great trench runs along the axis of the bay in the direction S. 35° E. Near the bottom of the trench the slope is gentle, while the straight side walls are steep and high. The north-east wall is an extension of the fault-scarp on the same side of the Sakawa valley, while the south-west wall is also a steep scarp passing a short distance to the east of the volcanic island of Oshima.

Before the earthquake of 1923, the depth of the trench varied from 1500 to 2000 metres. On the north-east side of the trench, the submarine plateau consists of two steps, the lower one 12 km. wide at a depth of from 1000 to 700 metres, the upper one forming a shelf with a depth of less than 200 metres. One other feature deserves notice—a fiord-like furrow along the floor of the Uraga Channel, with a branch on the east continued into the Boso peninsula as the depressed tract around Tateyama.

The earthquake of 1923, in Prof. Yamasaki's opinion, may be considered as the direct effect of an enormous blocking movement in the district. The most remarkable displacement was of course that which occurred in Sagami Bay. The subsidence was greatest, from 100 to 210 metres, along the axis of the trench. The margin of the uplifted block on its north-east side was raised 250 metres, that on the south-west side 120 metres. Besides these tilted blocks in the deep sea, the shelf of land along the

coast was also uplifted, though to a much less extent. The land was tilted as a whole with its raised margin to the south, the uplift gradually decreasing to the north as far as the Tama valley, after which elevation gave place to depression, never great in amount but covering a wide area. In consequence of these great movements, many fault-lines have newly appeared in the Boso and Miura peninsulas. Slips also occurred on the sea-bed where the slope is steep, those on both sides of the Uraga furrow being the most remarkable.

In this and other memoirs, attention is concentrated chiefly on the vertical displacements. The re-survey of the district has, however, revealed horizontal movements. These are described by Prof. A. Imamura in a brief paper read before the International Union of Geodesy and Geophysics at the Prague meeting in September last. Assuming that the positions of two points about fifty miles north of Tokyo have remained unmoved, it appears that the island of Oshima has shifted 3·78 metres in the direction N. 8° E., Manzirodake on the west coast of Sagami Bay 2·86 metres N. 9° E., Sengen-yama on the north coast 2·75 metres N. 112° E., and Nokogiri-yama on the east coast 2·57 metres N. 145° E. Thus, generally speaking, the whole epicentral district has made a clockwise twist about a vertical axis somewhere in Sagami Bay. C. D.

British Industries Fair.

THE distinguished general who called the English a "Nation of Shopkeepers" was aiming a scathing insult at our people. By the same token, Adam Smith and the older economists must have turned in their graves when the Government decided to take active steps for the encouragement of commerce. *Times have changed. We now aspire to the* proud title of a "Nation of Shopkeepers." In order to pay the appalling bill for the War and to restore our country to its pristine wealth, production and trade, especially export trade, must be stimulated by every resource, private or public. Faced by intensified foreign competition and the loss of our pre-eminence in the control of raw material, we are turning to scientific research, to a higher organisation of industry, and not least to a reasonable propaganda on the commercial side. A useful exhibition of our industrial effort is now organised annually by a Government department, the Department of Overseas Trade (Development and Intelligence).

This year's Fair, held in London and Birmingham on Feb. 20–Mar. 2, showed a marked increase in the number of exhibitors and the range of industry represented. By the admission of the general public during the daytime at a nominal charge, the cathedral-like silence of the earlier fairs has been replaced by a livelier atmosphere, without derogation of the serious purpose the organisers of the Fair have in view. Noticeable this year was the evidence of rapid exploitation of recent scientific discoveries. The British Drug Houses, Ltd., for example, already have on the market Vitamin D in the form of a sugared pill, equivalent to so many hours of sunshine. This firm has also prepared a form of malt containing three vitamins. Several forms of apparatus, some of them fitted with electric clocks, were on view for the administration of ultra-violet rays. Even powder puffs are now treated with these rays.

In the wireless section, many portable sets were shown, giving excellent results, in some instances at quite a moderate price. Lilley's sounding instrument warns a ship approaching rocks and records the depth of water under a ship's bottom. Even in the realm of toys, science has raised its standard. 'Thirsty' is the name of a toy dog the protruding tongue of which indicates changes of weather. The whole world will welcome the new instrument for testing the accuracy of singers' voices, exhibited by the Institute of Patentees.

Complexity is not necessarily a characteristic of modern invention. There is, for example, a simple pad called the 'Solapad,' worn next to the skin over the abdominal nerves, which claims to prevent travel sickness in its various forms—sea, train, motor-car, etc. The Ice Store Portable Refrigerator makes ice of the purest quality at an operating cost of one penny per day. Attention may again be directed to the 'Thermega' electro-radiant blanket, a simple and cheap but most useful electrical application. We have no difficulty in accepting the makers' assurance that dampness in beds is a source of great danger, lowering the vitality even when not a direct cause of disease. The blanket has also many obvious medical applications. Messrs. Grieve and Gordon are extending the use of eucalyptus oil as a disinfectant. Imperial Chemical Industries, Ltd., again provided an interesting exhibit, enlivened by a cinema show. Their nitrogen campaign for the improvement of grassland is making good progress. A new fertiliser, called 'Nitro-chalk,' has been placed on the market, consisting of a mixture of ammonium nitrate and dried carbonate of lime. Ammonium nitrate is unsuitable as a direct fertiliser, but can be made available as a fertiliser by mixing with carbonate of lime, of which the company has an ample supply at Billingham. The mixture has a nitrogen content of 10 per cent., and its price will be such that the farmer will only be paying for the nitrogen, the lime—itself a valuable fertiliser in certain soil conditions—being given to him free of charge.

Apart from the evidence provided by statistics of sales effected by the exhibitors, the visitor will be left in no doubt as to the usefulness of this Fair, and for those who are despondent about the future of British industry, it should serve as a tonic.

Spectra and Atoms.

"SPECTRA and Atoms" formed the subject of a lecture by Prof. A. Fowler before the Chemical Society on Feb. 23, when he gave in brief outline an account of the relations existing between series lines in the spectra of elements, and discussed how these relations harmonise with modern views concerning the electronic configuration of the atom.

Early investigations were primarily directed to the identification of regular series of lines which can be represented by simple formulæ, each line being described as the difference of two wave-numbers or terms. Recognition was early extended to different types of series—principal, diffuse, sharp, and fundamental—and Rydberg showed how the various series in the same spectrum are closely interrelated, leading to a simplification in the mode of representation. Prof. Fowler proceeded to discuss the application of Ritz's combination principle, and the restrictive effect therein of certain selection rules. In some spectra, all terms other than those of S type have two values, giving rise to series consisting of doublet lines, and in others three values yielding triplets, but a combination of two doublet terms does not give four lines, and one of two triplet terms yields

only six of the nine lines arithmetically possible. For the application of the relevant selection principle, the components of each multiple term must be distinguished by so-called inner quantum numbers.

In 1913, Bohr's theory came to illuminate the subject of spectral structure by its interpretation of spectroscopic terms as energy levels of the atom; spectral lines are regarded as representing the energy lost by an atom when it passes from a stationary or non-radiating state of a certain energy to another of smaller energy, the possible states being governed by quantum considerations. In its normal unexcited state the atom is in the condition of lowest energy, but it may pass to states of greater energy by the absorption of radiation or by collisions of certain types.

Prof. Fowler continued his discourse with a discussion of electronic orbits. The energy representative of a particular orbit is dependent on its size and—on account of the varying velocity of the electron and the consequent relativity variation of its mass—slightly different for orbits of the same major axis but different eccentricities. This view led to an explanation of the 'fine structure' of the lines of the Balmer series of hydrogen. Of the two quantum numbers employed, one, the principal quantum number, determines the size of the orbit, and the other, the azimuthal quantum number, determines its shape.

Bohr's ideas regarding the probable distribution of the electrons in atoms have been extended remarkably in recent years, so that it has become possible to specify with certainty the electron arrangement for most of the elements and the most probable arrangement for the remainder. These developments were made possible by advances in the analysis of complex spectra, and particularly by the discovery by Catalan, at that time working in Prof. Fowler's laboratory, of higher multiplicities. Another great advance originated in an investigation by Russell and Saunders of the spectrum of calcium, when it was observed that some of the new triplet terms, which also violated the familiar selection rule, represented amounts of energy greater than were necessary to drive a single electron completely out of the atomic system, indicating that a second electron was displaced while the other still remained in the system. Hence spectroscopic terms now have to be defined by 'group quantum' numbers, representing a kind of resultant of the orbital numbers.

Prof. Fowler referred to the important contributions of Pauli, Heisenberg, and Hund, and to the significance of two other quantum numbers involving the orientation of the orbit and the orientation of the spin of the electron respectively, and then surveyed the spectra of some of the elements in relation to the new table of atomic structures. The general conclusion is that all the main features of the spectrum of an atom can now be theoretically predicted if the electron configurations are known, and vice versa. The spectra of ionised atoms are also of great importance; Prof. Fowler referred in this connexion to Paschen's work on aluminium, to his own work on magnesium and silicon, and to the results of Millikan and Bowen. When atoms resemble one another in everything but nuclear charge and mass they are said to be 'isoelectronic,' and the relations between their spectra are beautifully simple. The lecture terminated with a description of Bowen's recent investigations leading to recognition of the 'nebulium' lines—lines appearing in the spectra of nebulæ and hitherto attributed to an unknown element—as being due to singly ionised oxygen and nitrogen and doubly ionised oxygen.

University and Educational Intelligence.

EDINBURGH.—The chair of chemistry, which will become vacant at the end of the current academic year by the resignation of Sir James Walker, has been offered by the Curators to Prof. James Kendall, professor of chemistry and Dean of the Graduate School in the University of New York, who has intimated his acceptance. Prof. Kendall, after graduating in Edinburgh, engaged in research under Arrhenius in Stockholm. In 1913 he was appointed instructor in chemistry in Columbia University, New York, and in 1922 succeeded Prof. Alexander Smith in the chair of chemistry in Columbia University. He went as professor of chemistry to the University of New York in 1926.

LONDON.—Dr. W. E. Gibbs has been appointed as from April 24 to the Ramsay Memorial chair of chemical engineering tenable at University College. Dr. Gibbs was educated at the Liverpool Institute High School and the University of Liverpool. He has had considerable technical experience, and since 1918 he has been chief chemist to the Salt Union, Ltd., where he has been responsible for the formation and organisation of the Research Department and the design and construction of the research laboratories. His published work includes "Report on Disperse Systems in Gases" (Brit. Assoc., Fourth Colloid Report, 1922) and "Clouds and Smokes: The Properties of Disperse Systems in Gases and their Practical Applications" (Churchill, 1924).

OXFORD.—A new mathematical professorship has been founded in accordance with the provisions of a trust created by the late Mr. Walter Rouse Ball, senior Fellow of Trinity College, Cambridge, who expressed a hope (but without making it in any way a condition) that it might be found practicable for the professor to include in his lectures and treatment historical and philosophical aspects of the subject. The holder of the office will be known as the Rouse Ball professor of mathematics, and he will receive a stipend of £1200 a year from the endowment fund of £25,000. Mr. Applebey, in introducing the statute, stated that it is proposed to establish a professorship on mathematical physics which will be attached to Wadham College.

Mr. John Purdon Maxton, of the University of Glasgow, has been appointed a research officer in the Agricultural Economics Research Institute.

Dr. T. V. Barker, of Brasenose College, reader in crystallography, has been appointed secretary to the curators of the University Chest as from April 1 next.

In his annual report on the University Observatory, published in the *University Gazette* for Feb. 22, Prof. H. H. Turner reviews the work that remains to be done before the international astrographic survey of the whole sky is completed. For one reason or another, several of the countries which originally agreed to co-operate, have failed to carry out their intended programmes. The Oxford staff has been able to assist the Vatican Observatory with its section, and it is now proposed, if funds be forthcoming, to undertake the section to the north of the Oxford section, so as to cover that part of the sky which should have been surveyed by the Potsdam Observatory. The seismological investigations initiated by John Milne in 1913 are being continued, and studies of the mass of Venus have been reviewed by Dr. Fotheringham.

A vacancy in the office of Keeper of the Department of Antiquities in the Ashmolean Museum is advertised. The stipend has been fixed at £1000 per annum.

Calendar of Customs and Festivals.

March 2.

St. Nunne, or Nuanita, daughter of an Earl of Cornwall and mother of St. Patrick. Two wells were sacred to her, one at St. David's, one in Cornwall, at Alternon, the latter having miraculous powers of curing insanity.

March 4.

From Feb. 25 until Mar. 4 (O.S.) is a period of eight days and seven nights known in Algiers and Morocco by various names, such as *lā-hsūm* or *tamġart*, meaning 'the old woman,' presumably because the winter is coming to an end, or the 'Master of the Snow,' *Ḥaiyan*. This period, which is represented as a bitterly cold time of the year, is marked for its rain, wind, and snows, dangerous to people, animals, and crops. No one cares to travel, agricultural operations are suspended, and flocks and herds are kept under shelter so far as possible. A thunderstorm at this time is hurtful to little children, animals, and bees, and makes milk and honey scarce; but if an east wind blows, the year will turn out good without scarcity. It is believed that the world will come to an end during this period. Moreover, legends indicate that this is a period of 'borrowed days.'

Variants current in the East, and especially a Palestinian version, put the matter clearly. An old woman, while feeding her flocks, mocked February because he had sent no rain. Three days only of the month remained. February borrowed three days from March and sent rain for six days, which washed the old woman and her flocks into the sea. Therefore the first three days of March are known as *El Mustakridât*—the 'Lent out ones' (see Westermarck, "Ritual and Belief in Morocco," vol. 2, p. 174 *sqq.*). In England, March 'borrows' days from April.

March 5.

St. Piran, Perran, or Peran.—One of the many Irish saints who are conspicuous in Cornish hagiology. Very little is known of his life and acts. He is said to have been born in Cork or Ossory about A.D. 352, and after passing the greater part of his life in Ireland, to have retired to Cornwall, where he lived near Padstow and died at the age of two hundred years. This remarkable span of life may be an attempt to eliminate chronological inconsistencies in the lives of the saint which appear to confuse him with St. Kieran, the precursor of St. Columba, who went to Scotland in the year A.D. 560.

St. Piran is an important figure in Cornish legend. His miracles in Ireland and his voyage to Cornwall on a millstone have already been mentioned (Nature, Jan. 21, p. 121). At least three localities in the country are known by his name, Perran-aworthan (Perran on the noted river), Perran-uthno (Perran the lesser), and Perran-Zabulo (S. Perrani-in Sabulo—Perran in the Sands), where he lived. The Church of Perran is also associated with the cult of St. Agnes. St. Piran is the patron of the miners, and Mar. 5 is kept as a holiday in his honour. According to the legend, he discovered tin; a black stone which he used in building his hearth melted and produced a beautiful white metal. St. Chiwidden, to whom he communicated his discovery, devised a method of producing the metal in quantity. The saints imparted their knowledge to the Cornish people and the occasion was celebrated by great rejoicing so that 'as drunk as a Piraner' became proverbial. The fame of Cornish tin spread far and wide, eventually reaching Tyre and giving rise to the Phœnician trade. To protect the sources of tin from foreigners, the markets for this trade were confined to the islands, and the tribes of St. Piran and St. Agnes built the rounds and earthworks as a further protection. St. Piran is thus anachronistically associated with two phases of Cornish prehistory—the discovery and working of tin, and the construction of prehistoric forts and earthworks.

Although it is possible that this story may be merely a piece of folk mythology of comparatively modern origin, it is also possible that it preserves a tradition from an older dispensation. St. Chiwidden is an entirely mythical personage, but Chi-wadden means 'a white house,' *i.e.* the blowing or smelting house, and in the corrupt form of Jewwhidn or Jew's house is applied to the old blowing houses. St. Piran was patron of a holy well at Perranzabulo, which had the property of healing sick children, and here may certainly be regarded as the representative of an earlier local deity.

St. Casimir of Poland.—Son of Casimir III., King of Poland, *b.* 1458, *d.* 1483, led a life of abstinence and chastity, studied to advance the Catholic religion in Poland and drive out heresy. Thirty-six years after his death he appeared in glittering armour, gallantly mounted, and led the Poles across an impassable river to defeat the Muscovites. In the following year he marched before the Poles in the air and again defeated their enemy. One hundred and twenty years after his death, his body and the rich stuffs in which it was wrapped were found entire and a sweet smell exhaling therefrom.

March 10.

The Forty Martyrs of Sebaste suffered at Sebaste in Lesser Armenia, A.D. 320, under the Emperor Licinius. The history of their martyrdom is chiefly remarkable for a novel form of torture devised by Agricola, Governor of the Province. They were exposed naked for three days on a frozen pond outside the walls of the town, in the blast of a bitter north wind, a warm bath being placed nearby. Only one of their number weakened, but he expired as he entered the warm water. His place was taken by the guard, who had been converted in the meantime by a vision. The relics of these martyrs, portions of which reached Constantinople, performed many miracles and healed many sick.

St. Mackerroge or Kerrock, bishop in the Province of Levin and Boin in Scotland, A.D. 560, illustrious for miracles. Under his counsel the pious King Congal II. ruled with prudence, zeal, and sanctity. The Scots for a time used his name as their battle-cry, but afterwards changed it for that of St. Andrew. St. Kerroge is sometimes represented in military habit with bent bow and arrow. His name has been given to a ferry (*Port a Chearaig*) and a market for hiring held at Callander, Perthshire, on Mar. 10, O.S. (Mar. 22). This fair is known also as 'tenth-day,' while a rock at the west end of the village is called by his name. "On the Feast of Kerrock every eel is pregnant," is proverbial in Gaelic.

Addenda.—The First Sunday in Lent in one of the Roman Liturgies of 1496 is called *Les Brandons*. In the *Gentleman's Magazine* for 1754 this is taken to refer to the custom among the French peasants of dancing around straw bonfires on this Sunday, and the brandon is said to be one of the sacred dances performed in church choirs as late as the seventeenth century, and only suppressed by ecclesiastical and civil authority after much popular opposition. (*Brandon* = lighted wisp of straw.) That the dance was regarded as an act of worship is shown by the popular Limousin liturgical response, "S. Martial pray for us and we will dance for thee."

Societies and Academies.

London.

Royal Society, Feb. 23.—**Sir Leonard Rogers**: The yearly variations in plague in India in relation to climate: Forecasting epidemics. The seasonal incidence of plague in India depends on monthly variations in mean temperature and humidity, expressed as saturation deficiency, as pointed out by St. John Brooks. Mean monthly temperature variations in hot weather and monsoon periods influence subsequent plague, through high temperatures reducing, and low ones favouring, its prevalence. Saturation deficiency in cold weather as well as in the hot season influences plague incidence, through high saturation deficiency, indicating low relative humidity, reducing prevalence of plague, and vice versa. The great yearly variations in plague can nearly all be explained by the influence of these climatic factors. In the three northern areas, Punjab, United Provinces, and Bihar, four of the six climatic factors become evident before the annual increase of plague from December onwards, and thus allow the more important yearly increases and decreases to be forecast, as a rule. This is also the case to a large extent in Central Provinces. In Deccan, with early increase of plague during monsoon months, forecasts are of less value.

W. S. Patton and **E. Hindle**: The North Chinese species of the genus Phlebotomus. Three species of sandflies were found in North China, namely, *P. major* var. *chinensis*, a variety of *P. sergenti*, and a third species now first described, *P. taianensis*. The first two, in Nature, seem to feed only on human blood; the latter on reptiles and batrachians. The former are of particular interest in connexion with transmission of Leishmania, as in both species the parasite readily develops to the flagellate stage, but only in one of them, *P. major* var. *chinensis*, is there any invasion of the anterior part of the alimentary canal. *P. major* var. *chinensis* normally has only one brood each year. The eggs are usually laid in June, the four larval stages are passed through during summer; the fourth stage larva remains unchanged throughout winter. About mid-May the larva pupates, the adult insect emerging about ten days later. This species only occurs for about six weeks, disappearing in July. *P. sergenti* has a similar life-cycle, but frequently the larvæ complete their development, pupate, and produce another generation in one season. *P. taianensis*, n. sp., resembles the latter in its seasonal incidence, but whereas the two other species are found mainly in houses, this sandfly is especially prevalent in temples and open buildings. In Nature the larvæ of all three species live in cracks in the ground, and are able to withstand freezing. Chinese sandflies have been found only in regions north of the Yangtze Valley. Their distribution, so far as known, agrees with that of Chinese kala-azar, and supports the view that sandflies are responsible for transmission of this disease.

H. Eltringham: On the production of silk by species of the genus Hilara Meig. (Diptera). With an appendix on the habits of the species, by **A. H. Hamm**. The males of certain flies of the genus Hilara (Empidæ) are known to carry silken structures which may or may not contain insect prey or fragments of plants. These structures are transferred to the females just before or at the instant of coitus. The secretion of silk by a mature insect has been hitherto unknown, save in the Embiidæ, Psocidæ, and Hydrophilinæ. The silk of the male Hilara is secreted by numerous unicellular glands situated in the dilated basal tarsi of the anterior legs; the duct of each leads to the base of a short hollow spine, from the apex of which the secretion can be forced to flow, hardening instantaneously on exposure to the air. The cocoons are transferred to the females during flight.

Society of Public Analysts, Feb. 1.—**L. V. Cocks** and **E. Nightingale**: The determination of butter in margarine. Small amounts of sulphuric acid may be volatilised and included in the acids recorded in the Kirschner value, unless special precautions are taken. When the Kirschner value of the butter in a mixture is not known, it is not permissible to state the actual percentage of butter with greater accuracy than between the limits of minus 13 per cent. and plus 24 per cent., both figures being calculated on the reading that would be obtained from the standard graphs for a butter fat with a Kirschner value of 23·5.—**B. S. Evans**: A new method for the separation and determination of small amounts of lead. The method is based on the quantitative deposition of the lead on copper from a cyanide solution containing ammonium oxalate. A percolation apparatus containing copper filings is used. By working in the cold the interference of tin, antimony, zinc, cadmium, and nickel is eliminated; bismuth is deposited, but, in the amounts present in commercial coppers, does not interfere. The deposited lead is converted into sulphate and then into chromate, which is dissolved in nitric acid, and the chromate ion is determined colorimetrically.—**W. R. Schoeller** and **A. R. Powell**: Investigations into the analytical chemistry of tantalum, niobium, and their mineral associates. (10) The separation of silica from the earth acids. Accurate results are obtained by fusing the mixed oxides with bisulphate, extraction of the fused mass with oxalic or tartaric acid, and treatment of the impure silica residue with hydrofluoric acid. (11) The precipitation of titanium by tannin. Tannin produces a red precipitate in oxalic or tartaric solutions of titanium; the precipitation is quantitative in the neutralised solution. Titania interferes with the tannin precipitation of tantalum from niobium, if present in quantities greater than about one-hundredth of the tantalic oxide, by causing a discoloration of the yellow tantalum precipitate.—**J. Reilly** and **P. J. Drumm**: The determination of carvone in dill oil. Carvone is precipitated in the cold from an alcoholic solution of dill oil by means of semi-carbazide hydrochloride and sodium acetate. The carvone semi-carbazone thus obtained melts at 141°-142° C., whilst its isomer (m. pt. 163° C.) is formed if the temperature of the reaction mixture is allowed to rise.—**Norman Rae**: Seasonal variations in the composition of the latex of *Hevea Brasiliensis*. Nitrogen, potash, and phosphoric acid rise to a maximum in February, fall until May, increase somewhat until July, and then fall to August. Leaf fall and renewal of leaves coincide with the fall in March, and maturing of seeds with that of July. The latex seems to be a food reserve used up when leaf growth and seed growth are most actively proceeding.

Linnean Society, Feb. 2.—**Major R. W. G. Hingston**: Nature notes from Mount Everest. Major Hingston accompanied the Mount Everest Expedition of 1924 as medical officer and naturalist. Particular attention was given to the methods by which animals adapt themselves to the special conditions associated with high altitudes. Altitudinal distribution was specially studied. Fishes and reptiles ascended to 15,000 feet. A varied assemblage of mammals, birds, insects, and spiders was collected at 18,000 feet. Moths, butterflies, and humble-bees were carried by wind-currents to 21,000 feet. Birds followed the climbers up to 27,000 feet. The highest plant was

taken at 19,000 feet. Small spiders were found living permanently at 22,000 feet.—**W. T. Saxton**: The life-history of Lunularia, with special reference to the archegoniophore and sporophyte. Fertile plants of Lunularia are only rarely found. The course of development of the sporophyte is strikingly different from that of other members of the Marchantiales. The structure of the sessile antheridiophore is similar to that of Fimbriaria and several other Marchantiaceæ. The first divisions in the sporophyte up to the 16-celled stage are quite normal, and the formation of foot and seta from the basal half proceeds as usual, but the divisions in the apical half are exceedingly regular and constant; and the formation of a single group of elongated sporogenous cells, dividing for some time by longitudinal walls only, is a unique feature.

Geological Society, Feb. 8.—**W. J. Pugh**: The geology of the district around Dinas Mawddwy (Merioneth). The Dinas Mawddwy area includes about 22 square miles of country in south-eastern Merioneth. It forms part of the Central Wales Plateau, and is dissected by deep valleys, somewhat modified by glacial action. The rocks consist of mudstones, shales, and slates, with subordinate bands of grit and limestone. They belong to the Bala and the Valentian Series. The area is located on the south-eastern flank of the Harlech Dome, and the fact that the rocks are folded around that great anticline determines the general direction of the strike, which is from south-west to north-east. The faults trend in three directions: (1) north and south; (2) north-east and south-west; (3) north-west and south-east. The north-and-south faults were probably formed at the same time as the folding. The north-west and south-east faults are parallel to the general direction of the dip, which is south-eastward, and they probably belong to a later period of movement than the strike-faulting (south-west to north-east). The rocks are intensely cleaved, and the strike of the cleavage-planes is practically parallel to the general strike of the strata. The cleavage-planes are either vertical or highly inclined south-eastwards. Since they are unaffected by the folding, it is inferred that the cleavage was formed after the folding.

PARIS.

Academy of Sciences, Jan. 23.—**Hadamard**: Repeated operations in the calculus of probabilities.—**A. Cotton**: The automatic regulation of a spectrograph with concave grating. A method of mounting is described which automatically places the slit, grating, and photographic plate in the positions obtained with the mounting of Rowland and of Eagle.—**Charles Moureu** and **Charles Dufraisse**: Autoxidation and antioxygen action. The theory of the catalysis of autoxidation; the mechanism. The authors consider that their views of the mechanism of antioxygen action are not necessarily opposed to the principles of thermodynamics. Independent experimental confirmation of their conceptions is given by the work of H. Gaffron on the addition of oxygen to certain amines in the presence of chlorophyll.—**Gabriel Bertrand** and **Mme. M. Rosenblatt**: The general presence of sodium in plants. The presence of sodium in plants has been a matter of dispute, and this, as the authors point out, has been largely due to the defective methods of chemical analysis employed. The authors depend on the formation of the triple acetate of uranyl, magnesium, and sodium for their sodium estimations, and give results of sodium and potassium determinations in twenty-two plants, those species being selected which have generally been regarded as free from sodium. The results shew that sodium exists in determinable proportions in all plants examined. The ratio potassium to sodium found varies from 729 in potato to 2·05 in peas.—**C. Camichel**, **P. Dupin**, and **M. Teissié-Solier**: The existence of a periodic phenomenon following Poiseuille's law in the flow of a fluid round submerged cylinders.—Lucien Cayeux was elected a member of the section of mineralogy in the place of the late E. Haug.—**Paul Mentré**: The projective displacements of two plane bundles with a right line in common.—**Lainé**: The equations $s=f(x, y, z, p, q)$ integrable by the method of Darboux.—**S. Serghiesco**: The number of roots common to several simultaneous equations.—**Henri Milloux**: A property of growth of integral functions.—**Nikola Obrechkoff**: The absolute summation of Dirichlet's series.—**Swyngedauw**: The position of the neutral line in the pulley belt.—**R. Duchêne**: The propagation of combustion in mixtures of hydrocarbons. An application of the photographic method of Mallard and Le Chatelier, with special reference to the phenomena during the early stages of the combustion.—**M. Latour**: An electrocapillary microphone. A conical capillary tube dipping into mercury and covered with a layer of an electrolyte has one wire dipping into the electrolyte and another into the mercury. The apparatus works as a microphone.—**Edmond Rouelle**: Some properties of the frequency demultiplier.—**Henri Marcelet**: The examination of some varieties of cod-liver oil in Wood's light. The light was obtained from a mercury vapour lamp and filtered through a screen allowing light of wave-lengths 3340 A to 3906 A. to pass. The true fluorescence of cod-liver oil is golden yellow, but this colour is modified in commercial oils, especially the dark varieties.—**B. Cabrera**: Concerning the evolution of the elements.—**Vasilesco Karpen**: Batteries with unalterable electrodes and Carnot's principle. From experiments with an element comprising carbon and platinised platinum electrodes with a solution of soda as electrolyte, the author has obtained results which are in contradiction with the second law of thermodynamics.—**M. Ballay**: A theory of the Ludwig-Soret effect.—**A. Duboin**: The complex silicates of copper. A description of the preparation and properties of the silicates K_2O, CuO, $4SiO_2$, and Al_2O_3, $2CuO$, $3K_2O$, $6SiO_2$.—**Raymond Quelet**: Parabrom-Δ-butenylbenzene.—**A. Mailhe** and **Renaudie**: The formation of hydrocarbons starting with propyl alcohol. A study of the products of the catalytic action of uranous oxide on the vapour of propyl alcohol at 400°-420° C.—**Georges Brus**: The action of chlorine and of bromine on nopinene.—**Pierre Pruvost**: Geological section of the boring of Terrières-en-Bray. This trial boring was carried down to a depth of 1173 metres, and details of the strata exposed are given. No indications of coal or petroleum were found.—**Paul Corbin** and **Nicolas Oulianoff**: The Prarion massif and the complex syncline of Chamonix.—**A. Demay**: The granulitic gneiss of the Pyfara and the Saint-Marcel syncline in the northern Cevennes.—**N. P. Péntcheff**: Researches on the rare gases of some thermal springs in Bulgaria.—**Henri Coupin**: The carbon nutrition of *Rhizopus nigricans*.—**J. Chaine** and **J. Duvergier**: Contribution to the determination of the species of fish of the genus Mugil.—**R. Lutembacher**: The structure of striated muscle from its optical properties. The experiments described suggest that the hypothesis of the presence in striated muscle of two different substances is unnecessary. It has been found possible to make membranes of celluloid or acetylcellulose from which photographs have been obtained, both in natural and polarised light, resembling the microphotographs obtained with muscle.—**R. Douris** and

J. Beck: The mode of action of reagents in the serum diagnosis of syphilis. The influence of pH.—N. Bezssonoff: The food regime based on oats and egg yolk and the duality of vitamin C.—Swigel Posternak and Théodore Posternak: A natural, optically active inosite-tetraphosphoric ester.—H. Bierry and M. Kollmann: The pancreas and the testicle in the course of polyneuritis in birds.—Marage: Deafness and musical composition.

CALCUTTA.

Asiatic Society of Bengal, Jan. 2.—R. B. S. Sewell: Prehistoric animal remains from the ancient Indian city of Mohenjo-daro, Sind. In the course of excavations at Mohenjo-daro in Sind, the Archæological Survey of India discovered a number of more or less fragmentary animal remains. Owing to the large amount of saltpetre in the soil, these bony remains rapidly deteriorate, and in the deeper, and presumably older, levels, comparatively few animals can be identified from these fragments. In all, some thirty species of animals, ranging from coral to the Mammalia, have been identified. Some of these were undoubtedly living in this region at the time when Mohenjo-daro was a flourishing city, but in other cases the remains, such as shells or horns, appear to have been brought from distant areas in the process of trade. This is the first find of prehistoric animal life in an Indian city.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 13, No. 12, December).—G. W. Stewart: X-ray diffraction in liquids: saturated normal fatty acids, isomers of primary normal alcohols, and normal paraffins. (*a*) Normal fatty acids. The lateral separation of the parallel collinear chains is 4·55 A.; the longitudinal spacing of the diffraction centres increases 2·00 A. for two carbon atoms, one for each of two molecules. (*b*) Isomers of primary n-alcohols. The attachment of CH_3 as a side branch alters the 'diameter' by 0·6 A., of OH by 0·4 A., of both by 0·65 A. (*c*) Normal paraffins. Lateral separation of molecules is approximately 4·6 A. The results all suggest the importance of molecular space array (cybotaxis) in liquids.—Jared Kirtland Morse: The structure and dimensions of the benzene ring. A model consisting of cubes having corners shared in common is put forward: such a model on a scale of 2 in. = 1 A. has been constructed. Twelve cube corners (electron positions) are on the surface of a sphere of radius 1·155 R, six cube centres (carbon nuclei) on a concentric sphere of radius 1·394 R, and the remaining twenty-four cube corners on another concentric sphere of radius 2·134 R, where R is the radius of the carbon atom.—Frank Peat Goeder: The space group of potassium, rubidium, and cæsium sulphates. From an examination of Laue photographs of the rhombic bipyramidal or holohedral crystals of the anhydrous salts, the space group is 2 Di - 13, (V_h^{13}).—S. C. Wang: The diamagnetic susceptibility of hydrogen molecule and of helium in the new quantum mechanics. The energy values obtained by the Ritz method from the approximate ψ functions developed agree fairly well with spectroscopic results.—J. R. Oppenheimer: On the quantum theory of the polarisation of impact radiation. Taking into account the spin of the impacting electron, the Heisenberg resonance principle, and the perturbing energy, it is shown that the polarisation diminishes with decreasing electronic velocity, changes sign at about 200 volts, increases to a maximum near the resonance potential and afterwards approaches zero. This is in accord with experimental evidence.—S. Lefschetz: The residual set of a complex on a manifold and related questions (second note).—Ernest P. Lane: Power series expansions in the neighbourhood of a point on a surface.—Marston Morse: The analysis and analysis situs of regular n-spreads in $(n+\nu)$-space.—H. L. Rietz: On certain properties of frequency distributions of the powers and roots of the variates of a given distribution.—Matilda Moldenhauer Brooks: The penetration of methylene blue into living cells. This dye penetrates into the sap of Valonia, but is gradually oxidised when the sap is exposed to air. The equilibrium quantity of dye in the sap is unaffected by the temperature and hydrogen ion concentration of the external solution, but its rate of entry decreases with decrease of temperature and increases with increase of hydrogen ion concentration within limits.—Leonell C. Strong: Studies on the effect of potassium alum–hydrochloric acid solutions on the growth and fate of neoplastic tissue (2). Result obtained on a rapidly growing transplantable sarcoma of the mouse. With this non-specific tumour, no slowing-up of the rate of growth could be observed with certainty.—Henry B. Ward: The influence of a power dam in modifying conditions affecting the migration of the salmon. Sockeye or red salmon spawn near the headwaters of coastal streams. In the Baker River, State of Washington, their course is determined by the impulse to 'buck' the current and, when a choice of waters is possible, as at the outflow of a tributary, they choose the cooler stream. A power dam 260 ft. high bars the normal salmon route up the Baker River; a fisher ladder and cable hoist have been installed to carry the salmon to the upper waters. Some fish exhaust themselves in the tail-race of the power-house, while others fight against the dam. Of those that are lifted over, only a portion go on to the headwaters. The dam has created a still lake with high surface temperature and cold depths with little current. This alters entirely the migratory conditions and may influence the type of fish.—Paul Slavenas: A note on the triple system, λ Tauri.—Hudson Hoagland: Quantitative aspects of tonic immobility in vertebrates. Measurements of the duration of 'death feigning' or tonic immobility in the lizard Anolis at carefully maintained temperatures indicate two independent reactions, one at 5°-35°, and the other at 5°-20° C., of a chemical nature. The presence is suggested of two independent inhibitory hormones which inhibit impulses from higher nervous centres, but pass impulses from tonic centres to the muscles.—Roland C. Travis and Raymond Dodge: Sensori-motor consequences of passive rotary and rectilinear oscillation of the body. The authors were tested on moving platforms, and the responses of the hands (an effort to keep the hands stationary) were observed. When blindfolded, compensatory movements were practically proportional to the acceleration. The higher the frequency of rectilinear oscillation, the more adequate was the perception of motion and its direction. The order of sensitivity of receptors for rectilinear oscillations is visual, kinæsthetic, and vestibular.—Barbara Stoddard Burks: Foster parent–foster child comparisons as evidence upon the nature–nurture problem. The results of Stanford-Binet intelligence tests of 200 sets of foster parents and foster children were compared with the results obtained from 100 sets of true parents and true children, and data as to the cultural, educational, and material aspects of the homes were considered. The contribution of home environment to intelligence is rated at 17 per cent.; environment may in exceptional cases raise or lower the intelligence quotient (I. Q.) by 20 points.—Herman C. Ramsperger: The thermal and photochemical decomposition of azo compounds and the problem of reaction rates.

Official Publications Received.

BRITISH.

Report on the Health of the Army for the Year 1926. Vol. 62. Pp. iv+186. (London: H.M. Stationery Office.) 3s. 6d. net.

Students from other Countries in the Universities and University Colleges of Great Britain and Ireland, Session 1927–28. Pp. 38. (London: Universities Bureau of the British Empire.) 1s.

The Carnegie Trust for the Universities of Scotland. Twenty-sixth Annual Report (for the Year 1926–27) submitted by the Executive Committee to the Trustees on 8th February 1928. Pp. iv+82. (Edinburgh.)

Bird Sanctuaries in Royal Parks in Scotland. Pp. 10. (Edinburgh and London: H. M. Stationery Office.) 6d. net.

Proceedings of the Royal Society of Edinburgh, Session 1927–1928. Vol. 48, Part 1, No. 1: The Action of "Active" Nitrogen on Iodine Vapour. By L. H. Easson and R. W. Armour. Pp. 9. 9d. Vol. 48, Part 1, No. 2: Contribution to the Studies of the Origin of European Sheep. By B. Kaczkowski. Pp. 10-14. 6d. (Edinburgh: Robert Grant and Son.)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 66, No. 374, February. Pp. 165-240+xxxii. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

The Quarterly Journal of the Geological Society. Vol. 83, Part 5, No. 332. Pp. 658-815+xx. (London: Longmans, Green and Co., Ltd.) 7s. 6d.

New Zealand Institute. Reference List of the Scientific Periodicals in the Libraries of New Zealand. Compiled by Gilbert Archey. Pp. 46. (Auckland, N.Z.) 5s.

1926 (Second Session), Legislative Assembly: New South Wales. Report (together with Appendices) of the Minister of Public Instruction for the Year 1925. Pp. 84. (Sydney, N.S.W.: Alfred James Kent.) 2s. 3d.

Hull Museum Publications. No. 144: Index to Hull Museum Publications, Nos. 96-143. Edited by T. Sheppard. Pp. 24. No. 150: The Mammals, Birds and Insects of East Yorkshire. (A Series of British Broadcasting Talks to School Children.) By T. Sheppard. Pp. 24. No. 151: Record of Additions. Edited by T. Sheppard. Pp. 31. No. 152: Exhibition of Contemporary British Sculpture (The Museums Association Circulating Collection), Wilberforce Museum, 11th February to 10th March 1928. Pp. 8. (Hull.)

FOREIGN.

Proceedings of the United States National Museum. Vol. 72, Art. 11: Rossite and Metarossite; two new Vanadates from Colorado. By William F. Foshag and Frank L. Hess. (No. 2707.) Pp. 12. Vol. 72, Art. 22: On newly discovered Meteoric Irons from the Wallapai (Hualapai) Indian Reservation, Arizona. By George P. Merrill. (No. 2718.) Pp. 4+3 plates. (Washington, D.C.: Government Printing Office.)

Occasional Papers of the Bingham Oceanographic Collection. No. 1: A Contribution to the Theoretical Analysis of the Schooling Behaviour of Fishes. By Albert Eide Parr. Pp. 32. (New York City: Bingham Oceanographic Collection.)

Bulletin of the Bingham Oceanographic Collection. Vol. 1, Art. 2: Scientific Results of the First Oceanographic Expedition of the *Pawnee*, 1925. Crustacea from Tropical East American Seas. By Lee Boone. Pp. 147. Vol. 3, Art. 2: Scientific Results of the Third Oceanographic Expedition of the *Pawnee*, 1927. The Stomiatoid Fishes of the Suborder Gymnophotodermi (*Astronesthidae*, *Melanostomiatidae*, *Idiacanthidae*), with a complete Review of the Species. By Albert Eide Parr. Pp. 123. (New York City.)

Memoirs of the Bernice P. Bishop Museum. Vol. 9, No. 3: Jaws and Teeth of Ancient Hawaiians. By H. G. Chappel. Pp. 20+4 plates. Vol. 9, No. 4: Observations on Hawaiian Somatology. By Louis R. Sullivan. Prepared for publication by Clark Wissler. (Bayard Dominick Expedition, Publication No. 13.) Pp. 76+5 plates. Bulletin 42: Handcrafts of the Society Islands. By Willowdean Chatterson Handy. Pp. 118+16 plates. Bulletin 43: Artemisia, Scaevola, Santalum and Vaccinium of Hawaii. By C. Skottsberg. Pp. 89+8 plates. Bulletin 44: Vegetation of Pacific Equatorial Islands. By Erling Christophersen. (Whippoorwill Expedition, Publication No. 2) Pp. 79+7 plates. (Honolulu, Hawaii.)

National Research Council. Organization and Members, 1927–1928. Pp. 64. (Washington, D.C.: National Academy of Sciences.)

National Research Council of Japan. Japanese Journal of Mathematics: Transactions and Abstracts. Vol. 4, No. 3. Pp. 103-213. Japanese Journal of Botany: Transactions and Abstracts. Vol. 3, No. 4. Pp. vi+267-349+77-122. (Tokyo.)

Journal of the Faculty of Science, Imperial University of Tokyo. Section 1: Mathematics, Astronomy, Physics, Chemistry. Vol. 1, Part 10. Pp. 371-416. 1.50 yen. Section 4: Zoology. Vol. 1, Part 4. Pp. 248-275. 0.80 yen. (Tokyo.)

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 18, Part 5: Untersuchungen über die natürliche Waldverjüngung bei Larix Dahurica Turcz. Von Shuzo Goto. Pp. 207-806+Tafeln 16-18. (Tokyo: Maruzen Co., Ltd.)

Library of Congress. Report of the Librarian of Congress for the Fiscal Year ending June 30, 1927. Pp. vi+302+15 plates. (Washington, D.C.: Government Printing Office.)

First Pan Pacific Conference on Education, Rehabilitation, Reclamation and Recreation, called by the President of the United States of America in conformity with a Joint Resolution of the Senate and House of Representatives of the United States and held under the Auspices of the Department of the Interior at Honolulu, Hawaii, April 11 to 16, 1927. Report of the Proceedings. Pp. 493. (Washington, D.C.: Government Printing Office.) 1 dollar.

CATALOGUE.

Sands, Clays and Economic Minerals for all Industrial Purposes. Fourth edition. Pp. 32. (Chatteris: Algernon Lewin Curtis.)

Diary of Societies.

SATURDAY, MARCH 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—C. Dodgson: The Life and Work of Albrecht Dürer (II.).

BRITISH PSYCHOLOGICAL SOCIETY (at Royal Anthropological Institute), at 3.—Dr. Saidullah: A Note on the Theory of 'Shape' in the Light of some Recent Experimental Work.—E. R. Clarke: The Evaluation of the Heterogeneity of the Binet Tests and the Resulting Fallacy of the I.Q.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch) (at College of Technology, Manchester), at 4.—Prof. C. H. Desch: Crystallisation in Non-ferrous Castings (Lecture).

HULL ASSOCIATION OF ENGINEERS (at Technical College, Hull), at 7.15.—A. W. Purchas: Theory and Practice in the Engine and Boiler Rooms.

MONDAY, MARCH 5.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Prof. H. G. Cannon: On the Feeding Mechanism of the Shrimp, *Chirocephalus diaphanus*.—Dr. C. H. O'Donoghue and Miss Eileen (Bulman) Abbott: The Blood Vascular System of the Spiny Dogfish, *Squalus acanthias*, Linné, and *Squalus sucklii*, Gill.—Dr. S. Williams: Sporangial Variation in the Osmundaceæ.—Dr. C. W. Wardlaw: Size in Relation to Internal Morphology. No. 3, The Vascular System of Roots.—J. Caldwell: Translocation.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.—At 5.15.—Prof E. Schrödinger: Wave Mechanics (I.).

INSTITUTION OF AUTOMOBILE ENGINEERS (Bristol Centre) (at Merchant Venturers' Technical College, Bristol), at 6.45.—G. L. Ensor: Notes on the Single Sleeve-Valve Principle.

INSTITUTE OF METALS (Sheffield Local Section) (jointly with Kindred Societies) (in Non-Ferrous Section, Applied Science Department, Sheffield University), at 7.30.—Dr. S. Z. de Ferranti: Electricity in the Service of Man.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—G. H. Jack: Ancient Bridges.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Prof. G. T. Morgan, R. Taylor, and T. J. Hedley: Syntheses under High Pressure.

SURVEYORS' INSTITUTION (at Institution of Civil Engineers), at 8.—P. J. Waldram: The Estimation of Damage in Ancient Lights Disputes.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—D. R. G. Cameron: Across the Sahara from Kano to Warghla.

INSTITUTION OF THE RUBBER INDUSTRY (London and District Section) (at Engineers' Club, Coventry Street, W.1).—L. J. Lambourn: Methods used for Determining Abrasion with Particular Reference to the Relation between Road Performance and Laboratory Results.

TUESDAY, MARCH 6.

ELECTRICAL ASSOCIATION FOR WOMEN (at Oxford Circus House, 245 Oxford Street, W.1), at 3.—M. A. Hussey: The Home Electric Laundry.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. F. A. E. Crew: Individual, Familial, and Racial Differences in respect of Immunities and Disease Resistance (Milroy Lectures) (II.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: The Behaviour of Animals (III.).

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. H. Harold Scott: (*a*) Report on the Deaths occurring in the Society's Gardens during the year 1927; (*b*) Carcinoma of the Tonsil in a Common Wolf (*Canis lupus*).—Major M. Connolly: On a Collection of Land and Freshwater Mollusca from Southern Abyssinia.—Enid K. Sikes: The External Morphology and Life-history of the Coccid Bug *Orthezia urticæ* Linn.

INSTITUTION OF CIVIL ENGINEERS, at 6.

LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.), at 6.30.—J. C. Robbins: Hibernation of Insects.—R. W. Hale: Beaks and Bills of British Birds.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—D. S. Munro: Modern Electric Wiring, particularly as applied to Small Houses.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—E. C. McKinnon: Storage Batteries in relation to Modern Supply of Electric Lighting and Power.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates' Meeting) (at Broadgate Café, Coventry), at 7.15.—A. E. Collins: The Problem of Selling Cars.

INSTITUTE OF METALS (North-East Coast Local Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—Annual General Meeting and Exhibition of Metallurgical Preparations and Products.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—C. H. Cooke: Lubrication.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.45.—Dr. F. W. Lanchester: Automobile Steering Gear—Problems and Mechanism.

ROYAL SOCIETY OF MEDICINE (Orthopædics Section), at 8.30.—H. Platt and others: Discussion on The Treatment of Acute Osteomyelitis.

INSTITUTION OF THE RUBBER INDUSTRY (Liverpool Section) (in Common Hall, Dale Street, Liverpool).—R. M. Fitzpatrick: Rubber Footwear Manufacture.

WEDNESDAY, MARCH 7.

INSTITUTE OF METALS (Annual General Meeting) (at Institution of Mechanical Engineers), at 10 A.M.—Presidential Address.—S. Beckinsale and H. Waterhouse: The Deterioration of Lead Cable Sheathing by Cracking, and its Prevention.—Dr. M. Haas: The Dilatometric Study of Light Metals.—Dr. Ezer Griffiths and F. H. Schofield: The

Thermal and Electrical Conductivity of Some Aluminium Alloys and Bronzes.—R. Chadwick: The Constitution of the Alloys of Magnesium and Zinc.

At 2.—H. O'Neill: Historical Note on Density Changes caused by Cold-working of Metals.—Major F. S. Grimston: Season-Cracking of Small Arms Cartridge Cases during Manufacture.—F. Hargreaves: The Ball Hardness and the Cold-working of Soft Metals and Eutectics.—W. L. Kent: The Behaviour of Metals and Alloys during Hot-Forging.—W. A. Cowan: Minute Shrinkage Cavities in Some Cast Alloys of Heterogeneous Structure.—W. A. Cowan: Note on the Composition of Old Roman Lead.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Dr. R. Hutchison: A Biographical Note on Sir James Wylie, Bart., M.D., a Medical Adventurer.—F. Prescott: Louis Pasteur and Fermentation.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. E. Schrödinger: Wave Mechanics (II.).

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Hilda K. Cargill, Dr. L. Hawkes, and Julia A. Ledeboer: The Major Intrusions of South-Eastern Iceland.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—G. W. N. Cobbold and A. E. Underdown: Some Practical Applications of Quartz Resonators.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at 39 Elmbank Crescent, Glasgow), at 7.—W. MacLaren: The Principles of Coal Cleaning.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—D. S. Munro: Modern Electric Wiring, particularly as applied to Small Houses.—A. J. Milne and R. H. Rawll: The Domestic Applications of Electricity.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.—D. T. Smout: Electric Welding.

GLASGOW UNIVERSITY ALCHEMISTS' CLUB (Annual Meeting) (at Glasgow University), at 7.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Caxton Hall, Westminster), at 7.—H. R. Hiscott: The Manufacture of Malleable Iron Pipe Fittings.

SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section), at 7.30.—F. S. Sinnatt: The Formation and Structure of Cenospheres; a Study of the Carbonisation of Coal in the Form of Particles.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (Annual General Meeting and Ordinary Meeting) (at Chemical Society), at 8.—*Presidential Address*.—Prof. T. P. Hilditch: Composition of the Fatty Acids present as Glycerides in Elasmobranch Oils.—R. T. Thomson: Behaviour of Indicators in the Titration of Ammonia, Sodium and Calcium Phosphates, the Methylamines, Pyridine Bases and Boric Acid.—H. R. Jensen: Cacao Tannin.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—J. H. Jarman: General Building Materials (Lecture).

ROYAL SOCIETY OF ARTS, at 8.—Dr. J. H. Jeans: Some Wider Problems of Cosmogony (Trueman Wood Lecture).

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 8.30.—Dr. T. de Martel and others: Discussion on Colectomy.

ROYAL MICROSCOPICAL SOCIETY (Biological Section).

THURSDAY, MARCH 8.

INSTITUTE OF METALS (Annual General Meeting) (at Institution of Mechanical Engineers), at 10 A.M.—G. L. Bailey: The Influence of Dissolved Gases on the Soundness of 70 : 30 Brass Ingots.—Dr. A. L. Norbury: The Effect of Quenching and Tempering on the Mechanical Properties of Standard Silver.—Dr. J. N. Friend and W. E. Thorneycroft: An Example of Roman Copper 'Soldering' and Welding from Uriconium.—Dr. J. N. Friend: The Relative Corrodibilities of Ferrous and Non-Ferrous Metals and Alloys. Part I. The Results of Four Years' Exposure in the Bristol Channel.—Dr. T. E. Allibone and C. Sykes: The Alloys of Zirconium. I.—Dr. T. Matsuda: On the Quenching and Tempering of Brass, Bronze and Aluminium-Bronze.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. A. E. H. Love: Biharmonic Analysis, especially in a Rectangle, and its Applications to the Theory of Elasticity (Lecture).

ROYAL SOCIETY OF MEDICINE (Balneology Section), at 5.—Dr. F. Fox and others: Discussion on The Value of Marine Health Resorts, with a Special Reference to Children.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. F. A. E. Crew: Individual, Familial, and Racial Differences in respect of Immunities and Disease Resistance (Milroy Lectures) (III.).

NATIONAL INSTITUTE OF INDUSTRIAL PSYCHOLOGY (at Royal Society of Arts), at 5.15.—Investigators of the Institute: The Attitude of Employees towards the Institute's Investigations.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. J. J. Fox: Optics and Chemistry (I.).

BRITISH PSYCHOLOGICAL SOCIETY (Education Section), at 6.—R. R. Dobson: Report of an Inquiry into the Attitude of Local Authorities towards Mental Tests.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Colour Group) (Annual Meeting), at 7.

SOCIETY OF DYERS AND COLOURISTS (Midlands Section) (at University College, Nottingham), at 7.30.—O. Mitchell: Further Work with Vat Dyes.

OPTICAL SOCIETY (at Imperial College of Science) (Annual General Meeting), at 7.30.—Dr. R. S. Clay: The Stereoscope, Illustrated by Demonstrations and Exhibits of Early Apparatus and Slides (Presidential Address).

INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre—Dublin) (at Trinity College, Dublin), at 7.45.—Dr. S. Z. de Ferranti: Electricity in the Service of Man (Faraday Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (Cardiff Branch).—W. K. V. Phillips: Engineering in the Cement Industry.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 30 Russell Square, W.C.1)—E. W. J. Mardles: Notes on Aeronautical Paints and Varnishes.

FRIDAY, MARCH 9.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—Col. I. A. E. Edwards: The Air Routes of India.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Sir J. J. Thomson: On Electrodeless Discharge through Gases (Guthrie Lecture).

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Mining Institute, Newcastle-upon-Tyne), at 6.—J. S. Brown: Measurement of Power.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—E. S. Huntingford: Air Compressors.

INSTITUTE OF METALS (Sheffield Local Section) (in Non-Ferrous Section, Applied Science Department, Sheffield University), at 7.30.—W. R. Barclay: Special Alloys in relation to the Corrosion Problem.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Deansgate, Manchester), at 7.30.—Dr. J. N. Friend: Researches on the Preservation of Iron and Steel with Paint.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. E. A. Milne: The Sun's Outer Atmosphere.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (jointly with Midland Centres of Institutions of Civil and Mechanical Engineers) (at Birmingham).

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Branch) (jointly with Manchester Association of Engineers).—N. Greenhalgh: Examples of Modern Tool Room Practice.

SATURDAY, MARCH 10.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Transformation of Matter (I.).

PUBLIC LECTURES.

SATURDAY, MARCH 3.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—J. E. S. Dallas: A Naturalist at Land's End.

MONDAY, MARCH 5.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. E. Schrödinger: Wave Mechanics. (Succeeding Lectures on Mar. 7, 12, and 14.)

UNIVERSITY OF LEEDS, at 5.15.—Sir John Russell: Science and Food Production.

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—Principal W. A. Stewart: The Production of Baby Beef.

TUESDAY, MARCH 6.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Prof. E. B. Poulton: Recent Discoveries throwing New Light on some of the Commonest Insects.

UNIVERSITY COLLEGE, at 5.15.—J. Ramsbottom: The Evolution and Classification of Fungi. (Succeeding Lectures on Mar. 13 and 20.)

UNIVERSITY OF LEEDS, at 8.—Prof. P. C. Buck: The Meaning of Progress in Music.

WEDNESDAY, MARCH 7.

MEDICAL SCHOOL, LEEDS, at 3.30.—Sir Berkeley Moynihan: Introduction to a Series of Lectures on Cancer.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.30.—Dr. G. R. Lynch: Some Problems in Medico-Legal Practice.

KING'S COLLEGE, at 5.30.—Sir R. A. Sampson: In what Degree is Science True?

UNIVERSITY COLLEGE, at 5.30.—Dr. A. Mansbridge: The Citizen and the Librarian.

THURSDAY, MARCH 8.

STUART HALL, ST. ANDREW'S HALL PLAIN, NORWICH, at 8.—F. W. Alexander: The Value of Sunlight (Chadwick Lecture).

FRIDAY, MARCH 9.

ARMSTRONG COLLEGE, NEWCASTLE-UPON-TYNE, at 6.—Prof. R. Robinson: The Relation of Some Plant Products to the Simple Sugars and the Amino Acids (Bedson Lecture).

SATURDAY, MARCH 10.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—C. Darrell Forde: The First Metal-Workers.

CONFERENCES.

MARCH 5 AND 6.

GERMAN SOCIETY FOR RESEARCHES ON THE CIRCULATION (at Cologne).

MARCH 8 AND 9.

INSTITUTION OF CHEMICAL ENGINEERS (at New Princes' Restaurant, S.W.1).

Thursday, March 8.

At 5.—Prof. B. W. Holman: The Theory of Magnetic Separation.

At 8.—Dr. B. Moore: The Combustion of Powdered Coal.

Friday, March 9.

At 11.30 A.M.—Sixth Annual Corporate Meeting.

At 12 NOON.—President's Address: The Economics of Power as Applied to Chemical Engineering.

At 2.15—Dr. O. Spengler: The Treatment of Effluents from Beet Sugar Factories.

MARCH 28 TO 31.

GERMAN BALNEOLOGICAL CONGRESS (at Baden, near Vienna).

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Popular Science.

POPULAR science is a phrase which almost inevitably conjures visions of Pepper's ghost, unpleasant smells, a loud bang, and a disapproving mother. Not only in chemistry and physics, but also in psychology, sociology, and economics, the term suggests a superficial acquaintance with the more amusing manifestations of natural phenomena or with some arguable thesis concerning political affairs rather than any widespread understanding of the relation between cause and effect. Nevertheless, there is a general lay interest in the march of science, and very laudable attempts have been made, and continue to be made, to keep the populace informed of the trend of its progress, its rate, its direction, its practical effects, and something of the spirit permeating its body of serving men and women. Such a presentation demands painstaking and prolonged effort. The material must not be inaccurate, yet it must necessarily be indefinite, it must be attractive but not sensational, dignified but not high-brow. It must not be presented in its native language, but in that of everyday speech; it must indicate some practical advantage or it must positively refrain from suggesting any such mundane possibility, according as it is intended to be read before or after dinner.

We need not debate the desirability of recording the progress of scientific investigation and of discussing cognate matters in such a way as appeals to the 'average' man. Obviously, if the task is not undertaken there can be little public appreciation of or sympathy with the objects to which the workers have devoted their labours, neither can there be full support in the provision of conditions necessary for the fruition of their efforts. Could one, for example, imagine an unenlightened community establishing a Ministry of Health, or a Department of Scientific and Industrial Research, or even a Broadcasting Corporation? It does not necessarily follow, of course, that progress is any the more rapid on account of public interest, especially when the problem happens to be one which may admit of confusion by the articulate assistance of partially informed critics, but it is indisputable that encouragement and provision are much more likely to be the outcome of knowledge than of ignorance. Apart from such a consideration, most readers of the general press seek to know more of the world around them, whether physical, moral, ethnological, or industrial, provided that the effort accompanying the stimulation of their interest is not too noticeable. If science is displayed for their benefit, it is not intended that they should be

creative investigators; if poetry, that they should rush into verse. Besides, ignorance of natural laws, as of other laws, is no insurance against the regrettable consequences which may arise from their neglect.

The translation of scientific news—nowadays so enormous in its bulk—into suitable language, and its condensation to comparatively minute dimensions, are undertaken in a systematic manner in the United States of America by an organisation known as Science Service, Inc., directed by Dr. E. E. Slosson, and functioning under the auspices of the National Academy of Sciences, the National Research Council, and the American Association for the Advancement of Science. This organisation publishes daily science news bulletins, and a weekly summary of current science entitled the *Science News-Letter*, in which current events, scientific discoveries, and résumés of progress, together with broadly-drawn reports of the proceedings of scientific conventions, are recorded in simple terms. In addition, there is compiled a weekly digest, intended to present the cream of the week's scientific news, which is regularly used by more than twenty broadcasting stations in the United States.

Fortunately, in Great Britain there is little fear that discoveries might be announced to the listening public in a manner savouring of sensationalism, or that accounts of scientific affairs might be so rendered as to appear ludicrous to the initiated, for the policy in this respect of the British Broadcasting Corporation and of its predecessor company has been exemplary. We are, however, familiar with the result of excursions by otherwise competent journalists into spheres with which they are not familiar; indeed, the distaste for publicity which is usually ascribed to undue modesty might, if the truth were known, quite possibly often be traced simply to a fear of misrepresentation. The American press is now able, however, to rely on telegraphic news 'stories,' prepared by the managing editor of Science Service, Mr. Watson Davis, and the members of his specialist staff, so that their reports of the proceedings of conferences and conventions shall be well-balanced and accurate, without losing their attractiveness as items of news.

In Great Britain there is, of course, fairly adequate publication and survey of the results of research, such publication being intended for the use of the scientific population itself, and being normally directed by members of that fraternity, but we seem to lack a widespread sense of the importance of an appeal to the non-specialist members of the community as part of their ordinary daily culture, an appeal which must, to be worth while, be sponsored by the most notable members of the professions, and to be effective by the more journalistically-minded among them. There is, after all, no valid reason why the dissemination of knowledge beyond the confines of schools and colleges, provided it is carried out with scrupulous honesty, dignity, and restraint, should not be acknowledged to be as valuable a social service as the collection and arrangement of the knowledge itself. True, this view has been given practical effect in certain influential sections of the British lay press by acknowledged authorities in a number of the sciences, but apart from one or two publications of admitted standing, there is little organised continuous effort in this direction. An attempt was made a couple of years ago to secure the interest of scientific societies and institutions in Great Britain in the establishment of a science publicity service, but the response was so disappointing that the scheme was abandoned.

Dr. E. E. Slosson, in a recent address before the American Association for Adult Education, made the somewhat surprising statement that archæology and astronomy—essentially remote and unpractical—head the list of the sciences in order of popular interest, and that the essentially practical sciences are low in the list. He ascribes this, probably correctly, to the same cause as that operating in the selection of, say, 'Futuristic Art' as a subject of study in a women's club rather than 'Domestic Economy.' He declares that scientific workers have been too humble and too modest in claiming credit for what they have done and what they can do in the control of human affairs, but have allowed statesmen, writers, and financiers to take all the praise for the advance in civilisation and the amelioration of living conditions that were really due to scientific research. If we look at the matter from the point of view of the wealth of nations, as Dr. G. E. Hale, the honorary chairman of the National Research Council, has recently done in *Harper's Magazine*, it is clear enough that the business of men of science is to help to guide mankind as well as to serve it. That is to say, if a scientific orientation can more universally be associated with moral and religious convictions in the equipment of the human mind, there will be less danger of the wicked and unscrupulous misuse of scientific power, less point in arguing the prohibition of poison gas, and an extension of that wider fraternal patriotism which distinguishes scientific international relations.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Magnetic Properties of Single Crystals of Zinc and Cadmium.

RECENT investigators have studied the thermal expansion, the electrical resistance, the elastic constant, the thermoelectric and the photoelectric effects of single crystals of metals, but up to the present few accurate results have been obtained for the fundamental para- or diamagnetic properties of such metals.

Last year the susceptibilities of the alkali metals were studied, and it was thought of interest to extend this investigation to a study of the elements of the second column of the periodic system. When these elements were studied previously (Honda and Owen), metals in the form of an isotropic aggregate of crystals were used. As zinc and cadmium form crystals of the hexagonal system, the value of the magnetic susceptibility parallel to the crystallographic axis would be expected to differ from its value in a perpendicular direction.

In making crystals for these experiments, the method described by Bridgman was used. He found that for cadmium and zinc the preferred manner of growth was with the basal plane parallel or perpendicular to the axis of the cylinder. Under a rough optical examination, the crystals used in the experiment referred to appeared to be orientated with the basal plane parallel to the axis of the cylinder.

To study the susceptibility, the crystals were suspended vertically from one arm of a balance so that the lower end hung between the poles of an electromagnet, and weighings were taken in the presence and absence of a known magnetic field. The crystal was rotated through 360° about a vertical axis, readings being taken every 15°. The results obtained are shown in the accompanying diagram (Fig. 1). At the position of maximum and minimum effect, readings were taken for a range of field from 5000 to 12,000 gauss, and corrections for iron impurities were made according to the method given by Owen. By this method, the amount of free iron contained in the metal was found to be of the order of $0{\cdot}5 \times 10^{-4}$ gm. of iron per gram of metal. The specific susceptibilities obtained in this manner were, for zinc, $-0{\cdot}183 \times 10^{-6}$ in a direction parallel to the principal axis of the crystal, and $-0{\cdot}147 \times 10^{-6}$ in a direction perpendicular to this. For cadmium, these values were $-0{\cdot}276 \times 10^{-6}$ and $-0{\cdot}169 \times 10^{-6}$. The values given by Owen, obtained from coarse-grained crystals, were, zinc $-0{\cdot}155 \times 10^{-6}$ and cadmium $-0{\cdot}18 \times 10^{-6}$.

It is intended to study a still larger number of crystals and to investigate the influence of low temperatures upon their magnetic susceptibility.

One of us, Elizabeth Cohen, has been enabled to co-operate in this investigation through the award to her of a studentship by the National Research Council of Canada.

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RICHARD RUEDY.
ELIZABETH COHEN.

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University of Toronto,
Jan. 21.

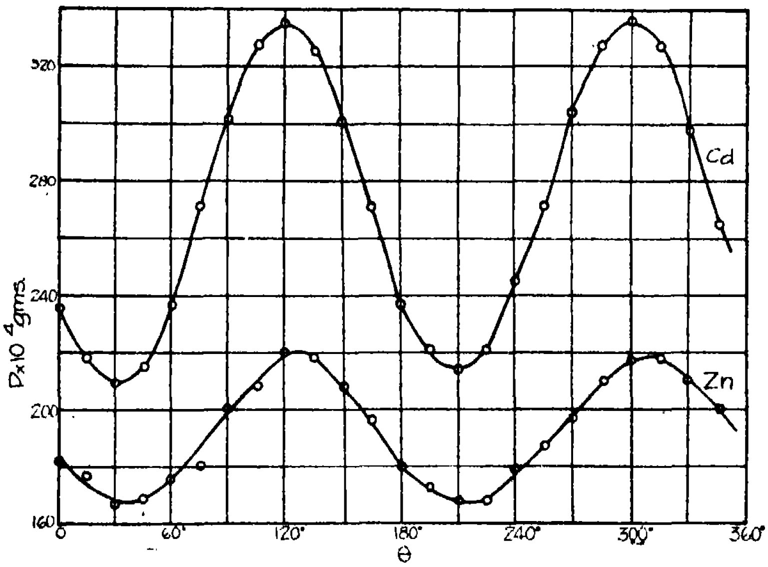

FIG. 1.

Passivity and Protective Oxide Films.

IN NATURE of Feb. 11 (p. 222) it is stated that "An X-ray examination of finely divided iron, nickel, and chromium, conducted by F. Krüger and E. Nähring at Greifswald, has shown conclusively that films of oxide thicker than 10^{-7} cm. are not present on the surface of a passive metal." Lest a wrong impression be gained from this statement, I would venture to add a few remarks on the factors which determine the thickness of protective films.

The film produced by oxidising agencies on metals necessarily ceases to thicken as soon as it becomes sufficiently protective to exclude the oxidising agent. Recent work (*Jour. Chem. Soc.*, 1020; 1927) has pointed to the fact that, on freshly abraded iron, the considerable thickening of the film experienced proceeds through the production of cracks due to the internal stresses left by the abrasion; only when this cracking of the film has ceased will the thickening come to an end. Since a cracked film produces no passivity, coarsely ground metal requires a longer time to become passive than finely ground metal, and develops a thicker film, especially if substances be present in the solution which are capable of penetrating the smallest cracks (*e.g.* chlorine ions). The films obtained from abraded specimens attain thicknesses of the order 10^{-6} cm., and can be isolated from their basis and studied. In the presence of a regulated amount of penetrating anions, the thickness may come to exceed 4×10^{-6} cm., and the films will then give rise to interference tints. Great thickening is only to be obtained under conditions which render the material less perfectly protective, and there is naturally some danger that the film will break down altogether. Under suitable conditions, however, considerable thicknesses may be reached; the writer has quite recently prepared

some specimens showing the complete sequence of interference tints right up to the late second-order colours; although produced at room temperature, the sequence of colours is the same as that of the 'temper colours' obtained at high temperatures, and the tints are, on the whole, brighter.

The tiny particles of metal used by Krüger and Nähring were presumably almost free from internal stresses. On stress-free metal there will be practically no cracking of the film, and the film will stifle its own growth as soon as it is continuous over the whole surface. There is no reason to think that the thickness will come to exceed 10^{-7} cm. In any event, it is not probable that these very thin films would cause oxide-lines. The work of Kohlschütter and Krähenbühl (*Zeit. Elektrochem.*, **29**, 570; 1923) on films of silver halides suggests that such films only assume their proper crystalline structure when they reach a much greater thickness; a 'pseudomorphic' stage precedes the 'idiomorphic' stage. Krüger and Nähring's attempt to check their method by studying mixtures of granular oxide with granular metal gives no indication of the behaviour of oxide-coated metallic granules.

Indeed, the main result of the research is to show how very unsuitable is the X-ray method for this particular purpose. The authors appear extremely satisfied at recognising the oxide lines in nickel powder mixed with 2 per cent. of nickel oxide. Chemical analysis would, of course, detect a far smaller oxide-content, and (unlike the X-rays) would detect it equally well whether the oxide be vitreous or crystalline, or whether it be pseudomorphic or idiomorphic. It is a little difficult to understand why—in a research where a negative result was probably expected—the authors should have chosen to adopt the less sensitive method. While, however, the X-rays appear unsuited to deal with a phenomenon confined to the surface layers, light rays, to which the metal is relatively opaque, give valuable information. It is often stated that the optical properties of passive iron are identical with those of active iron. This has recently been shown to be untrue by Freundlich, Patscheke, and Zocher (*Zeit. Phys. Chem.*, **128**, 321; 1927: **130**, 289; 1927), who have found that, on admitting oxygen to the surface of pure iron mirrors, a sudden change occurs in the phase relations of the two components of elliptically polarised light reflected from the metal; this change they attribute to an oxide film. At the same time—and, no doubt, owing to the same cause—the chemical activity suddenly falls off, the iron becoming unaffected by nitric acid of concentrations which have a marked action upon the iron mirrors if introduced *before* the admission of oxygen.

'Air-passivity' (*i.e.* marked change in chemical properties of iron, brought about simply by exposure to air or oxygen) appears to be a property of the pure metal. It is not shown well by the commercial varieties of iron (other than chromium steels), probably because the oxide-film produced by gaseous oxygen has discontinuities at the junctions of the different phases present. The phenomenon is, however, displayed both by Freundlich's iron mirrors, produced by the decomposition of the carbonyl, and also by the electrolytic iron used in the writer's own work. It has been somewhat satisfactory to find that the quite independent study of the two materials —obtained by two totally different methods and in forms quite dissimilar externally—has led to concordant results and identical conclusions.

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The Trail of the Germ-plasm.

IN his brilliant analysis of the phenomena of growth, T. B. Robertson ("Chemical Basis of Growth and Senescence," 1923) starts with the assumption that growth phenomena can be likened to certain chemical reactions which are subject first to an acceleration due to catalysis and in a later phase diminished by the products formed in the course of the reactions (autocatalysis). Growth phenomena so closely resemble such reactions in so many cases cited, that Robertson gradually assumes that his premise is correct, and finally ends in accepting the proof accumulated. Let the thesis be accepted as a working hypothesis. The two most awkward phenomena to bring in line with the hypothesis were found to be the carrying on of the germ-plasm intact in the course of development to the adult gonad, and cancer-like growths. In connexion with this hypothesis the following observations on germ-plasm may be helpful.

With regard to the trail of the gonadial germ-plasm in ontogeny a great deal has been written, but relatively very little determined. In a recent search among the literature of the subject, I tried to find out whether mitoses had *ever* been recorded in an adult gonadial epithelium, and found very little information. In 1923, Gatenby discussed the question of the formation of new egg-cells in the ovary of vertebrates (NATURE, July 7, vol. 112), and quotes recent work by Allen showing mitoses in the germinal epithelium of Mus (*Amer. Jour. of Anat.*, vol. 31, 5; 1923) as justification for a particular case in which ova may be regarded as being derived from the gonadial epithelium, the so-called somatic part of the ovary. He also gives a photomicrograph of a section of ovary of an adult frog, showing germ-cells in all stages of development, and states "it is indisputable that in vertebrates below the mammals seasonal accessions of new germ-cells take place," without, however, committing himself to views on how this accession occurs. It is admitted that even if mitoses occur in a gonadial epithelium, the interpretation may be made that such dividing cells may be immigrated primitive germ-cells.

In invertebrates germ-cells are found attached to —and apparently proliferating from—the germinal epithelium, and it is generally assumed that such germ-cells have arisen from the underlying epithelium. But the interpretation that mitoses in a germinal epithelium may be due to an immigration of primary germ-cells applies with greater force in the case of invertebrates. It is thus permissible to raise again in a different form the old problem, namely: Which and where are the germ-cells during adolescent and inter-spawning periods? In this inquiry it may not be enough to know the complete ontogeny of a germinal epithelium, unless it be proved at the same time that that germinal epithelium does produce from its own elements—gametes; for it is not impossible that a so-called gonad may be merely the locus in which gametes develop but do not necessarily originate.

On this problem the following observation, which is probably not an isolated case, is of interest. After *O. edulis* has spawned as a female and afterwards as a male (in one and the same summer) the gonoducts fill with leucocytes. My first interpretation of this phenomenon was naturally that the leucocytes were all phagocytes, and employed in cleaning up the gonadial passages ready for next year. No doubt the removal of unused and waste genital products is an important function of these leucocytes, but their abundance has frequently arrested attention and provoked the suggestion that other functions may be

being performed. In many cases there would appear to be no necessity for such large numbers merely for phagocytic purposes, although a purely physical explanation may be possible. Is it possible, therefore, that certain leucocytes may be potential germ-cells and only develop such potentialities in a suitable locus, the gonad, at a suitable time? Critical work which aimed at providing definite information on this problem would have great value whatever the result might be. Germ-cells, disguised as leucocytes—and not a few cases of such (as amœbocytes) are indeed known—could be pre-formed in the very earliest stages of development, and be subjected, while in the blood stream, to the maximum net and accumulative effect of the environment on the individual.

That this interpretation is not outside the region of probability may be deduced from Woodger's observations on the origin of the germ-cells of the fowl (*Q. J. M. Sc.*, **69**, p. 460; 1925), and Simkins on Trionyx (*Am. J. Anat.*, **6**, 36; 1925). The former states (italics are mine), "I feel no doubt about the continuity of the *primitive germ-cells* of the genital ridge with those of the splanchnic mesoderm of earlier stages, and with the *large cells of the blood-stream* in still earlier ones"; the latter finds that "*Isolated blood-cells* before the origin of the germ-gland rudiment more nearly answer to the requirements of *primordial germ-cells* than any other cells encountered."

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High Frequency Discharges in Gases.

IN the issue of NATURE for Feb. 4, Messrs. Taylor describe a 'new form' of high frequency discharge in gases at low pressures. This type of discharge is one of those which may be obtained when the gas is acted upon by an oscillatory force, derived either from a Tesla transformer where the oscillations are damped or from a generator performing continuous oscillations, and they occur in various forms, many of which are quite well known. The methods of maintaining continuous oscillations at high frequency by means of valves have added additional interest to electrodeless discharges as they provide a means of attaining a steady state of ionisation in the gas so that the currents and the potentials at the electrodes corresponding to the various forms of the discharge may be accurately measured. For this reason they have been included in the experimental courses in Oxford, and doubtless at other universities, and it may be of interest to describe a few of the more striking features which can be made the subject of simple experiments. Luminous discharges in gases may be maintained with long wave oscillations or with oscillations of a few metres wave-length. The resulting phenomena are much the same whether the potentials be applied between external or internal electrodes.

The distribution of the luminosity depends on several factors: the shape of the discharge vessel and the position of the electrodes, which may be internal or external; the nature and pressure of the gas; the applied potential and its frequency. Taking the very general case of a cylindrical tube 1 metre long and 3 cm. in diameter, with two external electrodes wrapped round in the middle of the tube about 10 cm. apart, the following are the main features of the discharge which may be observed as the pressure is reduced. Neon may be taken as an example of a gas which gives brilliant discharges over a large range of pressures from 50 mm. to 10^{-3} mm. of mercury, using a generator kept in oscillation by a 30-watt valve.

At comparatively high pressures the discharge takes place only in the gas nearest the two electrodes. As the pressure is reduced the luminosity extends along the tube until it fills the whole space between the electrodes. With further decrease in pressure the luminous column increases beyond the electrodes, and will finally fill the whole length of a very long tube. Still further decrease in pressure brings a contraction of the length of the luminous column together with a decrease in its intensity. When the pressure of the gas is of the order of 10^{-4} mm. a quite different phenomenon appears. The luminosity breaks up into sharply defined balls of light, sometimes perfect spheres, but in cylindrical tubes usually egg-shaped. Argon shows this phenomenon best, and gives an 'egg formation' with an exceedingly sharp boundary. In general, three balls of luminosity appear; one in the middle between the electrodes and one in each of the spaces beyond the electrodes, but by varying the applied potential it is possible to have one, two, or three 'eggs' existing together or separately.

At pressures of this order it is found that the discharge is maintained much more easily in the vessels of larger volume and in vessels of certain shapes, it is possible to have the discharge entirely outside the electrodes. Further reduction in pressure brings a decrease in the size of the 'egg,' and finally it disappears, leaving a slight diffused illumination from the gas. At very low pressures the glass between the electrodes begins to glow a red colour, and will show a greenish phosphorescence for some seconds after the stopping of the discharge. Quartz will continue to give out a green glow for many minutes after the discharge has stopped. If the quartz be heated above 150° C. it will phosphoresce very brightly for more than an hour, even though the heating be applied many hours after the discharge. Heating to about 600° C. will destroy this power of phosphorescence in quartz. Different types of glass do not seem to phosphoresce on heating.

When a discharge is passed through neon, at 5 mm. pressure, which contains mercury vapour as an impurity at a pressure corresponding to the saturation pressure at ordinary temperatures, and the discharge is passed between electrodes round the neck of a tube leading from a large bulb, it is found that the neon spectrum is developed very strongly in the narrow tube with very faint mercury lines, but in the bulb the spectrum is almost exclusively that of mercury. The neon spectrum appears in the strong, the mercury in the weak, part of the field. In general it may be noted that in monatomic gases impurities show themselves in the spectrum to a greater extent in the vessels of large volume where the field is relatively weak and at the higher gas pressures.

Various experimenters have measured the potentials to maintain these discharges under different conditions. One need only mention the researches of Gutton, Kirchner, Gill and Donaldson, and Townsend.

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Origin of the Semi-diurnal Pressure Wave in the Earth's Atmosphere.

THE small semi-diurnal wave of atmospheric pressure has long been recognised as a world-wide phenomenon. Simpson (*Q. J. Roy. Met. Soc.*, **44**, pp. 1-18; 1918) showed ten years ago how closely its value at individual places corresponds with the resultant of two twelve-hour vibrations, one parallel to the circles of latitude and one parallel to the meridians, as suggested originally by Schmidt (*Meteorologische Zeitschrift*, **7**, p. 182; 1890). The

mathematical investigations of Laplace, Kelvin, Margules, and Lamb have led to the conclusion that the atmosphere has a natural period of vibration of about twelve hours. The general opinion during recent years has in consequence been that the semi-diurnal wave of pressure is a forced oscillation of thermal origin, with the reservation that a considerable degree of mystery attaches to the precise way in which such a resonance effect can take place in an atmosphere complicated and changeable as that of the earth. Some meteorologists apparently go even further, and reject this theory completely. Goldie, for example (*Proc. Royal Soc. Edinburgh*, **47**, part 4, No. 25), has been led by a critical examination of many autographic records of meteorological elements, to take up a point of view the essence of which, to quote his own summary, is as follows:

"A semi-diurnal variation appears to some extent in many meteorological phenomena, in particular in barometric pressure, rainfall, visibility, atmospheric electric potential gradient, and atmospheric pollution, even though the variation of temperature, at least in the lower levels of the atmosphere, is very approximately a purely diurnal variation.

"The data examined in this paper suggest that, in the forenoon, insolation affecting the ground and the lower layers, and, in the evening, outgoing radiation affecting clouds and the upper part of the troposphere, each lead to a disturbance of the stability of arrangement of the atmosphere in the vertical direction and to a consequent increased mixing of layers. On the other hand, in the late afternoon and in the later part of the night, as the turbulences arising from the above two effects respectively die down, there is an improvement above normal in the laminarity of flow of atmosphére over the earth. The resultant effect is therefore, on the average, a semi-diurnal variation in the vertical structure and horizontal movement of the atmosphere, which variation is reflected in the meteorological phenomena mentioned above. It is shown in the paper that the various individual effects may be greatly exaggerated, or almost eliminated, or accelerated or retarded, at least in temperate latitudes where a suitable variety of types of upper air structure, from which to select, is available."

It is impossible to deal in detail in a short space with the evidence put forward in support of this view. All this evidence is indirect, and some of it decidedly ambiguous; it rests mainly upon differences in the character of the diurnal changes of pressure and temperature with different types of weather, and, above all, with different vertical gradients of temperature such as are found on the average in 'polar' and 'equatorial' air that reaches temperate latitudes. No direct observational evidence of a second maximum of convective movement in the troposphere in the late evening is brought forward. Since the diurnal pressure wave is present in clear weather, as well as on days when there are cumulus clouds in the sky to provide foci of radiation, it is evident that the theory relies upon the existence of strong outward radiation from relatively dry air at great heights in accordance with the conclusions arrived at by A. Angstrom (*Q. J. Roy. Met. Soc.*, **50**, pp. 121-125; 1924), to which Goldie makes reference. This is a pity, for there are ways of studying upward and downward currents at high levels directly: for example, by observations of the rate of ascent of pilot balloons, or observations of 'bumpiness' made by aeroplane. One would like to know the experience of aeroplane pilots on this point. Simple observation of the collapse of convectional day clouds in the late evening has never suggested to me anything but a gradually increasing tendency to stratification: the last remains of such clouds not infrequently take the form of flattened strato-cumulus, and have never been observed to change into mammato clouds, as might be expected to happen if each cloudlet were descending rapidly towards the earth.

It would appear that, although attempts at the interpretation on dynamical and thermodynamical lines of thermograms and barograms, for selected types of atmospheric structure, may well bring interesting new matter to light, the general conception of a forced oscillation of the atmosphere corresponding with its natural period of twelve hours, as the cause of the twelve-hour pressure wave, will probably continue to hold the field for some time to come.

E. V. Newnham.

Rainfall Interception by Plants.

In Nature of Dec. 11, 1926, p. 837, I outlined the results of some observations upon the interception of rainfall by plants. *Inter alia*, it was shown that where an ordinary gauge registered a catch of 1, an adjacent gauge bearing a 12-in. high cylindrical frame of wire-mesh carrying branchlets of *Podocarpus Thunbergii* Hook. registered 1·81 during the period June 1, 1925–May 31, 1926.

Lieut.-Col. Gold, in Nature of Dec. 25, 1926, p. 915, pointed out that the major portion of this interception gain was no doubt due to the frame catching rain which would otherwise have fallen on the lee side of the gauge. He further stated that this would become negligible were a large area to be covered by a comparatively close network of screens.

I accordingly endeavoured to test Col. Gold's statement by means of placing a gauge—screened exactly as described in the note of 1926—at the centre of a close network of concentric circles bearing the laced-in branchlets of Podocarpus. The heights of the circular screens decreased as the centre was approached, and the distances separating the circles were in all instances less than the heights of the latter. A control gauge was placed some yards distant. The catches recorded during the period of observation were:

Month.	Gauge in Centre of Screen Net-Work.	Control.
1927.	Inches.	Inches.
April	1·90	1·54
May	12·12	6·77
June	3·37	2·02
July	3·24	2·00
August	6·68	4·16
September	4·01	2·83
October	4·40	2·96
November	3·06	2·44
Total	38·78	24·52
Percentage	158	100

From observations during periods of rainfall it is obvious to me that, were a closer and more extensive network provided, the seeming interception gain would be reduced still further. I am indebted to Col. Gold for his criticism of the experiment.

The data given in the 1926 note require to be interpreted in light of the information yielded by this second experiment, but at the same time it is certain that the general truth of the argument they purported to support cannot be denied. The following observations at Deepwalls substantiate this claim:

(1) A gauge placed under several 15 ft.-20 ft. high *Virgilia capensis* Lamk., growing on the research station

hill at 1725 ft., registered 0·0025-0·05 in. in six hours during which periods dense *Nebelreissen* cloaked the hilltop, *no actual rainfall occurring the while*. A control gauge placed well away from tall vegetation during these self-same periods registered not the slightest precipitation.

(2) The taller the vegetation the greater the precipitation induced: occasional observations at the base of a row of 100 ft.-115 ft. high *Eucalyptus globulus* growing on the north side of the research station hill indicate that the catch in six hours of dense *Nebelreissen*—without any actual rainfall—may range from 0·0025 to 0·15 in. The writer, while working at the base of these in misty weather, has had to wear a rainproof, so heavy has been the fall of water from the foliage, whereas, when the wind is of low velocity, he has been able to leave papers lying 20-30 yards away from the trees without the records becoming wet. During wind of high velocity it has been noted that an interrupted fall of moisture occurs to a distance of about 40 yards in the direction of the wind.

A continuous series of observations during misty weather has not been possible, but it seems clear that an increased fall of from 10 in. to 15 in. per annum occurs under the Eucalpyts as the result of condensation of the hydrometeors. In mountain macchia and mountain forest on the south-west, south, and south-east slopes of the Outeniqua range and of its highest foothills—sites mist-clad on the aggregate a quarter to a half of the year—the increased fall as the result of condensation of the mists must be very much greater.

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Dec. 5, 1927.

Active Nitrogen.

IN the current issue of the *Journal of the American Chemical Society*, Dr. Bernard Lewis criticises certain aspects of the work upon active nitrogen which has recently been published from the Laboratory of Physical Chemistry, Cambridge. He states, *inter alia*, that "the authors (Willey and Rideal) neglect to consider many reactions initiated by active nitrogen which require more energy than two volts"; in spite of this somewhat sweeping statement which, if upheld, would stultify a good deal of the work under discussion, he does not quote or even hint at a single reaction which can be held to justify his contention. His next sentence, "The varied phenomena caused by active nitrogen make it evident that 2-volt level nitrogen molecules do not issue from the discharge," is equally illustrative of its author's tendency to state opinions as facts.

It is difficult to understand our being at variance over the obtaining of ammonia from active hydrogen and inert nitrogen. In the experiments at Cambridge, condenser discharges (identical with those employed in obtaining active nitrogen) were employed and careful precautions were taken against mixing of the gases in the discharges. Three concordant experiments showed that ammonia equivalent to about 0·2 per cent. active hydrogen (calculated as H_2) could be obtained if the gases after mixing were further treated with a little water vapour, admitted from another side tube, and drawn to exhaust through a condensing trap cooled by liquid air. In two runs, also, it was found that when the nitrogen was activated no ammonia was obtained, and the glow appeared to diminish slightly, a result which at the time was interpreted as being due to the decomposition by the active nitrogen of ammonia first formed from the inert nitrogen and active hydrogen; the quantity of active nitrogen present (1 per cent.) rendered this quite probable. The experiments were carried out only to test Wendt and Landauer's claims as to the properties of active hydrogen, and were part of the attempts to activate this gas by second-type collisions with active nitrogen as described in the second paper.

It is a pity that Lewis did not make a quantitative study, however short, of his ammonia synthesis from active nitrogen and active hydrogen. Lord Rayleigh has shown (*Proc. Roy. Soc.*, **85**, 219; 1911), and Dr. Rideal and the author have confirmed his observation, that ammonia extinguishes the glow of active nitrogen and chemical reaction appears to be traceable. This fact would appear to constitute a grave objection to Lewis's theory of the formation of ammonia from atomic nitrogen and atomic hydrogen, namely:

$$N + H \longrightarrow NH \quad . \quad . \quad . \quad (1)$$

$$NH + H_2 \longrightarrow NH_3 \quad . \quad . \quad . \quad (2)$$

Spectroscopic evidence, taken in conjunction with the decay of the afterglow being bimolecular with respect to the glow-producing system, leads to the view that the first step at any rate in the development of the luminosity is the recombination of nitrogen atoms, which are the primary reacting system according to his scheme. If, then, they are to take part in the ammonia synthesis, considerable changes—probably extinction—of the glow might be anticipated; conversely, if ammonia were produced in any quantity by any other mechanism, it should also affect the glow, but no mention of such a phenomenon occurs in his paper. The matter will later be discussed more fully in another place.

Recent studies of the decay of the after-glow have, it is believed, led to important clues as to the origin and nature of active nitrogen. It appears that between 1 mm. and 10 mm. pressure the decay process is very complex, although bimolecular with respect to the active nitrogen. Moreover, it appears very likely that the luminosity and the chemical activity are steps in an involved deactivation process; the first of these stages appears to consist of a ternary collision between two atoms and a molecule, as would be expected from the negative temperature coefficient of the decay process as observed long ago by Lord Rayleigh (*Proc. Roy. Soc.*, A, **86**, 262; 1912).

A full account of these investigations will shortly be published.

E. J. B. WILLEY.

Laboratory of Physical Chemistry,
Cambridge, Feb. 13.

Units of Energy.

DR. RUSSELL'S suggestion (NATURE, Feb. 4, p. 170) that the kilowatt-hour is the best unit of energy for practical purposes, ought to be popular with the gas companies. At present, by Act of Parliament, we have to purchase our energy from the public supply companies by two different measures, and the cheaper purveyor does not get full credit for his cheapness. The unit for electricity is of course the kilowatt-hour, $3·6 \times 10^6$ joules; the unit for gas energy is the therm—the energy required to heat 1000 lb. of water through 100° F., and this is 105×10^6 joules. Thus the therm is approximately 29 kilowatt-hours. In other words, when the price of gas per therm is the same as the price of electricity per kilowatt-hour, electrical energy is 29 times as dear as gas energy.

As to the scientific aspect of the question of units, it would be useful if someone with missionary zeal could provide handy reference tables bringing in all

the different forms of energy. The subjoined list gives some indication of what is wanted, and suggests to my mind the reflection that it would not be beneficial to adopt one unit of energy to the exclusion of the others.

For the benefit of meteorologists who are interested in the measurement of geopotential, I have included in the table the unit introduced by Prof. V. Bjerknes, the dynamic metre or, as I prefer to call it, the metre-leo. This is the gain in potential when a body is raised through 1 metre in a hypothetical place where $g = 1000$ cm./sec.^{2}. The metre-leo is 10^5 ergs per gramme. The specification of the upper levels of the atmosphere by geopotential rather than by height has certain theoretical advantages, the principal one being that points with the same geopotential are on the same level surface. Whether it is desirable to use the metre-leo in recording observations is a question on which opinion is at present sharply divided. The question has been answered in the affirmative by more than one international conference, but some of the most influential meteorologists hold strongly the contrary view. My little table, in which the simple relation between the second and third columns will be noted, may serve to show why the proposal has some attractions for students of dynamical meteorology.

F. J. W. WHIPPLE.

Kew Observatory,
Richmond, Surrey.

SPECIFIC ENERGY IN VARIOUS UNITS.

		Metre-gravity, Lat. 45°.	Metre-leo or Dynamic Metre.	Joule/gm.	kw. hr./tonne or mw. hr./gm.	Water-degree C. or cal./gm.
Potential energy	Metre in London	1·0006	0·9812	$9{\cdot}812 \times 10^{-3}$	$2{\cdot}726 \times 10^{-3}$	$2{\cdot}347 \times 10^{-3}$
	Metre in lat. 45°	1	0·9806	$9{\cdot}806 \times 10^{-3}$	$2{\cdot}724 \times 10^{-3}$	$2{\cdot}346 \times 10^{-3}$
	Dynamic metre	1·0198	1	10×10^{-3}	$2{\cdot}778 \times 10^{-3}$	$2{\cdot}392 \times 10^{-3}$
Kinetic energy	*10 metres per sec.*	*5·10*	*5*	0·0500	0·0139	0·0120
	100 km. per hour	39·3	38·6	0·386	0·107	0·092
Heat	Water 1° C. at 20° C.	426	418	4·18	1·16	1
	Air at const. pressure 1° C.	103	101	1·01	0·280	0·242
	Air at const. vol. 1° C.	73	71·5	0·715	0·199	0·171
Latent heat	Water–ice at 0° C.	$34{\cdot}1 \times 10^3$	$33{\cdot}4 \times 10^3$	334	93	80
	Steam–water at 100° C.	230×10^3	226×10^3	2260	627	540
Calorific value	Hydrogen (to H_2O)	$12{\cdot}4 \times 10^6$	$12{\cdot}1 \times 10^6$	121×10^3	34×10^3	29×10^3
	Carbon (to CO_2)	$3{\cdot}4 \times 10^6$	$3{\cdot}3 \times 10^6$	33×10^3	$9{\cdot}3 \times 10^3$	8×10^3
Electrical energy	Kilowatt hours per tonne	367·1	360	3·6	1	0·861

Density of a Luminous Gas and the Emission of Light by Atoms in Metastable States.

MR. I. S. BOWEN points out in an interesting letter to NATURE (Oct. 1, 1927, p. 473) that the low density prevailing in nebulæ favours the emission of light by atoms in metastable states, and thus he accounts for a number of hitherto unexplained nebular lines as the result of transitions from initial metastable states of ionised atoms of oxygen and nitrogen. There is no doubt, as Prof. Fowler, who has adduced further spectroscopic evidence in support of the suggestion, puts it, that "a satisfactory explanation of some of the most important nebular lines has at last been reached." The suggestion, however, implies that we have to give up the position that the transition of an atom from a metastable state to one of lower energy level resulting in emission is necessarily conditioned by the action on the atom of an agent external to it, an electric field, a magnetic field, or the impact of another atom. If, as is sometimes alleged, the influence of neighbouring atoms causes the emission of forbidden lines from initial metastable states, a high density, and not a low one, should be the condition favourable for such emission.

It has been shown by me that the intensity of the forbidden line λ2270 in the arc spectrum of mercury resulting in the transition from the initial metastable state 2^3P_2 to the ground level 1^1S_0 *increases* as the density of the vapour in a mercury arc is *diminished*, other conditions of excitation remaining unaltered (*Roy. Soc. Proc.*, A, vol. 117, p. 20, communicated July 7, 1927). Quoting from the paper, "these considerations would appear to indicate that the metastable state 2^3P_2 is not one in which, left to itself, the excited atom remains for ever in that state, but one whose average free life is large compared with the average life of other excited atoms . . . the (free) life of an excited atom in the metastable state is so long that in an arc under a pressure of the order of a couple of millimetres of Hg the probability of such an atom suffering during its life an inelastic impact resulting in a radiationless transition approaches certainty." It appears to me that the behaviour of the mercury line λ2270 described in the paper referred to above is of the nature of a crucial experimental confirmation of Bowen's brilliant suggestion.

B. VENKATESACHAR.

Physics Department,
Central College,
Bangalore, India, Jan. 26.

The Constituents of Low Temperature Tar.

IN NATURE of Dec. 4, 1926, p. 805, which has only recently come to my knowledge, I find a notice by Messrs. G. T. Morgan and D. D. Pratt which interests me greatly, because it contains a confirmation of an observation which I made and published some years ago (*Berichte der Deutschen Chemischen Gesellschaft*, **39**, 1238; 1906). It concerns the occurrence of β-methylanthracene in low temperature tars from certain coals. I have already demonstrated this for

three poor ('magere') coals, that is, geologically old Westphalian coals, with a coke content of 82 per cent.—at the same time the yellow hydrocarbon, crackene, was isolated—and it may well be supposed that the coal employed by Messrs. Morgan and Pratt displays a similar character. That β-methylanthracene is indeed concerned, I have already proved in a similar manner to Morgan and Pratt by the oxidation product of the hydrocarbon. More recently I have arrived at this proof by another way (*Berichte der Deutschen Chemischen Gesellschaft*, **59**, 2812; 1926),[1] which, however, leads to the same result, namely, the preparation of a double compound of the hydrocarbon with β-dinitroanthraquinone (Fritzsche's Reagent).

E. BÖRNSTEIN.

Berlin-Charlottenburg.

BY the courtesy of the Editor of NATURE we have seen the foregoing letter from Prof. Börnstein, in which he states that our letter to NATURE of Dec. 4, 1926, confirms an earlier observation of his as to the presence of β-methylanthracene in low temperature tars from certain Westphalian coals (*Berichte der Deutschen Chemischen Gesellshaft*, **39**, 1238; 1906). In a later communication (*ibid.*, **59**, 2812; 1926) Börnstein, Schliewiensky, and Szczesny-Heyl had expressed a contrary opinion, but Prof. Börnstein's footnote now indicates that this discrepancy was due to a typographical error. With this correction his two observations are now in agreement with ours.

We would take this opportunity of stating that investigations on the aromatic hydrocarbons of low temperature tar are still in progress in this laboratory. Other anthracene derivatives have been isolated in considerable quantities, together with complex hydrocarbons including the so-called 'crackene.' Further details of these researches will be published in the near future.

G. T. MORGAN.
D. D. PRATT.

Chemical Research Laboratory,
Teddington, Middlesex.

Activation of Hydrogen by Electric Discharge.

IN Dr. Elliott's absence, en route to Australia, I venture to indicate certain difficulties inherent in the hypothesis proposed by Mr. G. Glockler in NATURE of Jan. 21 for the mechanism of the formation of hydrogen sulphide in experiments on active hydrogen produced in an ozoniser discharge. At a constant alternating potential applied to the ozoniser electrodes, and at a constant gas pressure, it is clear that, as the velocity of gas flow is increased, the number of electrons per litre of hydrogen available for adsorption on the sulphur is increased since the interval in which recombination can take place is diminished. Dr. Elliott's experiments show that under such conditions the amount of hydrogen sulphide formed per litre of hydrogen decreases as the velocity of gas flow is increased.

It is to be anticipated that the passage of the gas through glass wool would greatly diminish any residual ionisation, due to surface adsorption and recombination. The rate of formation of hydrogen sulphide remains, however, unchanged when the glass wool is removed. ("Action of the Corona Discharge on Gases", G. A. Elliott, Thesis, University of London, 1927.) If a stray field capable of sustaining ionisation had existed in the neighbourhood of the sulphur, any reaction due to electrons adsorbed on the sulphur would also increase with increasing gas flow, since a greater mass of ionised gas would then come in contact with the sulphur in unit time.

At the lowest pressures investigated the luminous discharge did extend to the sulphur; the intensity of this stray glow could be greatly increased by attaching an earthed wire to the tubing below the sulphur. No change in the amount of hydrogen sulphide formed was obtained by this procedure: it appears that the hydrogen capable of reacting with sulphur is produced in the principal discharge in the ozoniser only. The suggestion that the formation of hydrogen sulphide results from encounters between simple positive hydrogen ions (H_2^+, H^+) and negatively charged sulphur cannot, therefore, be accepted.

R. WINSTANLEY LUNT.

University College,
London, W.C.1,
Feb. 10.

[1] In this communication to the *Berichte* the symbols α and β should be interchanged.

Movements of the Lower Jaw of Cattle during Mastication.

STIMULATED by the interesting communication of Dr. Jordan and Mr. Kronig (NATURE, Dec. 3, 1927) concerning the direction of rotation of the jaws of cows in North Sjælland during mastication, we have ourselves carried out similar investigations. We have made the interesting observation that the direction of rotation is the same whether the cow be taking in food through the mouth or ruminating. If according to the convention of the above-mentioned authors we choose as the positive direction that of the food, it follows that one and the same cow must be classed sometimes as right-handed and at others as left-handed. If we may assume that the processes of taking in food by the mouth and of rumination alternate, then it follows that the cases of right-handed and left-handed mastication must of necessity be equal in number. The fact that the former investigators did not find a ratio of exactly one to one is then presumably due to their not having made equal numbers of observations on the two different phenomena.

HANS RIEHM.
E. A. GUGGENHEIM.

The Royal Veterinary and
Agricultural College,
Copenhagen, Feb. 7.

The Spark Spectrum of Neon.

BY the use of a vacuum spectrograph, in which the spectrum was excited by electron impacts at controlled voltages between a Wehnelt cathode and a wire grid anode, we have discovered a new series of lines of considerably shorter wave-length than any hitherto reported for neon. There are 15 of these lines between wave-lengths 462·38 and 353·01. They show the wave number difference 782 expected of the neon spark spectrum, and have in fact led to an almost complete analysis of the spark spectrum, in which 203 lines have been classified in 59 multiplets. From this analysis the ionisation potential of the neon ion is found to be 40·9 ± 0·05 volts.

H. N. RUSSELL.
K. T. COMPTON.
J. C. BOYCE.

Palmer Physical Laboratory,
Princeton University,
Feb. 9.

Marcello Malpighi.

(1628–1694.)

THE three-hundredth anniversary of the birth of Marcello Malpighi, the Italian whom Sir Michael Foster designated "anatomist, physiologist, botanist, pathologist, biologist, and above all natural philosopher," occurs on Mar. 10.

Born at Crevalcore, a village near Bologna, Malpighi was one of the sons of a small farmer. Proceeding to the University of Bologna, he engaged in medical studies, graduating there in 1653, after four years' work, with a doctor's degree. Three years later he transferred to the University of Pisa, taking up the professorship of medicine; here he formed a friendship with Borelli, the mathematician, who encouraged him to pursue researches in anatomy. In 1662, Malpighi removed to Messina to occupy the chair of medicine, remaining there four years. Always subject to insecure health, a request to return to Bologna was willingly obeyed, and there Malpighi spent twenty-five years, fruitful in results. Summoned to Rome in 1691 as first physician to Pope Innocent XII., he died in that city three years later whilst holding office. Such is the summary of his ordinary life avocations.

In reality, however, we must extend these boundaries and regard Malpighi as a philosophic naturalist, a pioneer investigator, and a founder of microscopic anatomy. He had constant resort to the microscope, observing with its aid the passage of blood cells from arteries to veins. He made discoveries relating to the structure of the kidneys and spleen. He also investigated vegetable structure. If not endowed with a subtle instinct—it has been said that his physiology was necessarily of the unspecialised kind—he was yet competent to make general conclusions, fully endorsed afterwards.

We may appropriately allude here to Malpighi's connexion with the Royal Society of London in its earliest days, and with contemporaries such as Boyle, Hooke, Oldenburg, and Grew. Oldenburg, ever anxious to foster relations with foreign investigators, was doubtless first in the field to invite correspondence from Bologna. It seems to have begun in 1667. In the following year Malpighi wrote to Gresham College, sending a book, and expressing readiness to communicate "philosophical matters." A bond was henceforth established with the Society which almost obliterated nationality, actuated as it was by a true spirit of fraternity.

At this time, moreover, there was much Italian sympathy for science, of the kind, that is, that existed. It is recorded that at the very next meeting after Malpighi's letter was received, two Italian gentlemen were present, introduced by Count Ubaldino. They acquainted the Society of the singular respect which the Cardinal Leopold de Medicis had for them, and that he desired to have his excuse made for not having himself returned his acknowledgments for the History of the Society sent to him, which he had been hindered from doing by his lately acquired dignity of Cardinal; but that since that time he had desired and already obtained the Pope's permission to correspond with the Society, of which he now intended to make use to let them see the esteem which he had of them and their institution. Whereupon the president thanked these gentlemen for acquainting the Society with so favourable an inclination of his Eminence to them, and that they would study to entertain so noble and promising a correspondence with all reciprocal services that might be acceptable to his Eminence.

At a meeting of the Society held on Feb. 18, 1668/9, "Mr. Oldenburg brought in a packet sent to him by Signor Malpighi containing a manuscript history of the silk-worm, its whole life, and the anatomy of all the parts thereof, consisting of twelve folio sheets with as many microscopic draughts in folio. It was ordered that the hearty thanks of the Society be returned to the author by a letter to be drawn up by Mr. Oldenburg; and that he and Mr. Hooke be desired to peruse those papers, and to make a report thereof . . . and that the consideration of publishing them be referred to the council." As is well known, the decision was taken to print the treatise, "De Bombyce," and Lord Brouncker, the president, communicated the order to Malpighi. Hooke had found it "very curious and elaborate, *well worth printing*."

On Mar. 4, 1668/9, Marcello Malpighi was proposed by Oldenburg as an honorary member, and elected *nemine contradicente*. Oldenburg was directed to draw up a special diploma. It is scarcely necessary to say—the fact is generally known—that Malpighi never attended any meeting at Gresham College, and hence the Charter Book does not bear his signature.

A letter to Oldenburg, presented on Mar. 23, 1670/1, contained "several curious remarks on the communication between the bronchiæ and lungs in frogs, lizards, and tortoises." On Dec. 7, 1671, a manuscript was produced, sent by Malpighi, containing an abstract of his observations and considerations of the structure of plants. It was ordered that he be solemnly thanked "for his singular regard for the Society and his great care of improving natural knowledge: as also that it be signified to him that Dr. Grew had made the like attempt in his 'Anatomy of Vegetables,' lately published in English; and that the Society would be very glad to see Signor Malpighi's labours on that subject brought to that perfection which was intended by him." In the spring of 1680 the Society sent to Bologna some small microscope glasses (by Mellin) as a present. Later on, Hooke announced the welcome gift from Malpighi of his portrait "very well painted, as big as the life." A letter full of tribulation was received from him in 1684 mentioning the burning of his house, whereby he had lost all his *adversaria* and microscopes.

Malpighi's autobiography, and collections of many important contributions to the anatomy of plants and discoveries in physiology, were published in London in 1696, under the auspices of the Royal Society. In 1897, Malpighi's native town, Crevalcore, marked the bicentenary of his death (1894) by a festival of homage, when a bronze statue of the philosopher, erected in the market place, was unveiled. A memorial volume was issued afterwards, containing appreciations by Virchow, Weiss, Haeckel, Kölliker, and others.

This brief notice, written for remembrance' sake, may fitly close, as it began, with words written long ago in this journal by Sir Michael Foster—"To look across two centuries at a great man, struggling with the beginnings of problems which have since come down to us, some in part solved, but others with their solutions put still further off by the very increase of knowledge, is a useful lesson to every one of us. In any case the great men who in the past opened up for us paths of inquiry . . . ought not to remain mere names known to us chiefly through being attached to some structure or to some piece of apparatus. We ought all of us to be able to form some idea of what they were and what they thought." T. E. JAMES.

Geophysical Prospecting.

By Prof. A. S. EVE, F.R.S., McGill University, Montreal.

"Here we are on Tom Tiddler's ground
Picking up gold and silver."
—*Song of an Old Game.*

AN eminent geologist has said that "the best way to find out what is under the ground is to bore a hole in it." Truly the diamond drill is the miner's best friend in exploration, presenting samples of successive layers for him to worry over with the geologist; but drilling is an expensive game and the world is wide, so that some guidance is necessary as to where to bore the next hole.

Until quite recently the chief aids to exploration were (1) the divining rod, known in the U.S.A. as the 'doodle bug,' not now used by any mining engineer of repute; (2) magnetic surveys, whereby can be found magnetic ores, such as magnetite or pyrrhotite, but ineffective for non-magnetic ores such as pyrites; and (3) the intelligent applications of geological principles.

To-day, however, there is much more assistance available, new in type, and varied in character. Just as invisible and submerged submarine boats may be detected from the surface of the sea by some physical dissimilarity between the boat and its surrounding medium of sea water, so also ore bodies of fair magnitude can be detected by the wise appreciation of some inherent property different in the ore from the surrounding medium of rocks. Oil has not yet been detected by direct methods; the search has been rather for folds below the ground or for salt domes, where the oil tends to collect in paying quantities.

Now the chief methods of ore hunting, which is a good sport, are these: (1) Electrochemical detection; (2) electrical, tracing the equipotential lines between earthed conductors using direct or alternating current; (3) magnetic methods, as heretofore; (4) electromagnetic detection with direction-finding coils, not unlike direction-finding by ships at sea, only here the ore body must be stimulated by alternating currents flowing in horizontal or vertical loops, using audio or radio frequency. This is the hunt for an electrical echo.

In the search for oil the procedure is usually quite different, and this fact is evidence of the great flexibility of geophysical operations in the field. The chief methods for oil hunting are: (1) Seismic, using an artificial explosion and a seismograph a few miles away to detect the first swift message of the uproar, travelling by a route far down below the earth's surface; (2) gravitational, using that most exquisite and sensitive apparatus, an Eötvös torsion balance; (3) magnetic, where disseminated magnetite makes such search possible; (4) electrical, just as for ore bodies, but on a larger scale. So far, no certain information as to the success of this last method over oil fields is available.

Many of these methods have been already well tested over 'proving grounds' above known ore bodies, so that to some extent their rival merits are

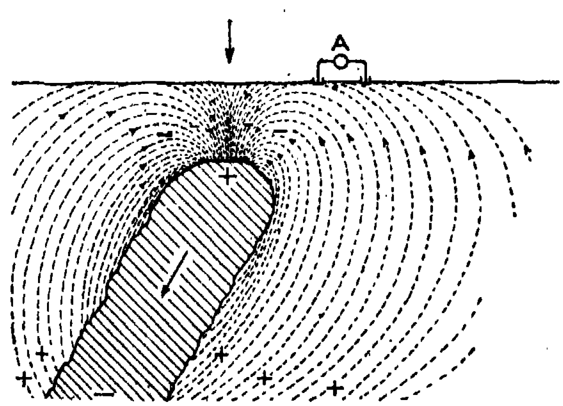

FIG. 1.—Diagram illustrating a sulphide ore body acting as a battery while being oxidised above by rain and surface water. Current lines are dotted and the galvanometer and two detecting electrodes are shown at *A*.

known to the initiated, while on the other hand many mine managers and engineers are puzzled to distinguish between those schemes which rest on a sound scientific basis, and other plans which may be termed psychological, fraudulent or subconscious methods, based on the mystical or unknown, sometimes worthy of study, but with a balanced scepticism.

Sulphide ore bodies are slowly oxidised by surface and rain water, so that the mass acts as a large battery with the negative electrode the higher, so that currents flow towards this upper region from below (Fig. 1). The current can be

readily detected by non-polarisable electrodes placed on the ground and connected by insulated wires to a sensitive galvanometer or portable microammeter. This method was first due to Barus, and it has been extended by Schlumberger, using porous pots containing a saturated solution of copper sulphate and a copper rod as electrode. All sulphide bodies which oxidise, and also

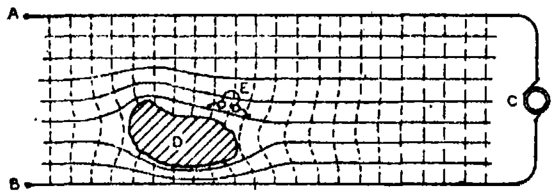

FIG. 2.—Diagram of an alternating current sent from generator C to two long bare copper conductors well connected to the earth. The lines of current flow are normally perpendicular to the conductors, but tend to crowd toward the good-conducting ore body D. E is the telephone (with amplifier) for getting silence points on the equipotentials which spread away from the ore body.

magnetite, may be detected by this simple and direct process. The depth of detection must naturally depend upon the size of the ore, the rate of oxidation, and the conductivity of the ground around and above it.

As to direct electric methods, it is safe to commend the long parallel bare copper wires pegged to the ground to which the current from a dynamo or a few 'B' batteries is led. Detection may be made, with due allowance for the natural or electrochemical currents, by the same electrodes and microammeter as those just described. Lundberg, to whom this parallel conductor scheme is due, uses about 500-cycle alternating current in the parallel conductors, and obtains his equipotentials with the help of iron electrodes thrust into the ground, whence insulated wires lead to a telephone headpiece, with such amplification as may be desirable. Since lines of current-flow converge into good conducting ore bodies, it follows that equipotentials tend to curve away from and around the ore body, both underground and on the earth's surface (Fig. 2). It is naturally impossible to detect by such methods those ores like zinc blende, the conductivity of which is almost identical with that of the surrounding rock. Nor is it possible to declare whether the indication is due to a worthless or to a paying vein.

Instead of two parallel wires, a large loop of well-insulated wire may be laid upon the surface of the earth and an alternating current from a 500-cycle generator passed around the loop. This current will cause an electromotive force and resulting current around the ore body. A coil near the surface of the earth will be stimulated by induction, and again detection can be made by head telephones and amplifier (Fig. 3). Direction, magnitude, and phase of this induced current can all be investigated, and the scientific problem is one of some complexity and great interest. Lundberg and Bieler, for example, use detection methods which are quite different in actuality though apparently the same to a superficial observer. One compares magnitude, the other, balancing phase difference, compares horizontal components with the vertical.

The Radiore Company uses a vertical loop of many turns to which is led alternating current of high or radio frequency (10,000 metres wave-length). The ore body is stimulated by induction rather than by radiation, and the effect is again detected by a loop, tuned to resonance, with amplifier and head telephones. The penetration to some depth into the earth and the emergence from that depth of the excited radiation presents some interesting and important physical problems awaiting further investigation. Dr. Appleton suggested to the writer the possibility of producing repeated maxima and minima in the coil by gradual change of wave-length in the loop, so that a vein or sheet of conducting ore body might have its depth determined by a method quite analogous to that by which he has found the height of the Heaviside layer far over our heads, which renders radio telegraphy or telephony effective by reflection and refraction. The difficulty arises, however, that in ore-prospecting short radio waves must then be used, and such waves do not travel far into the earth.

FIG. 3.—Transit tripod with coil, turning in azimuth or dip, and the telephones. Large horizontal loop with 500-cycle alternating current. Near Caribou Mine, Colorado.

Investigations of these and allied problems over a known ore body or 'proving ground' may well fall within the scope of government-assisted research. Thus, last summer the United States Bureau of Mines had a party working near the Caribou Mine, 10,000 feet up in the Central Rockies in Colorado. This party consisted of Dr. C. A. Heiland, of the School of Mines, Boulder, Colorado; Dr. D. A. Keys, of McGill University; and the present writer. Satisfactory and concordant results

were obtained with magnetic and diverse electrical methods, and a new scheme was also evolved which was quite effective in the dry region of the Rockies, but disappointing amid swampy districts when tested in Northern Quebec. Indeed methods must be varied to suit local conditions, and all eggs in one basket is a poor policy. The reports of this expedition will be published this year by the Bureau of Mines, Washington, following a

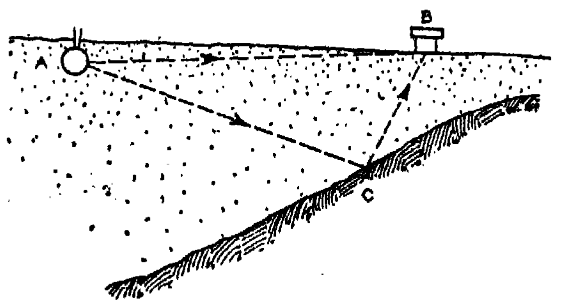

FIG. 4.—Diagram showing small charge at A sending out waves which are reflected upward from a fault or discontinuity at C and pass to B, so that the route by way of the fault (ACB) may be quicker than direct route AB, because speed increases with elasticity and therefore with depth. All the lines should be drawn slightly curved, concave upward.

brief summary, already published, of the elementary principles involved (Technical Paper 420).

Extensive experiments both in the laboratory and in the field have been made during the last four years by Dr. Max Mason, president of the University of Chicago. His interesting address to the Mining and Metallurgical Engineers of America has been printed, and can be obtained from the Physical Exploration Corporation, 111 Broadway, New York City. This is a valuable report which indicates the scope and possibilities of geophysical methods.

Let us revert to oil hunting. The sound work done in south-west Persia with the Eötvös torsion balance has been set forth clearly in Appendix 12 of the "Summary of Progress of the Geological Survey of Great Britain for 1926" (London: H.M. Stationery Office). In Texas and Mexico, although abundant work has been carried out by the great oil companies of America, yet all this information, whether obtained by gravitational or seismic methods, at great cost to these companies, is retained as confidential, and they do not publish the methods employed or the results obtained.

The Eötvös balance consists of two small heavy gold balls at the ends of a light aluminium bar suspended by a platino-iridium wire. If the balls were at the same level and if the earth were a uniform sphere at rest, the arrangement would be astatic. Actually, however, such a torsion balance, truly of the Henry Cavendish type, tends to set itself along the direction of maximum or minimum curvature of the irregular level or equipotential surface at the place under investigation, and we can find $g(1/R_1 - 1/R_2)$, the horizontal direction tendency (H.D.T.) in magnitude and direction. R_1 and R_2 are the minimum and maximum radii of curvature of the 'level' surface. The torque tends to set the beam along the ridge of an anticline and across the valley of a syncline. Eötvös, however, hung one ball about sixty centimetres below the other and thus determined also the direction and magnitude of the gradient of gravitation, which is the change of numerical value of g per horizontal unit distance. The vertical gradient of gravity does not here concern us at all. The theory of the torsion balance is often obscured by double partial differentials which alarm the unaccustomed reader, whereas the problem is one of ordinary statics with a slight admixture of dynamics and three-dimensional analytical geometry. The truly alarming feature of the work is the correction for altitude and latitude and for terrain and topographical features. In many cases, however, comparative values of the H.D.T. and of the horizontal gradient of gravity are all that are required for the determination of some local problems in geology or mining.

In seismic work, small charges of high explosives are used to obtain reflection of the shock from faults or discontinuous strata. In these cases the time to the seismograph by the direct route is comparable to the time by the reflected route, and the record is therefore hard to interpret (Fig. 4). It will be noted that this plan resembles quite closely the methods now available of determining the depth of the ocean by echo methods. Much larger scale work is used in the Gulf region. There large charges of 150 lb. of T.N.T. are exploded and timed by radio signal. The velocity of the shock is governed by the elasticity and by the density of the medium. Density varies but little with depth, but the elasticity increases with

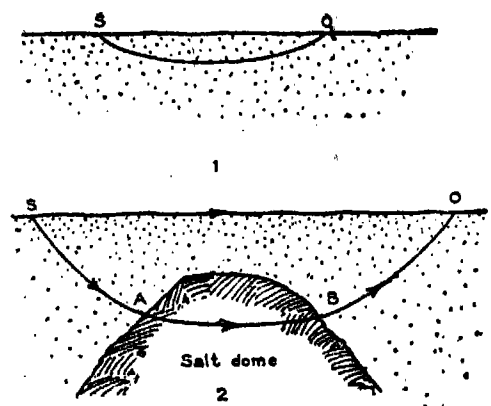

FIG. 5.—Diagram showing (1) that the quickest path from an explosion at S to an observer at O is a curved one, SO (diagram 1), through the earth, because elasticity increases with depth; and (2) that S and O are farthest apart and the quickest route $SABO$ (diagram 2) is by way of the salt dome beneath, which can be thus detected because of the high velocity of the waves in the salt dome.

the pressure, and the pressure with the depth, perhaps in a linear relation. Hence the first shock signal which travels a few miles and reaches the recording seismograph is that compressional wave which has passed deep down a few thousand feet into the earth and emerged after its curved and concave path (Fig. 5). If a salt dome intervenes, there is yet higher speed, and by numerous shocks and measurements the size and shape of the salt dome may be determined, the site purchased,

and the hunt for oil, now aided by torsion balance work, pursued. If success follows, there is avoided that scramble for the oil field which has so often in the past involved loss due to hasty and wasteful boring and pumping, and violent fluctuations in supply and cost.

To sum up: geophysical methods wisely used can be helpful and profitable. If the possibilities are over-stated or improper claims made, there will be a lack of confidence retarding that advancement which careful development should achieve.

News and Views.

The discovery in the United States in 1922 by T. Midgley that lead tetra ethyl has a remarkable action in delaying detonation or 'knocking' in the internal combustion engine when added to petrol in minute amounts, has brought this organo-metallic derivative from the obscurity in which it had remained since it was first prepared and described in Great Britain by Buckton nearly seventy years ago (*Phil. Trans.*, **149**, 431) to be an important article of commerce. It is an oily colourless liquid, density 1·66; of boiling point above 200° C., with decomposition. It possesses toxic properties which are specific in character and differ from ordinary lead poisoning in that the first symptoms are insomnia and fall in blood pressure. The oil is slightly volatile and can be absorbed through the skin. Attention has been directed recently by eminent chemists to these poison dangers which might occur with the indiscriminate use of petrol containing small amounts of lead tetra ethyl, and on Feb. 29 in the House of Lords it was announced that an Interdepartmental Committee is to be appointed forthwith consisting of representatives of the Ministry of Health, the Home Office, and the Medical Research Council, to investigate the poison hazard associated with the sale of ethyl petrol in Great Britain.

In 1924, at an experimental plant in New Jersey, where the manufacture of pure lead tetra ethyl was being carried out, a number of serious poison cases occurred, and the newspaper publicity which followed led to a voluntary suspension of the sale of ethyl petrol in the United States until the poison hazard had been investigated by the Surgeon-General of the U.S. Public Health Service. It was recognised that the manufacture and handling of lead tetra ethyl is attended with danger if not done with proper precautions, but the debatable points were the hazards to retail distributers, garage employees, and the individual users of ethyl petrol in which the lead compound is diluted by about one part in 1300. After elaborate and careful investigations, it was concluded by the Surgeon-General that no poison hazard could be traced to the use of ethyl petrol, and the manufacture of lead tetra ethyl was resumed on June 1, 1926. Researches in the direction of finding other substances of a non-poisonous character and equally as efficacious as lead tetra ethyl, have up to the present been without success, although iron carbonyl is used to some extent in Germany, so that unless a grave and well-established hazard exists, the abandonment of the use of lead tetra ethyl does not appear to be justified.

It is, perhaps, little appreciated in Great Britain that the present low price of sugar has placed British Colonies which supply us with this commodity in a distinctly precarious position; and it is not generally recognised how vital a matter Imperial preference is to some of the British West Indies, Mauritius, Demerara, and Fiji. There are two main factors concerned, one economic and one scientific; and the latter is the general low level of research work in our cane plantations. The almost universal aim in progressive cane-sugar countries is to induce the plant to produce more tons of sugar to the acre; for this purpose men versed in scientific methods have been enlisted. It must be confessed, however, that the British Colonies are very much behindhand in this respect. A short article in the current issue of the *International Sugar Journal*, under the heading "Scientific Work in the Plantations," deals with this matter, using as a text the action of the Oahu Plantation Company in the Hawaiian Islands, when faced with the serious situation caused by the trade slump following the boom year of 1920. In January 1921 this company founded a "Department of Agricultural Research and Control," and the results thus far obtained by its scientific officers on one single programme of work, namely, the proper feeding of the cane with artificials, are briefly summarised. Astonishing success has attended the application of scientific research to the fields for this purpose; and it is claimed that if in the factory a piece of machinery were invented giving equal financial results, it could be capitalised at one million dollars. So it would seem that such an investment in research is a paying proposition.

The quarterly report of the Empire Cotton Growing Corporation, issued on Feb. 9, clearly indicates the extent to which this body is involved in the present serious crisis in the Lancashire cotton industry. The purpose of the Corporation was described and discussed in our issue of Nov. 5, p. 645. Briefly, its income is, in the main, obtained from a levy of 6*d.* per bale of cotton entering England; and its aim is to enable British buyers to control this raw material, by increasing the amount grown within the Empire. The Act legalising the levy expires in July next, and representative bodies have been sounded as to the attitude likely to be taken up by the trade when the question comes before Parliament during the present session. The result of this inquiry appears to be that, while fully appreciating the work that the Corporation has been able to accomplish, it is unlikely that the spinners will agree to the continuance of the levy, at any rate at the present figure.

The position of the cotton industry has, indeed, become so precarious that drastic retrenchment in every possible direction has become a vital necessity.

and, as is so often the case, the reduction of research is considered a possible economy. The only hope is that the industry will consent to a reduced levy. If this is denied, the Corporation may have to close down—a contingency not only adverse to Lancashire, but also to most of the cotton growing dependencies of Great Britain. Lord Derby, in presenting the report of the executive committee, directed attention to some of the progress which has recently been made, and issued a powerful appeal to the Lancashire cotton trade to support the fresh Bill about to be introduced. The work of the Corporation is both economic and scientific; and one instance of marked scientific success is the result of plant-breeding work, which has cleared away the main hindrance to cotton growing in the important cotton tract of the Union of South Africa.

THE committee appointed on Jan. 16 by the conference of Thames riverside authorities in connexion with the floods in the London area of Jan. 6–7, presented on Feb 29 a unanimous and authoritative report. A technical sub-committee, which examined the hydrographic, meteorological, and hydraulic questions involved, reported that on the information at present available, more could not be said in explanation of the tide of Jan. 6–7 than that it was due to a combination of a spring tide, not in itself exceptionable, the raising of the water in the estuary by the meteorological conditions of the North Sea, and by flood waters from the upper Thames. On the question of future probabilities, it was reported that the whole subject of tides in the Thames requires further expert investigation, and it is recommended that this investigation should be undertaken by the Tidal Institute of the University of Liverpool, in co-operation with the Hydrographic Department of the Admiralty and the Meteorological Office. A scheme of warnings of the possibility of storm-floods was drawn up and recommended by the committee, subject to any improvements which the report of the special investigation on tides may suggest. The main points of this scheme are the following: (1) Public announcement to be made by the Meteorological Office, after consultation with the Port of London Authority, should climatic and tidal conditions be such that exceptionally high tides may be expected. This is an initial precaution. (2) Special watch to be kept at Southend, and, should the tide reach a specified high point, warning to be given to the appropriate authorities. (3) Watch then to be kept at selected points, and public warning to be given in the locality if the water reaches danger level, the London County Council to specify the danger level at each point and the locality to be warned.

MUCH interesting historical information on exceptional high waters in the Thames is set out in the Committee's report, and it is concluded that on the basis of records alone, there was no reason to expect a tide of the magnitude of that of Jan. 6–7. So exceptional was this recent storm-flood that its high water was eleven inches above the highest previously recorded, namely, that of Jan. 18, 1881. The Committee shows that whereas during the last thirty years the yearly average height of high waters at Crossness, on the seawards border of London, has remained steady, the corresponding average at Hammersmith has shown a small but continuous upward trend. The phenomenon at Hammersmith is probably to be attributed to the dredging and other changes which have been made in the bed and sides of the river, but the Committee quite properly points out that what is important for flood-works is not average high-water levels, but what may be expected in the way of exceptionally high tides.

LITTLE progress appears to have been made as yet in the discovery of principles which will enable storm-floods to be forecast from a knowledge of meteorological conditions. From noon until midnight on Jan. 6, there was a north-westerly gale over the North Sea and a westerly gale over the English Channel. On the other hand, the flood of Jan. 18, 1881, was preceded by a south-easterly gale which changed to easterly and then to north-easterly. The floods which occurred on the eastern shores of the North Sea in January 1916 have been studied by L. Grossmann, of the Deutsche Seewarte, and by D. la Cour, of the Danske Meteorologiske Institut. Those which occurred on the coast of Flanders during the German occupancy have been studied by Bruno Schulz, of the Deutsche Seewarte. More progress has been made in correlating with meteorological conditions those much smaller but fairly steady changes in sea-level which are almost invariably present in addition to the regular tides. In recent years important contributions to this subject have been made by R. Witting of the Helsinfors Havsforskningsinstitut for the Baltic and by A. T. Doodson of the Liverpool Tidal Institute for British waters. It has been shown by the latter that it is possible at present to forecast about half of these non-storm effects, providing that one is supplied with a substantially accurate forecast of the distribution of atmospheric pressure.

HALF a century has been spent by the Institute of Chemistry of Great Britain and Ireland in increasingly effective service to the community as well as to the profession, and the intention of its members to continue vigorously in the same service is apparent. At the fiftieth annual general meeting, held on Mar. 1, in the unavoidable absence of the president, Prof. A. Smithells, Mr. E. R. Bolton, vice-president, read the presidential address, in which the importance of the continued loyal co-operation of all the members in this direction was emphasised. The membership has increased during the past year by 202, the roll of fellows and associates now totalling 5388. The associateship is a recognition not only of competence but also of personal acceptability; adherence to the code of professional ethics, moreover, is a sign of a definite orientation towards the highest ideals of the professional man. The determination to keep Great Britain in a leading position in chemical industry, evident in recent developments among our greatest

manufacturing concerns, has created an unprecedented stir in centres of chemical education; the address referred to the desirability of convening a conference to consider generally the education of the chemist. It has been a function of the Institute to make representations to public authorities whenever it has appeared that there was inadequate understanding of the aims of, or of the responsibility involved in, the work carried out by professional chemists, and to protest when mean conditions of service have been offered. The existence of local sections of the Institute in the principal centres throughout the country has enriched the corporate life of the profession. Prof. A. Smithells was re-elected president for the new session.

BENJAMIN LEIGH SMITH, Arctic explorer, was born on Mar. 12, 1828, and the centenary of his birth deserves recognition for his disinterested and courageous efforts to add to Arctic geography. He graduated at Jesus College, Cambridge, attaining a high place in the Mathematical Tripos. Proceeding to the bar, he was 'called' at the Inner Temple in 1856. He lived a long span, dying in 1913, aged eighty-five years. Leigh Smith made in all five voyages to the Arctic regions. The first, carried through in 1871, in the *Samson*, was directed to exploration north-east of Spitsbergen. Two further voyages were similarly devoted to the Spitsbergen zone. In these he combined the attainments of a scientific observer with the skill of an experienced navigator, whilst both were coupled with that sense of enthusiasm which is indispensable to the pioneer. In the winter of 1880. Leigh Smith built a steam vessel at Peterhead—the *Eira*—of 360 tons burden, and 123 feet long by 25 feet beam. She had a complement of twenty-five, and was intended for a summer cruise in the vicinity of Franz-Josef Land. Much was accomplished before disaster overtook the expedition. The *Eira* was crushed in the ice on Aug. 31, 1881, and sank. The crew built a hut of turf and stones and wintered, along with their leader, living for the most part on walrus and bears. In June following they left in boats, reaching Novaya Zemlya, where relief was available. At the anniversary meeting of the Royal Geographical Society in 1881, the Patron's Gold Medal was awarded to Leigh Smith on the grounds (announced by Mr. C. R. Markham) that he had made important discoveries along the south coast of Franz-Josef Land, establishing new starting points for polar research; and for previous geographical work in the Arctic regions, all of which had been carried out entirely at his own expense and were personally directed. There is a portrait of Smith in the National Portrait Gallery, by Stephen Pearce.

AN interesting glimpse of primitive Europe still surviving is afforded by the story of the career and death of Samuele Stocchino, quoted from the *Corriere della Sera* by the *Times* on Feb. 27. Stocchino was the terror of Nuoro, the wildest province of Sardinia, and is known to have killed eleven men in vendetta besides having committed many minor outrages. He was thirty-two years of age, and the son of a brigand who was sentenced to twenty years' penal servitude. Stocchino behaved with conspicuous bravery during the War, but at its termination took to the mountains to carry on his vendettas. He has now been shot by the carabinieri after a hunt lasting for eight years. He was finally caught in an ambush, and for some time his body lay where it fell beneath a tree. His relations, belonging to eleven families, all dressed in black, filed past it in procession, each touching the left foot of the body in passing, it being the popular belief that by so doing the doom overhanging the family was averted. Pieces of the brigand's clothes were distributed to serve as amulets. Finally, the population of Nuoro sprinkled salt and dry olives on the threshold of the 'cursed' house where the brigand was born as a propitiatory rite. The use of salt as a protection against evil influences is interesting. It will perhaps be remembered that in a matrimonial case heard a year or so ago in Devonshire, one of the grounds of complaint by the husband was that his wife, believing him to have bewitched their child, always sprinkled salt around his chair.

MR. A. J. B. WACE communicates to the *Times* of Feb. 27 an account by Prof. Persson of the excavations of the Swedish Expedition in Greece at Dendra, at the foot of the Mycenæan citadel of Midea, in Argolis. A cemetery of important rock-cut chamber tombs has been excavated, two of them being found to contain funerary offerings such as are usual in better-class tombs of this type and dating from the latter end of the fourteenth century B.C. A third tomb was of unusual size and was immediately apparent to be out of the common. The entrance passage, hewn out of the rock, is 60 ft. long and 6 ft. wide. On its floor, which lies 17 ft. below the surface, was a mass of stones from the wall barring access to the door, and under this lay a female skeleton, accompanied by a long bronze pin, spindle whorl, and ornaments in glass paste once masked with gold leaf, which had been left by plunderers of Mycenæan times. In the chamber under two great stone slabs was found a collection of thirty-three bronzes packed one within the other, and brilliantly patinated in green, blue, and brown. These included six large jugs, seven bowls, four tripods, five lamps, a six-pronged fish-spear, a sword, two knives, and two razors. Several are decorated with delicately engraved flowers or shell-fish, others with geometrical patterns. Many of the objects retain their wooden handles.

THIS find is one of the richest of early bronzes yet made in Greece. It has been possible to fit together some of the many fragments of limestone on the floor. They have proved to be a sacrificial stone, and further apparatus of sacrifice, of which other evidence appears in traces of smoke on the walls and a quantity of charcoal. On the floor was a bronze sword with a hilt ornamented with glass beads in hundreds, boars' tusks cut and pierced to sew on a leather helmet, an iron stud from a sword hilt, and hundreds of small

(*Continued on p.* 393.)

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Reviews.

Science and History.

Classics of Modern Science (Copernicus to Pasteur). Edited by Prof. William S. Knickerbocker. Pp. xiv + 384. (New York and London: Alfred A. Knopf, 1927.) 18*s*. net.

THERE is a great problem facing the study and the teaching of history throughout the civilised world. On one hand, it is more and more of a commonplace that we must study history, and that the historical way of looking at things is essential to right action. On the other, there remains the greatest divergence as to what sort of history should be studied. Nay, more; on the subject suggested by this book there is not so much divergence as an almost complete severance and ignoring of one side by the other in the discussion. The editor begins by quoting Du Bois Reymond to the effect that "the history of science is the real history of mankind." He cordially accepts that statement, and adds that the sooner we realise it on a grand scale, the more we shall hasten the happiness of mankind. Now, what Du Bois Reymond held was that the real history of mankind is simply ignored by all those who are generally recognised as 'historians.' It is not that they criticise or oppose it 'in its place,' but they say that it is not their business; it is not what they mean by history.

This is the extraordinary position, and as it is impossible to believe that such a misunderstanding or divorce between two connected aspects of human thought can be permanent, one welcomes any modest and practicable attempt to make a bridge. This book is distinctly of the bridge-building kind. It is compiled by a professor of English in the University of the South, U.S.A. It consists of typical extracts chosen from the writings of thirty-six men of science from Copernicus onwards, and the preface ends by commending science as one of other efforts towards "bettering man's estate." The author holds that for English courses, where emphasis is laid on ideas as inspiration in writing, men of science, being necessarily clear thinkers, have provided excellent illustrations of straightforward and coherent writing.

From this point of view, the book, so far as we know, is unique in English, and deserves special attention as a fresh approach to the problem from which we started. There are two other methods now in progress for bridging the gulf, and it may be interesting to put them side by side with this. One is that going on within the ranks of men of science themselves, which found expression a few years back in a resolution, and a committee appointed by the British Association, aiming at including some teaching of the history of science in the last two years of the science course at school. The book, compiled by Mr. Whetham and his daughter, called "Cambridge Readings in the Literature of Science," and published by the Cambridge University Press, would be useful material for students of that kind rather than for the English courses which Prof. Knickerbocker has in mind. The Cambridge book traces the development of definite subjects; the structure of the universe, the nature of matter, and the development of life are the topics chosen as being of transcending importance. This plan involves much more detailed and technical matter than would be suitable for general reading, and the book thus becomes clearly one for those pupils who make natural science their principal study. It does not help us directly to solve the problem of the bifurcation in history.

A third method remains, which is happily gaining ground among the writers of history text-books. This is to introduce, at the most telling points in the ordinary political narrative, some account of the contemporary development of thought, especially in the sphere of scientific discovery. It was, in fact, an anomaly too flagrant to be defended, to teach Greek history without Pythagoras or Archimedes, the Renaissance without Leonardo or Galileo, the modern world without Newton or Darwin. If once a few such *points de repère* can be secured, the battle is more than half won. Interest once aroused, and the right of place granted, it is inevitable that inquiry spreads and teachers and taught alike begin to ask what led up to the achievements of these great men, and how has their

work affected later thought, and, more especially, the evolution of society.

The last point is capital, and the orthodox historians are perfectly right in asserting that social structure is the proper subject of history. They are wrong in ignoring the part which science has played in forming it. We, on the side of science, shall fail if we do not make clear the growingly preponderant rôle which science has played in that direction. Specialism on both sides has proved the most serious obstacle to a better mutual understanding. The political historian is more and more absorbed in the overwhelming mass of his documents, and is apt to think that the attempt to set up such connexions as we have here in mind is illegitimate or at the best premature. . . . It is all so complicated and obscure; we do not know enough to 'generalise.'

What, however, we do know unquestionably, is the steady and triumphant progress of science, or organised thought, and it is a very proper subject of inquiry to consider the effects of this on the life we live as political and social beings. On the other hand, the scientist has his own special line of research, increasingly narrow as a rule, and is content to leave social reactions to 'historians' proper.

Hence the fatal gap which must be bridged, if science as a social and intellectual force, and history as a synthetic record of man's evolution, is ever to be realised. It will be clear from the examples given that the goal must be slowly and variously approached. But in the pioneer stage of any undertaking a special welcome is due to those who have the same vision of the goal, who wish to follow the same path as ourselves and actually begin to blaze a track through the jungle. For that we thank Prof. Knickerbocker, and wish his book success.

F. S. MARVIN.

Watt: the Man and his Engine.

James Watt and the Steam Engine: the Memorial Volume prepared for the Committee of the Watt Centenary Commemoration at Birmingham, 1919. By H. W. Dickinson and Rhys Jenkins. Pp. xvi + 415 + 105 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1927.) 63*s*. net.

JAMES WATT died on Aug. 19, 1819, and to commemorate the centenary of his death energetic steps were taken in Birmingham. It was hoped that sufficient funds might be collected to erect a Watt Memorial Hall in Birmingham, to found a 'Watt Chair' in engineering at the University of Birmingham, and to publish a memorial volume. Commemoration proceedings lasting for several days were successfully held in Birmingham in September, but the sum collected fell far short of the amount aimed at. Finally, it was decided to found a 'James Watt Fellowship' in engineering, and for this purpose a sum of £5000 was handed over to the University of Birmingham. A portion of the remainder was used for this memorial volume, and the balance is in trust until such time that it may be used towards the objects for which it was originally subscribed. Urgent as is the need for a hall and buildings devoted to engineering and kindred sciences in Birmingham, it may be said that the volume under review is probably the fittest memorial to the great engineer.

A life of Watt was, apart from the centenary, long overdue. It is more than sixty years since Dr. Smiles wrote "The Lives of Boulton and Watt" in a popular style, and it was in 1854 that Muirhead published his work on "The Origin and Progress of the Mechanical Inventions of James Watt," dealing largely with letters and patent specifications. These are the only previous comprehensive works on the subject, although there have been numerous smaller popular books and papers dealing with some particular phase or side of the engineer's life.

The Committee was fortunate in obtaining for the memorial volume Mr. H. W. Dickinson and Mr. Rhys Jenkins. It had at hand a very great number of records, letters, and drawings, and the examination and selection of these in itself has been a great task. The three chief sources of information on the subject have been the Boulton papers, now in the Assay Office at Birmingham, the papers relating to Watt belonging to Major J. M. Gibson Watt—the present representative of the family, and kept at his seat at Doldowlod, Radnorshire—and the Boulton and Watt collection in the hands of the City of Birmingham. The numerous footnotes in the volume, and the many reproductions of original drawings, make one realise what a mass of information has fortunately been preserved having a direct bearing on the steady growth of the greatest implement which has helped forward the civilisation of the world. We share with the authors their regret that the volume finishes with the retirement of Watt from active business in 1800, but it is a matter of congratulation that one is now able to follow even so far the progress of the man and of his work.

The book is divided into these two sections, the

first and much smaller one dealing with "Watt the Man," while the much larger portion is devoted to "Watt and the Steam Engine."

The first portion is a very human document, and places before one a vivid picture of Watt in his younger days; and although, as stated, he was shy, modest, and unassuming, yet he was capable of attracting the friendship of men of position in the scientific world much higher than he then occupied. This trait in his character, in spite of the fact that later in life he became apparently less amiable, seems to have remained with him to his great advantage throughout his life. What must be fully appreciated is the fact that Watt was never apparently strong in health, and the arduous work he did in London in 1755–56 probably further weakened him. On his return to Glasgow he was fortunate in the circle to which he was admitted, including as it did so many eminent scientific men, several of whom were to remain his friends for many years. Perhaps it is due to the story of his watching the kettle, but many will be surprised when it is shown that he was twenty-nine years of age before the idea of a separate condenser, rightly said to be the greatest single improvement ever made in the steam engine, came to him. Two years after this he became a land surveyor, about the same time making the acquaintance of Dr. Roebuck, of Carron Works, and the following year meeting Matthew Boulton in Birmingham. It was the help and acquaintance of these two men that supplied what Watt lacked. Perhaps it was the financial difficulties that the former found himself in that even helped matters forward, for Watt and the engine he had built at Kinneil were transferred to Birmingham in 1773–74, and progress from this time was slow, it is true, but steady and ever growing under the guiding hand, encouragement, and advice of Boulton. The progress of the world would probably have been delayed had Watt found remunerative employment as a surveyor, or had he accepted appointments offered him in Russia shortly before this time.

The partnership with Boulton and the twenty-five years' life given to his patent extended from 1775 to 1800, and this period covers the connexion Watt had with the development of his engine and its details. In spite of the strenuous and anxious time he so often had, which his letters so clearly show, he still was able to take interest in other work. It was, in fact, during this time that he brought out the copying press, was interested in bleaching by chlorine, and investigated the composition of water. On the latter the authors' researches have not thrown any additional light.

The help Watt received from Boulton is ever in evidence, and, as the authors point out, Boulton in writing in 1769 to him, said, "I do not intend turning engineer," but his sound practical advice on engineering points was often of the greatest assistance to the inventor, and one can only regret that Watt in 1788 did not give, apparently, the financial assistance Boulton then required and would have liked to have received.

The chapter on Watt's life in retirement is short, but renews the regret one has that the efforts made to purchase for the nation his house at Heathfield were unsuccessful. One cannot, however, but be grateful that the room which was his workshop has been removed in its entirety to the Science Museum, South Kensington, and that it is under the care of one of the authors of this volume.

The second section of the book is of the greatest interest to engineers. It first of all deals in chronological order with the engines built under Watt's patent. Later it is shown that very little of the actual work was done at Soho in early days; it was not until 1795, indeed, that any castings were made at the new foundry. The procedure was for drawings to be made by Watt, and the various parts to be made in different localities, and the whole erected on the final site. Watt produced these drawings during nearly the whole of the time under review at his house at Harper's Hill, less than half a mile from Birmingham Town Hall. A very large number of these plans is reproduced, and with the copies of original drawings of details will be studied with interest by all who are attracted by the history of the development of the steam engine.

The developments of the various parts of the engine are dealt with in great detail. These show that although it is said with truth that Watt, after his patent, "made no change in principle, no improvements in the direction of securing increased economy of steam," yet he was ever working on perfecting these details and supplying other improvements of working. These, which are fully dealt with, and of which the construction is shown, include the valve and its gear, parallel motion, the governor, the indicator, etc. It seems somewhat strange that more attention was not given to the efficiency of the boiler, for at first, in Cornwall, where most business was done, payment was at the rate of one-third of the saving made in coal consumption over that used by the old atmospheric engine. If more had been done in this direction,

Watt might have overcome his dislike for greater pressures.

The question of the application of the crank to Watt's engine is considered at some length, and the steps he took in devising methods of producing means of avoiding it for 'rotative' engines is also dealt with comprehensively. It is interesting to note that in the four years after 'Pickard's' patent had run out, in 1792, only six engines with cranks were built by Boulton and Watt, the others being still fitted with the sun and planet motion. Watt was naturally dependent largely on his staff. Murdock, both as a craftsman and inventor, is well known, but interesting notes are included on Southern and others not so well known, and on certain engineers who were engaged in different directions. One would have thought that Rennie would have been included in the former list. The "Directions for erecting and working the newly invented steam engine," issued in 1779, are given in full.

The book is well produced, but its size, which is unavoidable, makes it one for the table rather than for the hand.

The Plague in Shakespeare's Time.

The Plague in Shakespeare's London. By F. P. Wilson. Pp. xii + 228 + 16 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1927.) 12*s.* 6*d.* net.

THIS work aims at narrating in detail the history of the plague in London in the early part of the seventeenth century. It is based on materials supplied by contemporary books and documents. The story opens with a brief account of our modern knowledge of plague, and contrasts this with the many and fantastic views held in Shakespeare's time of the cause and cure of the disease.

Plague has been a powerful stimulus in bringing about social reforms and in developing and shaping our ideas and laws on public health. The great mortality among the humbler classes during the prevalence of the Black Death in 1348–49 compelled and initiated reforms which ultimately led to the emancipation of the working classes. It was the destruction caused by plague which stirred the Government of the day to draw up and enforce orders to stay the disease. A very interesting account of the rise and development of the plague orders from their inception in 1518 is detailed in the second chapter of this book.

Among the permanent officials who were responsible for the control of plague epidemics, the brunt of the work fell upon the constables. They had to report the true number of persons who died of the disease; they had to shut up and mark infected houses and arrest "wandering beggars and idle persons." If they neglected their duties they were severely punished; at the same time they were in great danger of contracting infection. The places of casualties were quickly filled by deputies, since acceptance of the post was compulsory, recalcitrant citizens being brought before the Lord Mayor and duly punished.

When plague became epidemic certain temporary officials were appointed. For example, in 1583 each alderman was required to choose monthly two substantial and discreet citizens to be surveyors in each parish. But in May 1609 and afterwards, examiners were appointed for two months, and those who refused were imprisoned "until they shall conform themselves accordingly." The duties of the examiners were to take care that all orders were duly observed; they had to look for infected houses and to appoint and supervise the warders, searchers, and other minor plague officials.

The sanitation of London in Shakespeare's time was very primitive. It closely resembled that of an eastern city of to-day. The most potent factors in causing the plague were the great overcrowding, and the character of the houses. For example, a proclamation of Sept. 16, 1603, complained of the crowding of dissolute and idle persons in small and narrow rooms, and ordered all houses infested with multitudes of dwellers to be razed to the ground and not to be rebuilt. All attempts, however, to check the growth of London were in vain, and, far from remedying the evils, led to gross overcrowding and the erection of mean hovels in holes and corners of the city and suburbs.

Another potent cause of the trouble was the foul condition of the streets. The duty of cleansing the streets devolved mainly upon householders, but partly also upon scavengers and rakers. In Shakespeare's time two scavengers were appointed to each parish and held office for a year. Like the constables, they gave their services willingly or unwillingly for nothing. Their office was not menial; they were citizens and householders, men of some importance in the parish, civic dignitaries. They did not clean the streets themselves, but were responsible for the rakers who did. The work does not seem to have been done efficiently, for sensitive persons complained of the dunghills which pestered narrow lanes and alleys. The pudding wives and tripe wives were accustomed to throw into the channels, paunches, guts, and entrails, and also the water in which these were boiled.

Citizens were incredibly careless in disposing of carcasses. In 1578 it was found necessary to forbid them to throw out of doors any dead dogs, cats, whelps, or kitlings. In 1625 carcasses of horses, dogs, and cats lay rotting in Moorfields, Finsbury Fields, and elsewhere about the City. No wonder, then, that the streets of Elizabethan and Jacobean London were thronged with dogs. Many parishes supported a dog-killer of their own. We are quite prepared to accept, therefore, Defoe's estimate that forty thousand dogs were killed during the plague of 1665.

In such circumstances, rats, whether dead or alive, attracted minor attention, even as they do in an eastern city to-day. There were, however, we are told, many ratcatchers in Elizabethan London who, according to Richard Deering's "Madrigal of London Cries," shouted in the streets, "Rats or Mice. Ha' ye any rats, mice, pole cats, or weasles ?" Or "Ha' ye any old sows sick of the measles ? I can kill them, and I can kill moles, and I can kill vermin that creepeth up and creepeth down and peepeth into holes."

The picture of an eastern city to-day is completed when we learn that London was "a City of kites and crows." In these days in England kites and ravens were protected birds, because they were such excellent scavengers. Kites were so bold in London, it is said, that they snatched bread out of the hands of children while they were eating it on the streets.

What a reformation has been effected in our habits since these days. In this process we have expelled from our cities not only the kite, the carrion crow, and the black rat, but also with them the plague, relapsing fever, cholera, dysentery, and other diseases, now often called tropical diseases, but in truth diseases peculiar to a primitive state of social and economic development.

Much might be said about segregation as that measure is revealed in this carefully compiled work, but space forbids this. Nevertheless, a passing reference must be made to the Pest House, an illustration of which is reproduced on p. 82. A reprint of a map published in 1682 shows the situation of this building. The site, Mr. Wilson states, is a little north of the existing buildings of the French Protestant Hospital, a few hundred yards up Bath Street on the left-hand side as one walks from Old Street.

Not the least valuable parts of this book are the last chapters, which give a detailed account of the progress of the plague in London from 1603 to 1625. This account is enlivened by sundry references to contemporary history, and is illustrated by excellent reproductions of some of the original Bills of Mortality.

These chapters are followed by notes on a number of matters referred to in the text. Then follows an Appendix divided into two parts. Part I. deals with the Bills of Mortality of the sixteenth and early seventeenth centuries, the machinery which produced them, and an estimate of their trustworthiness. Part II. is concerned with an estimate of the population of London in the early seventeenth century.

Readers will find this book not only interesting but also a valuable work of reference to original documents which have a bearing on the plague in Shakespeare's time. The author and the publishers alike are to be congratulated on the excellence of their work.

Education in Hygiene.

(1) *Healthy Growth : a Study of the Relation between the Mental and Physical Development of Adolescent Boys in a Public Day School.* By Dr. Alfred A. Mumford. (Oxford Medical Publications.) Pp. xxiii + 348. (London : Oxford University Press, 1927.) 16*s*. net.

(2) *Personal Health.* By Prof. Emery R. Hayhurst. Pp. xi + 279. (New York : McGraw-Hill Book Co., Inc. ; London : McGraw-Hill Publishing Co., Ltd., 1927.) 15*s*. net.

(3) *Good Health and Happiness : a New Science of Health.* By J. Ellis Barker. With an Introduction by Sir W. Arbuthnot Lane. Pp. 525. (London : John Murray, 1927.) 7*s*. 6*d*. net.

(4) *Towards Health.* By Prof. J. Arthur Thomson. Pp. viii + 242. (London : Methuen and Co., Ltd., 1927.) 7*s*. 6*d*. net.

THE replacement of instinct by reason in the ordering of human affairs has not proved an unmixed blessing where the health of the individual is concerned. Instinct unerringly acts not only for the benefit of the individual but also of the race ; too often reason is short-sighted, and what recommends itself to reason as convenient and pleasant for the moment proves in the long run to contain seeds of disaster. For example, the discovery by primitive man of the art of cooking was undoubtedly an immediate benefit. Many new substances were rendered available as foods, and the nutritive qualities of others multiplied. But the result has been that the mammalian organs evolved to deal exclusively with raw fibrous material have become to a large degree superfluous. Our complicated and elongated alimentary canal remains a cumbrous and inconvenient heritage. Our teeth, no longer

required for the purpose for which they were evolved, have lost their survival value. They have consequently lost their resistance to decay, and are the most vulnerable of our organs.

The returns of industrial sickness and the results of school medical inspection both reveal an appalling amount of preventable illness in the population. It is largely the result of ignorance. For example, a school dental service has been introduced, not alone as a means to cope with the ravages of dental disease in children, but also as a preventive measure. But less than half of the parents take advantage of it at all, and of the small proportion who do, the majority take advantage of it too late to save teeth which are already decayed. So to the provision must be added a propaganda organisation.

The problem of the hygienist is now to spread amongst the population the necessary knowledge which all must have to enable them to avoid the insidious menaces which are the accompaniments of modern social life. "The people perish for want of knowledge." Therefore the ministries and the municipalities are concentrating upon health propaganda and health organisation. To aid the good work there is a brave outpouring of books, amongst which the four we have before us stand out as typical examples, each approaching the subject at a distinct and widely differing angle.

(1) Dr. Mumford sets out in "Healthy Growth" the untiring and conscientious work which he has carried out for many years in observing the growth and controlling the health of the boys at the Manchester Grammar School. He reviews the attempts made to use the mass of statistics which he has collected. One by one, accepted formulæ were tried and finally discarded in favour of the criterion of *time increment*. Some consideration of the results has already appeared in our columns (NATURE, May 8, 1926, p. 656). Though convinced that there is a definite relation between physical and mental growth, Dr. Mumford has experienced great difficulty in demonstrating it satisfactorily. He now thinks that he is able to do so by the use of an expression for physique consisting of the weight divided by the height multiplied by the square of the chest circumference. This he terms the 'buoyancy index,' $W/(H \times C^2)$. Groups of advanced scholars compared with groups of retarded scholars show positively that better buoyancy is associated with high mental performance. But when the advanced scholars are compared amongst themselves, it is found that those who obtain the highest marks have the least buoyancy. This somewhat anomalous result can be interpreted only by the assumption that the possession of a certain degree of physique is necessary for superior mental development, but competition at our secondary schools is so severe that those who excel in examination do so only at the expense of their physical development. Should this prove on further investigation to be well founded, the system of competitive examinations must receive a mortal blow.

"Healthy Growth" is by no means an easy book to read, but it is necessary for all those who have to deal with the problems of the adolescent youth. In view of what comes later, it is a remarkable achievement to have written a treatise on the growth of adolescents without one reference to diet.

(2) "Personal Health" is a popular text-book written by the professor of hygiene in the Ohio State University. It is beautifully produced and profusely illustrated. The method followed is to take the bodily systems in order and to discuss influences which promote and hinder their efficiency. It is well done, and the final result is summed up in fifteen rules for personal health, which are well balanced, sane, and will be supported by all hygienists.

It is sad to reflect upon the numbers

> "Who have died because they never knew
> These simple little rules and few."

Those connected with diet are excellent, and keep this much-debated subject in its proper focus. They are: Rule 7. Avoid overeating and overweight. Rule 8. Get back to Nature in the matter of foods you eat. Remember that Nature's food products are grains, vegetables, fruits, nuts, meat, milk, eggs, and water. Rule 9. Select your food widely from the above; get a certain part fresh every day, *i.e.* not canned or bottled. Drop fads and chew well. Do not diet except on medical advice.

Prof. Hayhurst's first rule is "Ventilate every room you occupy," and his fifteenth is "Keep serene no matter what happens."

Unfortunately, all such rules are counsels of perfection and cannot always be followed even when known. We were travelling to Cambridge lately by rail, and were careful to open the window by which we were sitting. Presently a fiery-faced don came across from the opposite end of the compartment and with some emphasis pulled up our window. After the air had become sufficiently close we ventured, when his attention was distracted, to drop the window ever so little. So soon, however, as our friend perceived the freshening atmosphere, he made an infuriated rush for the

window and banged it up again. The net result of this deplorable journey was that we had obeyed the first rule of health very imperfectly, and the last not at all.

(3) "At the age of forty every man is either a fool or a physician." Therefore the presentation of the point of view of the intelligent layman is very welcome. Mr. Barker, however, proves disappointing. His thoughts run chiefly on food. He makes great play with the comparative mortality tables furnished by the Registrar-General. He points out that doctors as a class suffer much more from digestive and renal diseases than do agricultural labourers. From this he makes the deduction that doctors do not understand the principles of health, particularly in relation to diet. It has not occurred to him that the corollary to this deduction is that the agricultural labourer understands more about health than does the doctor.

The truth is that the labourer's vocation forces him to adopt more or less a healthy mode of life while the doctor's condemns him, *malgré lui*, to an unhealthy one. The general practitioner lives a life unapproached for stress and hardship. During periods of epidemic prevalence he is constantly in contact with disease. He rarely has time for meals and must bolt his food. His day's work extends to twelve or fourteen hours without intermission. He cannot afford to take the rest he enjoins upon his patients. When he feels his temperature rising, he alone must not succumb, and therefore doses himself with antipyretics and stimulants and sets out in all weathers to visit the sick. When, dead beat, he retires to bed after an exhausting day, it is ten to one that he will be called out again into the bitter night. Living at this pressure, it is inevitable that digestion and arteries suffer. If Mr. Barker took the relative mortality statistics of soldiers and civilians, he would very probably find that the former die more frequently from bullet wounds; his deduction would be that the soldiers die because they do not understand fire-arms.

If Mr. Barker were right, what would be the answer to the question asked by Sir George Newman in his latest report: "Why is infantile mortality lowest in doctors' families?"

Mr. Barker gives the ideal regime he himself follows, which has restored his own personal health. Here is an extract: "My breakfast consists of a portion of bran porridge, made of equal weights of coarse oatmeal and ordinary bran cooked two minutes."

By all means the book should be read; more than half of it consists in interesting quotations from authorities ancient and modern, which make it a veritable medical anthology of the *vis medicatrix Naturæ*. But it is not wise to attempt to follow the advice it contains without first consulting the family doctor.

(4). Finally, we have a book from the fluent pen of a distinguished biologist. Naturally, it introduces a most valuable element into our discussions on health. Like all Prof. Arthur Thomson's books, it is written in that flowing, easy, informative style which makes them such a pleasure to read. He does not think it necessary to devote much space to food—only 2½ pages out of 232. He focuses attention bravely upon the problems of heredity, of birth-control, of sex education, and other highly controversial questions. But his urbanity and fairness are such that he can step even on our favourite corns without greatly annoying us. The biologist sees the species rather than the individual, and reveals the important truth that much which is done socially for the weakly individual is not in the interest of the race as a whole. On birth-control, Prof. Thomson conducts a gentleman's controversy with Prof. Pembrey, but so just is he to his opponent, and so fairly does he state the latter's case, that we leave with the impression that upon this topic at least the physiologist is the better biologist.

The Lady Hygeia must often be at bitter feud with her sister the Lady Eugenia. It is useful to be reminded that the hygienist does not necessarily have the last word.

Animal Biology.

Animal Biology. By J. B. S. Haldane and Julian Huxley. (Clarendon Science Series.) Pp. xvi + 344. (Oxford: Clarendon Press; London: Oxford University Press, 1927.) 10*s*. net. Cheap edition, 6*s*. 6*d*. net.

DURING the last ten years there have been important changes in the biological sciences. The classical divisions into which animal biology falls are physiology and zoology. In both these subjects it is increasingly felt that a wider scope is necessary. In physiology this widening process is already advanced, as the flourishing condition of its daughter subjects, such as biochemistry, testifies. The position of zoology, on the other hand, is at present difficult. Modern zoology is founded upon the work of Darwin; yet although his work primarily depended upon observation of the living animal, its consequence was to make zoology drift more and more towards pure morpho-

logy. Detailed and comprehensive knowledge of animal types and their anatomy has of course been vital to zoology, but at the present time the sterility of the old methods, which restricted investigation to the comparison of the anatomies of dead organisms, is clear. It is not that morphological methods are unsound, but that the real problem of the living animal is how it lives and how it has been evolved, and to study this one must understand not only its morphology but also its function. It is not perhaps too much to say that such understanding demands a greater knowledge of physiology and the principles of physics and chemistry than the average zoologist has until recently possessed.

It is essential, then, that the zoologist should study function as well as form in the animals he observes. How necessary this is can be seen when one considers that a Lamellibranch mollusc feeds with 'gills,' so called, which have no respiratory function, and that its 'liver' has yet to be shown to possess *any* function in common with the typical organ of the vertebrate. The lamellibranch liver forms no secretion; it is an organ of phagocytic ingestion and of absorption. A digestive organ on a plan more different from a vertebrate liver is hard to conceive.

As for physiology, its intimate relation to medicine has resulted in its restriction almost entirely to the study of one single group—the vertebrates. Its great recent advances have now brought it to the stage when many fundamental generalisations are being made; but the process of generalisation is seriously handicapped by lack of knowledge of other types. There has been a tendency to consider animals other than vertebrates merely as 'lower animals' of simpler organisation, and with this has come the implication that the physiology of these simpler organisms would not differ fundamentally from that of the vertebrates. The fact that the animal kingdom consists of many separate phyla which have evolved along different lines for untold ages has not been fully appreciated.

The arthropod has evolved independently of the vertebrate and is in its own field just as highly developed. We have no reason to suppose that this tremendous morphological divergence has not been accompanied by as vast a physiological divergence. Yet it is common to find in textbooks a photomicrograph of an insect's muscle illustrating an account of the physiology of striped muscle, although almost all such work has been done on vertebrates. Now vertebrates and arthropods having been separate for so long, and having in all probability evolved striations in their muscle quite independently, there is no reason to assume *a priori* that we have similar contractile mechanisms in both cases. If we find that the processes actually are similar in such cases, it indicates a remarkable restriction in the types of physiological mechanism which can be arrived at by protoplasm. The recent work of A. V. Hill and others has shown that certain fundamental processes in contraction do, in fact, appear to be identical in the muscles of many different phyla.

A mechanism of this kind, which appears to depend upon a fundamental property of protoplasm, is obviously of far greater importance than one which is merely peculiar to a single group, the vertebrates, and the fact that several mechanisms common to the whole animal kingdom have recently been discovered is one of the most important steps made in physiology. Such discoveries simplify the whole problem, and the physiology of man himself can be elucidated by the study of other organisms of widely different origin.

It seems necessary, then, that the zoologist in his training should learn something of the physiology of the types he studies, and the physiologist should be familiar with the variety of animal forms and able to relate their physiological processes to those of the vertebrate. The question is, How is this to be done? The ideal condition is plainly to awaken a broad interest in the relations between the various sections of biology while the student is still young. It is at this point that such a book as "Animal Biology," by J. B. S. Haldane and J. S. Huxley, will prove extremely valuable, for the authors have succeeded admirably in co-ordinating the several branches of zoology and physiology.

The book opens with an introductory chapter based on the physiology of the frog. What knowledge of function the student has is connected with his own body, and from man to frog is an easy step in the development of ideas regarding function in different organisms. It is much better to begin in this way than to enter into a preliminary discussion of Amœba, protoplasm and its properties, a matter unfamiliar and of extreme complexity.

The next chapter gives a general account of development based on that of the frog, gametogenesis, Mendelian heredity, evolution, and natural selection. The inter-relations of these subjects are well expressed, and the explanation, which is much helped by the many illustrations, should

counteract the tendency to treat each subject as separate.

There follows a chapter on metabolism and the building up of protoplasm. It is a pity this is so short, and a brief outline of the chemical nature of the proteins, carbohydrates, and fats would easily be grasped by the student and would help to give him an idea of the molecular basis of protoplasm

The next few chapters deal in detail with elementary physiology—respirations, functions of blood, digestion, excretion, and the nervous system. The whole book, especially in its early chapters, contains an amazing amount of information in a small space and repays attentive reading

An interesting chapter on internal environment considers the composition of the plasma and the function of dissolved substances, endocrine secretion, and immunity A clear and interesting account is given of the relationship of development and regeneration, and the effect on these of environmental factors Chapters x to xii are very good reading in an easy style. The proofs of evolution are given, the possible modes of evolution criticised, particularly from the point of Mendelian heredity and the influence of natural selection, and finally the results of evolution discussed and compared One of the most interesting features in the book is the table of comparative sizes of organisms (pp 276-280). It comes as a shock to realise the immense variations in size met with in Nature. To choose a few:

$10^{57} \times 1{\cdot}8$	= minimum weight of universe.
$10^{27} \times 6$	= weight of earth.
10^{10}	= big trees of California
10^{-15}	= smallest filter-passing organism
10^{-18}	= hæmoglobin molecule.
10^{-27}	= an electron

The book is well got up; there is an index and glossary of technical terms, and the illustrations are numerous and well reproduced The price (6*s*. 6*d*.) seems very reasonable. It is hard to find anything to criticise even in details: the plasma of land animals is more near to sea-water diluted to 4 to 5 times its volume than to 3 times (p. 159); and it is scarcely true to imply (p. 172) that any severed piece of a Protozoon can regenerate the whole organism, since regeneration in Protozoa depends absolutely on the presence of nuclear material in the segment.

To sum up, the book is an excellent one, and could be advantageously read by the advanced worker as well as the student. One feels, however, that at the present time it will be of more value to the university student than to schoolboys under 16½, for whom it is apparently intended. The book is certainly not beyond the grasp of an intelligent boy, but there are so far few schools where the general scientific education would be sufficiently advanced at that age for such a book to be fully appreciated. One hopes that soon it will be otherwise.

C. F. A. P.

Science and Psycho-Pathology.

Psychopathology: its Development and its Place in Medicine By Dr. Bernard Hart Pp. vi + 156. (Cambridge At the University Press, 1927.) 7*s*. 6*d* net

It is a fortunate circumstance that works of a strictly technical character in which no concession is made to easy understanding prove sometimes to have interest and value for a circle far wider than that to which they are primarily directed This book is addressed to a medical audience, its point of view is that of an adept in a special branch of medicine, and it keeps to its theme with uncompromising closeness. Nevertheless, through a happy combination of its subject with its author's philosophic temper and expository skill, it is a work that anyone interested in the general field of science may be advised with confidence to read.

The book is made up of three parts. The second and third parts are entitled respectively "The Psychology of Rumour" and "The Methods of Psycho-therapy," and are comparatively short essays The latter is of chiefly technical interest; the former is an examination of the psychological nature of testimony, a theme admirably suited to the easy lucidity and firmness of touch that are characteristic of Dr. Hart's writing.

The greater part of the book is occupied by three lectures on the development of psycho-pathology and its place in medicine These were the Goulstonian lectures delivered before the Royal College of Physicians of London, and are thoroughly worthy of their author and of the occasion of their delivery. In these lectures there is given a comprehensive and judiciously compressed review of the efforts of medicine to explain and to treat the common class of disorders now universally regarded as of mental origin and known as the psychoneuroses From this review there emerges the fact that the only system of doctrine which even affects to deal with the whole field in a radical and comprehensive way is that which has the rather awkward name of psycho-analysis and is the work of Sigmund Freud. It is naturally, therefore, to a critical examination of this system that Dr Hart chiefly directs himself.

It may be said at once that the discussion is the

best that has been published on a very thorny topic. Dr. Hart is well equipped for his difficult task; he has knowledge and independence of mind, and is quite free from those defects of advocacy or detraction that have spoilt so much writing on this matter. He gives a summary but adequate general account of the Freudian system, and examines with especial care the claim that is made for it of being in strict accord with the methods of science. It may perhaps be well here very briefly to remind the reader that the work of Freud in psychology falls naturally into three broadly distinct divisions—a somewhat arbitrary separation that makes consideration of the great bulk of the material rather less difficult. In the first place comes the work on the elementary mechanisms of the mind by which were elucidated such processes as conflict, repression, and the effects a repressed system is capable of producing. This work is uniformly guided by the principle that mental events are determined by the relation of cause and effect as rigidly as are physical. It is already very widely accepted and has had a great influence on psychology in general. Secondly, there is the evolution of a comprehensive theory of the mind which assigns a practically complete primacy in power and significance to the impulse of sex. Thirdly, there is the elaboration of a method of examining the contents and working of the mind which is at once an implement of psychological research and a method of treatment for the psychoneuroses.

This is, of course, the famous method of psycho-analysis which has come to give its name also to the whole doctrine of Freud. The claim is made for this method that it is unique in the access it affords to the mind and that it is capable of exact scientific use. Upon the justice of this claim the whole Freudian system depends. The process of psycho-analysis—to describe it very crudely—consists in the patient talking about himself and his experiences under the direction and influence of the physician. In this relation the influence of the physician must and is admitted to become very great. In view of this fact, Dr. Hart points out that the psychological facts elicited by the physician can perhaps no longer be regarded as, so to say, the pure facts of observation, but should be looked upon as tainted by the physician's direction and so no longer fit material for the foundation of scientific theory. This is his principal criticism of the Freudian system, and as it is directed to the validity of the method on which the whole is founded, it is plainly fundamental. This objection is met from the psycho-analytic side by the view that the unconscious processes of the mind of which the physician is in search are characteristically refractory, and only to be influenced with the greatest difficulty. As, however, this feature of the unconscious is only to be ascertained by the process of psycho-analysis which is itself in question, the argument seems only to bring us back to our starting-point.

Of the element in the Freudian system which has aroused the sharpest dissent—the sex theory itself—Dr. Hart's discussion is a model of rational and open-minded inquiry. He finds no inherent irrationality in the theory, but although he is very sparing of *a priori* considerations in general, he seems to feel the difficulty, which perhaps comes most naturally to the biologist, of ascribing an exclusive influence in forming the mind to one impulse, and denying any influence to all the other impulses of the flesh.

The author discusses shortly the independent confirmation of the psycho-analytic doctrine that has been sought in therapeutic results, in the study of myth, and in that of insanity. In regard to the last-named subject, where of course his opinion is an authoritative one, he says that the evidence is "perhaps more convincing than in any other field, because phenomena can be observed in the speech and actions of the insane which are entirely conformable to the principles deduced from the psycho-analytic method, and in which any influencing of the patient by the physician is excluded by the nature of the case."

It has been possible to touch only on some of the topics of this invaluable review of the Freudian case. Enough has perhaps been said to show the exemplary tone in which it is written and the gratitude Dr. Hart has deserved both from the critics of Freud and from the disciples of this revolutionary genius. Dr. Hart describes his ultimate attitude as one of benevolent scepticism. The cause of psycho-analysis is especially likely to benefit by such criticism as his, for it has had to contend with a curious and perhaps unique disadvantage. It has given to its advocates a new insight into motives and has enabled them to explain and to discount hostile criticism, often quite correctly, as essentially conditioned by non-rational processes in the critic's mind of which he has been quite unaware. To possess an infallible answer to opponents is not wholly to the advantage of a developing body of doctrine. It may be inspiriting to the believer, but it tends to weaken that anxious search for truth in hostile opinion which is the last gift of the scientific spirit.

Man's Early Settlements.

Peasants and Potters. By Harold Peake and Herbert John Fleure. (The Corridors of Time, 3.) Pp. 152. (Oxford: Clarendon Press; London: Oxford University Press, 1927.) 5*s.* net.

Priests and Kings. By Harold Peake and Herbert John Fleure. (The Corridors of Time, 4.) Pp. 208. (Oxford: Clarendon Press; London: Oxford University Press, 1927.) 5*s.* net.

THE results of anthropological and archæological studies constantly need readjustment and comparison, and both must occasionally be controlled by the statements of antiquity. The period under review in the present studies presents very special difficulties, for on nearly every vital point there are almost as many opinions as doctors. The subject of the third part of "The Corridors of Time" is the development of the pastoral and the agricultural peoples between about 5000 and 3500 B.C., and involves a consideration of the domestication of animals, a study of the prehistoric period in Babylonia and Elam, of the early pre-dynastic age in Egypt, and of the earliest remains at Anau in Turkestan and in Crete, with a sketch of the anthropologists' views of the races of men involved. The fourth part is devoted to an account of the early history of Sumer and Akkad and of Egypt, and a description of all those settlements which in the authors' opinion may belong to the period 3500–2500 B.C., again with a synopsis of the probable migrations of races which may conceivably be connected with the period discussed. From the Nearer East the reader passes to the Mediterranean islands and Thessaly, back to Turkestan, thence to the Danube, finally to end by the Black Sea. The handy volumes form an interesting *aperçu* of an immense period of time over a very large area, involving many different studies.

The authors are so well aware of the diversity of opinions on wide questions that it is unnecessary to discuss the many debatable questions. The pertinent criticism is rather that some questions are represented as disputed on which competent opinion is agreed, while isolated opinions are accepted as certain which should rather be presented as very questionable. The First Dynasty of Ur is placed so early as 3752 B.C., while Ur-Nina of Lagash is dated shortly before 3000 B.C., a matter of great importance for Sumerian chronology; on epigraphical and archæological grounds it is impossible, on grounds stated by specialists, to assume a gap of 700 years. Doubt is expressed as to whether the principal object of the Egyptian mines in Sinai was turquoise or copper; but mining engineers have reported with no uncertain voice on the matter, and most Egyptologists believe that *mafkat* should be translated 'turquoise.' On the other hand, Dr. Frankfort's theory of the painted pottery of Susa is relied upon as certain, perhaps on the principle *qui tacet consentit*; but M. Pottier's careful study, together with the excavators' notes, presents another, equally possible, view, and no excavator of a Mesopotamian site could argue that the layer of earth between the graves called 'Susa I.' and the 'Susa II.' level is necessarily due to an abandonment of the site.

The question of origins, with which the authors are primarily concerned, must always be fascinating, and the two schools which profess the dogmas of the single or the multiple origin are likely to subsist for some time yet. But advances are slowly made. It is now generally accepted that we have no evidence of a true 'neolithic' age in Asia, as the writers correctly remark, though they fall into the error of referring to "stone age graves at Tell el Obeid." Yet another step remains to be taken. Apart from the pastoral and agricultural communities, cities existed for trade, which was as important in pre-dynastic Egypt and in early Sumer as it ever became in later times, for only so can the astonishing wealth of both civilisations be explained. Cities like Ur contained a considerable class engaged in industry, and the population did not consist solely of "Peasants and Potters." Trade is indeed frequently alluded to in these volumes, but the hasty and partly incorrect statement about the new Indian evidence has not allowed of a just consideration being given to two vital points: (1) the extent of trade connexions and their character; (2) the kind of cultural influence exerted in cases such as this, proved beyond a doubt. The vagaries of trade, also, deserve a closer consideration, and we could wish that the doubtful theories about racial connexions of dynastic Egyptians and Arabians and Sumerians had been omitted in favour of an explanation of the manner in which evidence of a trade connexion between Sumer and Egypt first appears late in the pre-dynastic period and seems to disappear after the Third Dynasty.

The absorbing interest of this problem leads too often to that speculation about the unknown which is the bane of archæology. As Egypt and Mesopotamia gradually become defined and limited in their possibilities, North Syria, Asia Minor,

Arabia become the dumping-grounds for theories. Yet what little we do know rarely favours the hypotheses. Is it really conceivable that the Egyptians were taught the art of making their stone vases by men from Arabia? Does a single stone vase in the form of a camel prove such a theory? What are the latest statements about that vase? Or again, did bedouin from the Arabian desert invade the plains of Babylonia? Every known invasion by Semitic-speaking peoples into Akkad followed the Euphrates valley from at least so far north as the Khabur, and none of these peoples were nomads straight from the desert.

The learned authors have undertaken a difficult task, and on the whole succeeded in the attempt to correlate various subjects. That their views evoke criticism is no more than they expect. The reader will not fail to appreciate the ability with which scattered matter has been collected and compressed into a form well calculated to instruct in strange lore. A second edition will probably be required; in that case some of the bad minor errors, such as Sharain for Shahrain, and Azag-Bau (an old, erroneous reading of the signs Ku[g]-Bau), some mis-statements about excavations, and some wrong citations of authorities, might be corrected.

Technology of Paints and Varnishes.

The Industrial and Artistic Technology of Paint and Varnish. By Alvah Horton Sabin. Third edition, revised. Pp. xi + 459 + 9 plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1927.) 25*s.* net.

THE name of Sabin is so closely identified with the technology of paint that the reappearance of this book as a new edition will give a thrill of pleasure to most readers. The book is very like the earlier edition, preserves the same general form, and aims at giving an account of the principles involved in the manufacture, application, and use of paints and varnishes. It is obvious throughout that the book bears the impress of the author's own personal experiences, and consequently some may think that undue importance is laid upon certain aspects of the work whilst other sections receive inadequate treatment. The author has very wisely forestalled criticism in that regard by quoting in his preface the amiable maxim of Erasmus, that "a reader should sit down to a book as a polite diner does to a meal. The entertainer tries to satisfy all his guests; but if it should happen that something does not suit this or that person's taste, they politely conceal their feelings and commend other dishes, that they may not distress their host." The present reviewer entirely subscribes to this view of the matter, and in doing so finds a perusal of this book not only very pleasant but also stimulating to a high degree.

The first edition, published in 1904, was chiefly concerned with the subject of oleo-resinous varnishes; since then, important developments have taken place in varnish-making, particularly through the advent of Chinese tung oil, which has entirely changed, and in Sabin's opinion not always for the better, especially in the matter of durability, the character of many of the products of the varnish maker's art.

In America, where now tung oil trees are being grown extensively, the use of this oil has long been established as an essential raw material of the industry, for it possesses properties which are unique among the drying oils. In England, tung oil has also found its place in varnish-making practice, but the extent of its use here is nothing like what it is in America.

This condition is probably due to several causes apart from the innate conservatism of the Englishman. In the early days, it was generally regarded in England as a kind of substitute for linseed oil, a view which working experience should soon show to be incomplete. It took much time, however, for people to realise that the peculiar properties of tung oil, namely, its extraordinary capacity for rapid gelation under heat, the water-resisting quality of its films, and the power it has of carrying rosin varnishes into a high quality class of product, made the oil worthy of study on its own account.

Another important point which has a bearing upon the subject is the fact that American practice is far behind European in the use of heat-treated oils. This deficiency has been responsible for a readier application in America of special oils like tung and perilla. These essentially Eastern products have long been used in the regions of their origin and have formed the basis of the remarkable Chinese and Japanese and similar lacquers. The chapter devoted to this subject is most interesting and instructive.

Naturally, one would expect reference to be made to nitro-cellulose lacquers, but the treatment given is very general and rather short, although the author subscribes to the view that the extraordinary development in these lacquers during the last few years has had an influence upon the paint and varnish industry, the full effect of which cannot

yet be judged. The first use of a pyroxylin lacquer was recorded many years ago. The War brought an extraordinary demand for aeroplane dope and left a legacy in the shape of enormous plants for the manufacture of nitro-cellulose for which there was no immediate demand.

One thing has been achieved by the advent of cellulose lacquers, particularly through the agency of the enormous solvent industry which has grown up alongside: the paint and varnish industry now realises that it is a chemical industry. Proper application of this fact, with all that it implies, will do much to stimulate scientific development work all round, and to clear away the misunderstandings and uncertainties attending the 'secret' processes of the 'art,' which are a drag on real progress. As Mr. Sabin says, "the only trade secrets lie in the incommunicable intimate knowledge of the expert, and are made valuable only by his unceasing care, vigilance, and conscientiousness."

Mr. Sabin has throughout followed the historical method, and the text is freely embellished with historical comparisons. It is indeed most astonishing to realise the extent of the knowledge of centuries ago. The insight displayed by the ancients into the working of the processes they described is remarkable. The explanation of the wrinkling of paint as given by Eraclius more than a thousand years ago is almost uncanny, having regard to the present state of knowledge on that vexed question.

One closes the book with the feeling that it is unfair to dwell upon the glories of the immediate past. True it is that history is but the record of past events, which we should take, if we are wise, to mould our course in the future, but one feels rather uncomfortable in realising the extent of the knowledge of those early practitioners in this ancient art. L. A. JORDAN.

Principles and Practice of Electrical Illumination.

Modern Electrical Illumination. By Cyril Sylvester and Thomas E. Ritchie. Pp. xi + 416. (London: Longmans, Green and Co., Ltd., 1927.) 42*s*. net.

ONE of the most noticeable features of the post-War period has been the increasing recognition of the importance of illumination in modern life, socially, commercially, and industrially. Illumination for social purposes has always been appreciated for its own sake, as witness the magnificent salons of the eighteenth century with their myriads of candelabra, representing the acme of their day. The commercial value of the attractive lighting of shop windows and showrooms is of course obvious, while many of our stores could prove that it is easily the cheapest form of publicity. These reasons will not, however, explain the great developments which have taken place in industrial establishments.

In the old carbon lamp days, illuminations of one foot-candle were regarded as adequate for most purposes, while before the invention of the Welsbach mantle, illumination intensities even lower must have been normal. The change in our standards is probably due in part to the increasing demands made on visual processes in almost all occupations as a result of the ever-growing complexity of modern civilisation, together with the somewhat belated realisation of the importance of good lighting for the most efficient functioning of the eye. It is only very lately, and largely as a result of war conditions and problems, that public attention has been focused on such matters as industrial fatigue, visual acuity, and the comfort of the worker in relation to output, spoilage, and accident. In Great Britain we have the evidence which is being provided by such impartial organisations as the Industrial Fatigue Research Board, the Illumination Research Committee of the Department of Scientific and Industrial Research, the National Illumination Committee, and the Illuminating Engineering Society.

The problems of illumination are very varied and have points of contact with many branches of engineering and science, so that we have been witnessing in the last few years the appearance of a new specialist—the illuminating engineer. Two of the foremost of these specialists are responsible for the work under review, in which they "have put forward the essentials of good lighting practice, have advocated those which should be adopted and have pointed out errors which should be avoided." Their first chapters deal with the eye, vision, colour and general principles, and are perhaps not so satisfactory as the rest of the book. Then follow chapters on industrial lighting, shop-window lighting —which is very well done—followed by an extensive treatment of street lighting. Motor-car headlight illumination is then dealt with, but is rather disappointing in its brevity, only one type of anti-glare device being mentioned. Chapters are devoted to flood lighting, domestic lighting, the lighting of public buildings, theatres, etc., electric signs, stage lighting, and train lighting, on all of which the authors have useful information and suggestions to communicate.

In the main the authors have accomplished their task in a very creditable fashion. The treatment is at times, however, inclined to be dogmatic even on matters of taste. For example, the authors are very fond of referring to the correct lighting or the correct type of fitting, whereas illumination problems, like quadratic equations, have more than one solution.

Much important data for the illuminating engineer are given in the form of tables, and several B.E.S.A. specifications of illumination materials are quoted in full. With regard to the tables, no attempt seems to be made to explain the application of some of them in practice; the tables of coefficients of utilisation appear as it were spontaneously, and the important depreciation factor is not explained either in the tables or in the glossary, though it is perhaps defined by implication on p. 267.

The work represents to a large extent the valuable personal experience of the authors, who have a penchant for the more luxurious and artistic aspects of the various problems with which they deal. Indeed, as the chief illuminating engineers of two important electrical companies, their experience of ambitious illuminating engineering schemes is probably unique. The average illuminating engineer has usually to treat his subjects (and his clients) in a more modest manner.

The illustrations, of which there are about 360, are a very valuable portion of the book, which is exceedingly well produced. The quality of the illustrations accounts for the apparent high price of the book, which is well worthy of study by architects as well as by all illuminating engineers.

Chinese Art and Handicraft.

Chinese Art. One hundred Plates in colour reproducing Pottery and Porcelain of all Periods, Jades, Lacquer, Paintings, Bronzes, Furniture, etc. Introduced by an Outline Sketch of Chinese Art by R. L. Hobson. Pp. 15 + 100 plates. (London: Ernest Benn, Ltd., 1927.) 30*s*. net.

THOUGH the splendid, well-nigh perfect, illustrations displayed in the one hundred colour plates of this volume may provide its most attractive feature for the general reader, all who desire to possess a clear and tersely written account of the progressive development of Chinese art, in many of its most important manifestations—valuable not only in themselves but also for their world-wide influence on the work of the artists and craftsmen of other nations—will appreciate Mr. Hobson's narrative, which forms the fitting prelude to the work; especially since his extensive knowledge of the subject matter has not overwhelmed his power of presenting the reader with a lucid and arresting narrative. The entire essay is, indeed, excellent; alike in its appreciative, yet judicial, tone and poise as well as in the selective power displayed in the marshalling of all the salient historic and cultural evidence in a brief précis which he modestly entitles an "Outline Sketch of Chinese Art." Were all descriptive accounts of national or racial achievements in art and handicraft written with such sympathy and understanding, the path of the student who is at the same time a collector, even on a modest scale, would become, at once, more pleasant as well as better garnished.

In striving to select an illustrative example of the spirit with which this essay is suffused, we cannot do better than extract a few sentences from the first page of the introduction:

> "Another impression which recent discoveries have profoundly modified is that Chinese Art developed behind closed doors, unaffected by the doings of the outer world. It is now clear that in the greatest periods of her history China not only admitted, but welcomed, influences from Western and Central Asia—Scytho-Siberian, Hellenistic, Byzantine, Persian and Indian—and that, if in later times she suffered periods of virtual isolation, she was ready enough to experiment even with European art when she made its acquaintance in the seventeenth and eighteenth centuries. . . . So that during the years when her art traditions were being formed she was absorbing outside influences, and in many ways the art of the T'ang dynasty speaks in a language more intelligible to the European of to-day than does the more modern art which we have been taught to regard as typically Chinese."

The book is so profusely and admirably illustrated that every reader will feel impelled to turn again and yet again to an examination of the plates. The examples selected are, almost without exception, absolutely exemplary in their class; while, in addition to the specimens of pottery and porcelain, which seem naturally to appeal from the first onset to anyone who attempts to survey the vast panorama displayed by the artistic activities of the Chinese races throughout their long history, there are numerous beautiful reproductions of some of their magnificent achievements in painting (note the superb painting of "The Ch'ang Lo Palace, after Li Ssŭ-hsün," now in the British Museum); and in lacquer, of which Mr. Hobson has selected a series of notable and beautiful examples. Of this class the reader's attention may be specially

directed to the reproduction given on Plate lxxxviii. of one panel from a twelve-fold screen now in the Victoria and Albert Museum, and to that on Plate xciii., which gives a wonderful presentation of an oblong panel in carved red lacquer encrusted with jade, malachite, and imitation lapis-lazuli. The bronze covered-pail for sacrificial wine, dating from the Chou dynasty (1122–255 B.C.), now in the famous collection of Mr. Eumorfopoulos, as well as the bronze cover of a lady's toilet-box decorated with painted designs of the T'ang period and the bronze mirror-back with designs in low-relief, also of the T'ang period and from the same collection, are beautifully rendered on a series of plates. The T'ang dynasty dish in translucent green jade from the Alexander collection, as notable for its exquisite form as for its precious colour, Plate lxxx.; the vase in translucent jade from the time of the Sung dynasty from the Malcolm collection, Plate lxxxi.; and the brush-pot in jadeite, possibly of the Yüan dynasty, are enough to make any collector's mouth water.

WILLIAM BURTON.

Hondius's Map of the World.

Reproductions of Early Engraved Maps. 1: *The Map of the World on Mercator's Projection*, by Jodocus Hondius, Amsterdam, 1608. From the Unique Copy in the Collection of the Royal Geographical Society, with a Memoir by Edward Heawood. On 25 Sheets, and Index Sheet, 20 in. × 15 in., in paper cover. Memoir, pp. 24. (London: Royal Geographical Society; Edward Stanford, Ltd., 1927.) 63*s*.

THIS magnificent work, the first part of a projected series of reproductions of early engraved maps, will be welcomed by all historians of geography. The original map was acquired by the Royal Geographical Society in 1919. It is in twelve main sheets, each about 18½ inches by 13½ inches, surrounded by smaller sheets containing the title and decorative borders. Though the coloured boundaries and decorations are faded, and the paper darkened with age, most of the engraving is clear, and the collotype plates render its details faithfully; even on the reduced photograph of the whole map much of the lettering is legible.

Though Hondius's map is just a century later than the first-printed world map by Waldseemüller (1507), and though Mercator's copperplate in 1569 had popularised this kind of map—as the woodcut edition of it shows—its nearer precursors were on other projections, cylindrical and stereographic; and Hondius himself reverted to a projection in hemispheres in 1611–18. His own earlier maps (1588–91) and the globes in the Middle Temple Library (1592) seem to have been engraved in England; but he appears at Amsterdam in 1593, and worked there until his death in February 1612. Full details of his copious publications, and descriptions of those which are extant, will be found in Mr. Heawood's learned introduction to this facsimile; they give a striking illustration of the interplay of English and Netherland cartographers at this time.

The quaint custom of filling the waste spaces of ocean with letterpress gives to this map a double interest for geographers; for Hondius used this opportunity to expound Mercator's projection and illustrate his own graphic method of constructing the scale of latitude, thus avoiding the necessity of further reference to his former associate, Edward Wright, who had quarrelled with him for what Wright considered premature use of his own calculations. In other matters Hondius himself had less to contribute, either to Mercator in the uses of the map, to Plancius in its details, or to Blaeu in its decorations; on the other hand, some of his novelties are attributable to English sources—Drake for north-west America, Raleigh for Virginia and Guiana. Though he restores to the map the continental land south of Magellan's Strait, which he had broken in 1602 into islands "discovered by the English," he omitted the Arctic island-world imagined by Mercator, and so both cleared the way for later explorers and stimulated their zeal.

To his expert aid in appreciating the peculiarities of the map itself, Mr. Heawood has added the convenience of a translation of its quaint Latin letterpress, with its candid admission (for example) "that no space should be left vacant, we have appended the distribution of the Sons of Noah, that it may be manifest how the World began to be settled after the flood, and from what centres colonies were first sent out into other shores"; though Hondius has to admit that it is quite uncertain who was the father of America. It is interesting to note that in his allegorical group he gives two separate figures for the Americas—one in the background of his Asia, the other of his Europe and Africa—and in the letterpress contemplates European as well as Asiatic origin for American peoples. This is a more ingenuous device than the fourfold symbolism of the title-pages of the next generation—Grimston, Heylin, and their contemporaries.

J. L. M.

Our Bookshelf.

Primitive Culture and Customs.

Maya Cities: a Record of Exploration and Adventure in Middle America. By Thomas Gann. Pp. 256+32 plates. (London: Gerald Duckworth and Co., Ltd., 1927.) 21*s.* net.

Dr. Gann's account of his explorations in the season 1926–27 has no sensational discovery to record such as he has given us in previous volumes. It is not on that account lacking in interest. Travel in the forests of Central America could scarcely fail to provide some thrill, either by way of fresh discovery or of personal danger. Dr. Gann experienced both. He covered both new ground and old. His most important discovery he himself considers to be the series of lofty narrow-roomed temples to the west of Bacalar Lagoon, which he had named Tzibanchè; but his discovery of a ruined city, where a mound only was thought to exist, on the site he names Minanhã, seems likely to afford an even more fruitful field for future exploration. On the sites already known which he visited, he worked at Tuluum, Uaxactun, where there *is* the earliest and the longest series of Maya Old Empire dates, and Lubaantun, the site now being explored by the British Museum expedition. He also visited Tikal in search of a treasure temple of which the existence was revealed to an Englishman by Indians more than sixty years ago. He was unsuccessful in his search; but his determination to make it the objective of his next journey leaves his readers with a thrill in anticipation of his next book.

The Fellāhīn of Upper Egypt: their Religious, Social, and Industrial Life To-day, with special reference to Survivals from Ancient Times. By Winifred S. Blackman. Pp. 331. (London, Bombay and Sydney: George G. Harrap and Co., Ltd., 1927.) 15*s.* net.

For six seasons Miss Blackman has spent six months at a time living in intimate contact with the Fellāhīn of Upper Egypt. In this volume she gives a popular account of a part only of the information she has collected about their customs, culture, and beliefs. It is extraordinarily interesting, especially when she is dealing with customs relating to childbirth and fertility and the observances and practices of the village medicine man and woman. A curious combination of offensive and defensive magic is seen in the practice of cutting out human figures in paper, sticking pins in them, and then burning them as a cure for children suffering from the effects of the evil eye. The chapter on ancient Egyptian analogies, again part only of the author's material, indicates the value of such studies as these to the Egyptologist in providing material which may serve to elucidate obscure points in his own special field. It is to be hoped that Miss Blackman may be able to continue her studies and extend them to Lower Egypt.

Papers on the Ethnology and Archæology of the Malay Peninsula. By Ivor H. N. Evans. Pp. x+164+43 plates. (Cambridge: At the University Press, 1927.) 15*s.* net.

The papers which Mr. Evans has here republished, after most have appeared in various scientific periodicals, are classified into four sections: Pagan races, Malay beliefs, Malay and other technology, and archæology. Some are of rather a specialist interest, but all are important in varying degree, for the most part as pieces of first-hand observation. Mr. Evans has been fortunate enough to visit some of the Negrito tribes of Siam and has obtained linguistic and cultural material which, though slight, is still of considerable value for comparative purposes. The section on archæology contains additions to our knowledge of the early inhabitants of the Peninsula, especially in regard to bronze and iron; but the most instructive chapter here deals with the exploration of cave shelters, in which Mr. Evans finds a culture showing a considerable correspondence with that in the rock shelters of Indo-China and exemplified in the type of primitive implement found in Sumatra by Dr. P. van Callenfels.

Experimental Psychology.

Elementary Conditions of Human Variability: a Study of the Variation of Successive Responses to Similar Stimuli at Different Levels of the Cerebro-Spinal System of a Human Subject. By Prof. Raymond Dodge. (Columbia University in the City of New York. Publication No. 10 of the Ernest Kempton Adams Fund for Physical Research, established Dec. 17, 1904.) Pp. xii+107. (New York: Columbia University Press, 1927.) 1.50 dollars.

This, the tenth monograph published by the Adams Fund for Physical Research, unlike its predecessors, which came from the pens of workers in physical science, is written by a psychologist. The subject matter, however, has a direct appeal to the physicist, since it deals with that shortcoming of the individual observer from the ideal which has long passed under the term of 'personal equation,' a factor which varies from observer to observer, and in the same observer from moment to moment. The present monograph gives a quantitative analysis of the changes occurring in certain selected human reactions, *e.g.* the knee-jerk, the lid reflex to sound, horizontal vestibular nystagmus, word reactions and memory tests, all of which permit of a trustworthy technique in their recording.

From a series of observations taken at various times throughout the day and extending over a period of two years, certain types of variation in the responses become evident; *e.g.* diurnal rhythm and general depressions, to mention only two of interest in industry as regards efficiency

and incidence of accidents. The effects of repetition on motor co-ordinations, the development of refractoriness, the course, transfer, and loss of training and phenomena of the learning process indicate other interesting points which are discussed. Subjective details are presented, but the value of this contribution to psychological science rests mainly on the information obtained from the trustworthy physical methods used for recording.

The Effects of Music: a Series of Essays. Edited by Max Schoen. (International Library of Psychology, Philosophy and Scientific Method.) Pp. ix + 275. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1927.) 15*s*. net.

A NUMBER of investigators have collaborated in the issue of this volume, which presents, under the editorial supervision of Dr. Max Schoen, studies of the effects of music and its more or less mysterious influence upon human personality. A few are reprints, notably one by Dr. Charles S. Myers, on individual differences in listening to music (*British Journal of Psychology*). The rest are in the main chosen from among papers submitted in a competition conducted by the American Psychological Association.

The effects of vocal and instrumental music on the moods of 20,000 selected individuals were obtained by phonograph recordings. These are fully described by Dr. Schoen and Dr. Esther L. Gatewood. Such collections of data through the medium of broadcasting would doubtless be impracticable; but the suspicion arises whether not a little of the acute and varied criticism extended to the official broadcast programmes may represent the expression of moods of the character detailed by the writers. Another section, of considerable general interest, by Dr. Ida M. Hyde, studies the changes produced by contrasted musical selections on electro-cardiograms, pulse rate, systolic, diastolic, and pulse pressures, and blood velocity. There is much in these essays which is of value both to professional teachers and to students of music.

Medical Manuals.

(1) *Sunshine and Health.* By Dr. Ronald Campbell Macfie. (Home University Library of Modern Knowledge.) Pp. 256. (London: Williams and Norgate, Ltd. [Thornton Butterworth, Ltd.]; New York: Henry Holt and Co., 1927.) 2*s*. net.

(2) *Clinical Application of Sunlight and Artificial Radiation: including their Physiological and Experimental Aspects, with Special Reference to Tuberculosis.* By Dr. Edgar Mayer. Pp. xvi + 468 + 38 plates. (London: Baillière, Tindall and Cox, 1926.) 45*s*. net.

(1) "SUNSHINE AND HEALTH" is one of the Home University Library series, and is therefore written with the object of summarising our knowledge of this subject for the benefit of the general reader. The author, Dr. Campbell Macfie, is but little concerned with therapeutics. He presents a short historical survey of man's speculations and theories of sunlight, and then proceeds to describe concisely, but with a wealth of detail, the nature and properties of radiant energy, its biological value and therapeutic uses. Radiation other than solar, and various types of lamps used in actino-therapy, receive brief reference.

Dr. Macfie is careful not to exaggerate the importance of light in evolution and growth, emphasising the fact that radiation cannot impart the vital spark to a group of molecules, however complexly arranged; its functions are stimulation, regulation, and reinforcement, in the development of living things. He points out that light, though necessary to plant life, is not an essential feature in animal physiology. He warns the reader that sunshine can play but a minor part in healthy metabolism, that man is as likely to suffer from excess of insolation as from deficiency, and that some of the results of actino-therapy might be due to other factors operating at the same time. The well-established facts, however, are by no means ignored, and full credit is given to radiant energy as a therapeutic agent in rickets, lupus, and other conditions.

(2) The volume which Dr. Edgar Mayer has written is entitled "Clinical Application of Sunlight and Artificial Radiation," but it contains also a very detailed and inclusive study of the biological, physiological, bactericidal, and experimental aspects of the subject, with an extensive bibliography and a complete index of authors and subjects.

Although actino-therapy is considered mainly in its application to tuberculosis, the survey of radiation in its other aspects could not be more comprehensive. The value of this book lies not only in its complete presentation of the subject. So rapid has been the development of the use of light as a therapeutic agent that the medical profession has been left somewhat bewildered, while unqualified practitioners and fascinated laymen apply ultra-violet rays indiscriminately. It must be remembered that the subject is still in its infancy; harmful effects of the application of actinic energy have been noted, and the tragedies of pioneer X-ray workers are still in our minds. Only by careful observation and cautious scientific investigation can this form of energy be made a useful agent in the struggle against disease.

The Principles of Ante-Natal and Post-Natal Child Hygiene. By Dr. W. M. Feldman. Pp. xxiv + 743 + 14 plates. (London: John Bale, Sons and Danielsson, Ltd., 1927.) 25*s*. net.

THE author intends this book as a companion to his "Principles of Ante-Natal and Post-Natal Child Physiology," child hygiene including "everything that tends to preserve the life, health and welfare of the child during its various stages of ante-natal and post-natal development." The intra-uterine development is regarded as the most important period in the child's career, and consequently the question of heredity is fully discussed, together with the relative importance of this factor and of environment when applied to child welfare and eugenics.

Three chapters are devoted to the causes and prevention of ante-natal, intra-natal, child and maternal mortality; much of this mortality is preventable, and the means available for dealing with the various factors responsible are clearly set forth. Half the total infant mortality occurs in the first month of life, and one-third on the first day; this is due to lack of adaptation in some direction to its changed environment on the part of the new-born child.

The second half of the book deals very fully with post-natal hygiene, and contains an immense amount of very practical information as to nutrition, breast feeding, artificial feeding, diet, exercise, and sunlight. The author gives not only the requirements of the child under varying conditions, but also the reasons for his statements, together with much of the experimental evidence available. The prevention of disease, both infectious and otherwise, is considered, and the book ends with chapters dealing with physical and mental growth, the psychology of the child, and adolescence.

The whole book is extremely interesting, because wherever possible the author has given the history of customs connected with the subject under discussion, and portraits of relevant investigators. Many statistics are also included, and there is an excellent chapter dealing with statistical methods and the pitfalls to be avoided. E. E. HEWER.

Local Immunization: Specific Dressings. By Prof. A. Besredka. Edited and translated by Dr. Harry Plotz. Pp. xi + 181. (London: Baillière, Tindall and Cox, 1927.) 16*s*. net.

THIS small but unduly costly book is a translation, with some additions and emendations by a fellow-worker, of Prof. Besredka's "Immunisation locale," published in 1925 (Masson et Cie). According to Besredka, the production of immunity to various infective organisms is best achieved by bringing to bear on the cells most receptive for the specific micro-organism, either the micro-organism itself or a filtrate of its growth, the final issue being a desensitisation of these receptive cells so that a further inoculation of germs is rendered inert. In anthrax infection the author believes that the guinea-pig skin is the only receptive tissue in that animal, while in enteric fevers the cells which require desensitisation are those of the intestinal mucous membrane. In the latter disease immunisation is produced by oral administration of the killed organism in association with bile, which is held to facilitate, by its catarrhal action on cells of the intestinal mucosa, the impression of the specific oral antigen on these receptive cells, with resulting desensitisation. These examples of local immunity are, in the author's view, not accompanied by any very marked development of antibodies demonstrable in the blood serum.

Both the experiments and the interpretation put upon them by Besredka and his pupils have given rise to considerable controversy, and it may be stated that the great majority of workers who have entered this field of research have not reached conclusions in agreement with Besredka's particular theory. None the less, the subject of local immunity is one of intense interest, and Besredka has done good service in raising the issue, as it has directed attention to many peculiarities in local defence mechanisms, particularly in the skin, and to the bearing of quite non-specific inflammatory processes on local defence.

Actions and Uses of the Salicylates and Cinchophen in Medicine. By Prof. P. J. Hanzlik. (Medicine Monographs, Vol. 9.) Pp. xiii + 200. (Baltimore, Md.: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1927.) 16*s*. net.

THE salicylates are among the most commonly used drugs and are administered in a wide range of morbid conditions; they are freely advertised to the public and somewhat recklessly taken for many transient ailments in which a physician is not consulted. They have received extensive investigation in the laboratories of pharmacologists and bio-chemists. Yet there is by no means complete understanding of their effects, and much controversy has centred round their mode of action. Recent work, however, has done much to rid these drugs of erroneous traditions which have been handed down with their use, and Prof. Hanzlik's monograph is of considerable value in summarising research and indicating present views on the subject.

Among the more important conclusions are the facts that salicylates are not specific for acute rheumatism, and that their good effects in this disease appear to be due mainly to their antipyretic and analgesic action, allowing comfort and rest. Most doctors prescribe sodium bicarbonate with salicylates with the intention of avoiding toxic effects, but there seems to be little trustworthy evidence that alkalis prevent salicysm; their main use is to counteract gastric irritation. The metabolic influence of salicylates and cinchophen—which is better known in Great Britain as 'atophan'—is fully described, but the therapeutic value must depend on a fuller understanding of morbid metabolism. Considerable prominence has been given to cinchophen during the last few years in advertisements and medical literature, and it should be emphasised that idiosyncrasy to this compound is by no means rare, and very unpleasant effects have followed its use in medicinal doses.

Prof. Hanzlik discusses many interesting features, and his book will certainly be of value, not only to physicians who use these drugs, but also to pharmacologists and others who are specially concerned with them.

Manual of Psychiatry. Edited by Dr. Aaron J. Rosanoff. Sixth edition, revised, enlarged, and illustrated. Pp. xvi + 697. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1927.) 30*s*. net.

THIS well-known text-book maintains the high standard set in previous editions. The chapters on the personality and on word associations and their application are particularly welcome in a text-book of this nature.

In discussing the presence of spirochætes in the

brain in general paralysis, no mention is made of the excellent work of Jahnel during the past few years, and the illustrations showing spirochætes in the brain are poor. The treatment of general paralysis is considered in a very brief manner; a chapter might well have been devoted to this, one of the most interesting and fruitful subjects in modern psychiatry. Malarial treatment is dismissed in nine lines! The author appears to consider that the high temperature of the malarial attacks is the curative factor—this is not the commonly accepted theory. There is also no mention of the use of hexamine in the prevention of paretic convulsions. Under the etiology of dementia præcox we find no mention of Mott's well-known work. Kretschmer's recent contributions on the relation of physique and character to syntonic and schizoid states and to manic-depressive insanity and schizophrenia are not even mentioned.

Notwithstanding these faults, the manual ought to be in the hands of every alienist.

Modern Methods in the Diagnosis and Treatment of Renal Disease. By Prof. Hugh MacLean. (Modern Medical Monographs.) Third edition, revised and enlarged. Pp. viii + 135 + 4 plates. (London: Constable and Co., Ltd., 1927.) 12*s*. net.

THE appearance of a third edition of Prof. Hugh MacLean's monograph on renal disease is a sure indication of the well-deserved popularity of this book. Since the first edition was published, the importance and value of renal function tests have become definitely established. Experience has shown that the methods given in former editions are sufficient and trustworthy, so that no alteration has been required in the sections dealing with investigations of kidney disease. Indeed, there is little material revision in this edition except in the chapter on treatment, which has been rewritten with full practical details. The principles of treatment are based strictly on the pathology of renal impairment and its known effects; and although therapeutic measures are considered thoroughly, and in some cases suggested tables of diets are given, it is possible to apply these principles to any given degree and type of renal disease. The simplicity of classification, and the practical way in which it is written, entitle this book to be considered one of the most valuable publications on the subject.

Bird Life.

The Baby Bird and its Problems. By W. Bickerton. Pp. xvi + 135 + 39 plates. (London: Methuen and Co., Ltd., 1927.) 10*s*. 6*d*. net.

WHEN we had read the first chapter of this book, we admit that we put it down feeling slightly dazed by it. "The Call of Spring" may be described as an ecstasy of adjectives. Long, long sentences are but partly broken by an infinite variation of colons, semi-colons and commas, generally followed, we notice, by an 'and' or a 'but.' We have, however, read this short chapter again and have come to the conclusion that in it the author does himself gross injustice. When we came to the later chapters, which are longer and in which, therefore, the author has had more to write and less time to think, the language becomes much more simple and infinitely more interesting.

We do not suppose that the book is intended for grown-up students but it is full of information for the young, whilst the information is given in a very charming manner. Naturally, in a book of this kind, a record consisting almost entirely of the author's own observations, there are bound to be many *dicta* with which his readers will not agree. For example, he says that the stone curlew is a mountain breeder. He holds up the dove as an emblem of peace, though it is well known to possess a character for quarrelsomeness surpassed by few other birds. Again, when he comments on some of his bird problems, we are inclined to think that he sometimes reverses cause and effect. Thus, on p. 37, he says that some birds construct no nest because their young are born in an advanced stage of development, yet the converse would hold equally good. Again, he says that birds which lay white eggs have learnt to lay them in holes and burrows in the ground. Most naturalists believe that eggs have protective coloration because they are not laid in holes of trees and burrows in the ground. It is probable that primitive birds hid their eggs, as do lizards nowadays, in crevices of rocks and other places in the dark, so that white or yellowish eggs are the primitive type.

An interesting chapter is the one on "Eggs; their Qualities and Meanings," in which the author compares the size of the egg with the length of the bird, though this would have been still more valuable had he compared the weights, for we see no reason why a long-tailed small bird should lay an egg larger than a large bird with a short tail. The photographic illustrations at the end of the book are admirable and are a fitting *finale* to a book in which children may learn much and their elders may read with interest.

(1) *Realities of Bird Life: being Extracts from the Diaries of a Life-loving Naturalist.* By Edmund Selous. With an Introduction by Julian S. Huxley. Pp. xvi + 351. (London: Constable and Co., Ltd., 1927.) 14*s*. net.

(2) *The Charm of Birds.* By Viscount Grey of Fallodon. Pp. xii + 243. (London: Hodder and Stoughton, Ltd., 1927.) 12*s*. 6*d*. net.

(3) *The Heart of a Bird.* By Anthony Collett. Pp. viii + 287 + 8 plates. (London: Nisbet and Co., Ltd., 1927.) 10*s*. 6*d*. net.

THESE three recent books on the evergreen subject of bird life have something in common. All of them deal with field observation and are based almost wholly on personal experience. All of them are descriptive rather than analytical. Each in its own way succeeds in conveying not a little of the charm of these living things and of the pleasure to be derived from intimacy with their ways.

(1) From the point of view of scientific interest, chief place may be given to Mr. Selous, who once again enriches our knowledge of bird behaviour.

He presents his material in the form of extracts from his diaries, loosely arranged in chapters according to their principal topics. It is a very readable book, into which one may pleasurably dip at almost any point. It is also packed with valuable observational records, dealing especially with courtship behaviour among birds, an extremely interesting subject of which too little is known. For the student desirous of obtaining information on particular points, the form of the book is a disadvantage, but this can be overcome by the use of an index of unusual adequacy.

(2) Lord Grey writes with his accustomed distinction. As the respective titles indicate, his record is less objective than that of the more deliberate observer. One is more aware of the personality of the writer, and one is made to feel and to share the pleasure which watching birds has given him. Of all the aspects of bird life upon which he touches, song seems to have interested him most, and nearly half the book is given mainly to this subject. No novelty is claimed for any of the observations: the most familiar fact is stated with the simple and infectious pleasure of one who has discovered it anew for himself. Nevertheless, there is much here on the subject of bird song which is not often to be found in books, even those of more ambitious aim. The woodcuts by Mr. Robert Gibbings are well suited to the work.

(3) Under a not altogether happy title, Mr. Collett gives us twelve pleasing essays, each dealing with the bird life of one of the months of the year. He generalises to a greater extent than the other authors just mentioned, his method being to sum his knowledge rather than to recount his separate experiences, but it is quite evident that he has seen what he describes.

(1) *Days with the Golden Eagle.* By Seton Gordon, in collaboration with his Wife. Pp. xx + 176 + 19 plates. (London: Williams and Norgate, Ltd., 1927.) 12*s.* 6*d.* net.

(2) *The Book of the Golden Eagle.* By Capt. C. W. R. Knight. Pp. xii + 296 + 33 plates. (London: Hodder and Stoughton, Ltd., 1927.) 21*s.* net.

THE almost simultaneous appearance of two works on the golden eagles of Scotland suggests a comparison and contrast. The main theme of both volumes is the life-history of the eagle, from egg to adult, as it is revealed day by day to the patient watcher by the eyrie; and both stories are vivid with the personal experiences of the authors, for in bird photography interest in the doings of the photographer appears to be second only to interest in his quarry. Mr. Seton Gordon, however, devotes only about a quarter of his space to this detailed study. The remainder of his book is given over to more general themes bearing upon the golden eagle: an account of Scottish eyries, descriptions of typical eagle country, the incidence of eagles on grouse preserving and sheep farming, Highland stories and traditions of the eagle, and the history of the golden and white-tailed eagles in Britain.

Captain Knight confines his account to his own observations; it is, in short, a sprightly history of his experiences in the taking of his wonderful eagle film, and of his training of a young eagle to fly to the lure. Mr. Gordon's book is for the reader who would know almost all that is to be known about the golden eagle; Captain Knight's for him who prefers a racy story of eyrie-hunting expeditions.

Zoology in the Laboratory.

(1) *A Laboratory Course in General Zoology: a Guide to the Dissection and Comparative Study of Animals.* By Prof. Henry Sherring Pratt. Pp. x + 244. (Boston, New York, Chicago and London: Ginn and Co., Ltd., 1927.) 7*s.* 6*d.* net.

(2) *The Skate* Raja erinacea *Mitchill: a Laboratory Manual.* By Prof. Charles W. Creaser. Pp. xi + 57. (New York: The Macmillan Co., 1927.) 4*s.* 6*d.* net.

(3) *The Biology of the Frog.* By Prof. Samuel J. Holmes. Fourth revised edition. Pp. x + 386. (New York: The Macmillan Co., 1927.) 10*s.* 6*d.* net.

(4) *Textbook of General Zoology.* By Prof. Winterton C. Curtis and Prof. Mary J. Guthrie. Pp. xv + 412. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1927.) 18*s.* 6*d.* net.

(5) *Leitfaden zu tierphysiologischen Übungen.* Von Prof. Dr. Paul Kruger. Pp. viii + 92. (Berlin: Gebrüder Borntraeger, 1927.) 3 gold marks.

THE output of new text-books or of new editions of old ones is as steady as the advance in scientific knowledge and advances in teaching methods. For the latter reason it is always very interesting to compare the productions of different countries and to note the trends in teaching. American text-books are usually of special interest, for they may be used by the English student (if the language used remains reasonably English) and the American publisher has the advantage of a wider sale than in his own land. Naturally, they must be of high grade. English publishers of text-books should not forget the American market, a field which is frequently less well explored by advertisement than it might be.

(1) Pratt's laboratory manual is called "General Zoology," but it is nothing of the kind unless general be taken to mean 'diffuse.' It is an extraordinary collection of elementary references to invertebrate types; only structure is mentioned and often only external characters. To this are added the frog and the perch. It is difficult to see for whom it could possibly be intended.

(2) The laboratory manual on the skate is the kind of handbook which might be used as a guide to dissections of this type. Such books, if they are going to be useful for the student, should be illustrated. This specimen contains only two old illustrations. Its style is bad and many expressions are extraordinarily misleading.

(3) Holmes's work on the frog stands on a different plane, and is an effort to provide a complete description of the frog, including its physiology, habits, and instincts as well as structure. Much information is brought together which otherwise

only exists in scattered form. The only fault of the book is that it remains clearly a new edition of an old work, many chapters of which have needed considerable revision. Here and there the revision is still not up-to-date.

(4) Curtis and Guthrie's work is another American text-book which demonstrates how usual it is in America (compared with England) to combine the study of function and structure in zoological laboratories. It is a well-written volume and, on the whole, up-to-date. The physiology is perhaps rather 'thin,' two short chapters comprising the physiology of the vertebrate type, and this is practically human physiology. On the other hand, there are many good features, and the different sections are well balanced.

(5) Kruger's little book of 92 pages (costing 3 marks in Germany) is very interesting, for it shows that zoology students in Berlin have a short practical course in animal physiology. The book is a student's guide to this laboratory work. It is mainly a collection of bio-chemical tests and is extracted from a larger volume by the same author. It must be a very useful manual to German students.

Handbuch der Zoologie: eine Naturgeschichte der Stämme des Tierreiches. Gegründet von Prof. Dr. Willy Kükenthal. Herausgegeben von Dr. Thilo Krumbach. (1) Dritter Band: *Tardigrada; Pentastomida; Myzostomida; Arthropoda, Allgemeines; Crustacea; Arachnoidea.* Sechste Lieferung. Pp. 593-720. Siebente Lieferung. Pp. 721-848. Achte Lieferung. Pp. 849-976. Neunte Lieferung. Pp. 977-1158 + xvi. (2) Siebenter Band: *Sauropsida, Allgemeines; Reptilia; Aves.* Zweite Hälfte, Erste Lieferung. Pp. 112. Zweite Lieferung. Pp. 113-224. (Berlin und Leipzig: Walter de Gruyter und Co., 1927.)

(1) The sixth, seventh, eighth, and ninth parts of the third volume of this handbook contain the descriptions of the rest of the orders of Crustacea—Anaspidacea, by Dr. P. A. Chappius, Mysidacea, Cumacea, Tanaidacea, Isopoda, and Euphausiacea, by Prof. Carl Zimmer, Amphipoda by Prof. J. Reibisch, and Decapoda and Stomatopoda by Prof. H. Balss. Under each order is found an account of the structure (usually with adequate references to physiology), distribution, life-history, ecology, and classification, with a list of the more important memoirs. Numerous figures from recent papers are included. Three pages have been added in order to include a summary of the results of the observations of Prof. Graham Cannon and Miss Manton (1927) on the feeding of Hemimysis. The account of the Crustacea extends to 800 pages. The figures of larval forms of the Decapoda should have included better representations of the internal anatomy, which is too much neglected even in the Phyllosoma larva, where the internal structure could have been well shown.

The contributions to this volume maintain a high standard, and the articles will be of great service to teachers of zoology and to advanced students. The volume is provided with an excellent index.

(2) In these two parts Dr. E. Stresemann deals with the external features of birds, the structure and arrangement of feathers, coloration, skeleton, musculature, nervous system, and sense organs, and the digestive, respiratory, and vascular systems. The microscopic structure of the more important organs and their physiology receive careful attention. The account is well illustrated, and a large proportion of the figures is from recent memoirs. The author is successfully handling a difficult subject, and his volume on birds promises to be a very helpful and up-to-date part of the 'Handbuch.'

Sagitta. By S. T. Burfield. (Liverpool Marine Biology Committee Memoirs on Typical British Marine Plants and Animals, edited by Dr. James Johnstone, 28.) Pp. viii + 104 + 12 plates. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1927.) 6*s*. 6*d*.

This latest addition to an excellent series of memoirs will be welcomed by all zoologists, especially by senior honours students. *Sagitta bipunctata* Quoy and Gaimard, or the 'arrow-worm' as it is appropriately termed in common speech, is a well-known and important member of the marine plankton and has frequently been studied, from both the morphological and ecological aspects, by workers on both sides of the Atlantic. This book is a detailed account of the anatomy and minute histology of this living slip of transparency, and the author has included sections in which what is known of the affinities, occurrence, habits, vertical distribution, and parasites are briefly discussed. Gametogenesis and development also receive attention. The whole is illustrated by more than a hundred line-drawings and diagrams, but one feels that some of these would have been more effective had they been reproduced on a rather larger scale. Probably space-saving considerations precluded this possibility. The preparation of the memoir has obviously entailed a great deal of work, and the author is to be congratulated on its successful accomplishment.

Recent Advances in Anatomy. By Prof. H. Woollard. (The Recent Advances Series.) Pp. vii + 302 + 4 plates. (London: J. and A. Churchill, 1927.) 12*s*. 6*d*.

Prof. Woollard has written a very stimulating sketch of some of the progressive movements in anatomy, which gives an idea of the wider vision that is now opening out in this hoary subject. He has not attempted, however, to deal with the whole range of anatomical progress, but has discussed only these topics of which his associations in America, in Holland, and at University College, London, have given him a personal knowledge and interest. The vitalising influence of the functional point of view is everywhere apparent in the wide range of topics, neurological, cytological, and embryological, he has thus selected;

and the book will exert a healthy influence in emphasising the expression of this principle in the growing points in anatomy.

The chief criticism is that the author has crowded into a limited space an amazing amount of detailed and novel information without including enough of the older knowledge to link on the new data. Hence he is not easy to follow and understand. When the time comes for preparing a new edition of this work—which is so useful that the occasion should not be delayed very long—the author ought to make a drastic revision, not merely to correct the typographical errors and the too numerous ambiguities, but also to prune the list of facts, so as to give more room for interpretation.

Natural History of Insects.

Mosquito Surveys: a Handbook for Anti-Malarial and Anti-Mosquito Field Workers. By Malcolm E. Macgregor. (Published for the Wellcome Bureau of Scientific Research.) Pp. 293. (London: Baillière, Tindall and Cox, 1927.) 15s. net.

In 1922 the author was sent to Mauritius on behalf of the Colonial Office to make a thorough study of malaria, and he has prepared this account of the mosquitoes of that island and of Rodriguez primarily for the information of the Medical and Health Department. The first part forms a clear and concise introduction to mosquito anatomy and life-history which the author is well qualified to provide, but "trochanta," "pleuræ," and "colleoterial" are surely due to slips of the pen. The statement that the spermathecæ are usually three in number requires further qualification. There are said to be (p. 50) two diverticula of the œsophagus, whereas three, the correct number, are indicated in the figure and given on p. 219. The method suggested for determining the sex of the pupa is "by the presence or absence of rudimentary testes," but a quicker determination can usually be made by examining the processes in which the external genital armature is developing.

The second part is devoted to the classification of mosquitoes and to a useful account of the four species of Anopheles found in Mauritius—the genus is absent from Rodriguez—and of the Culicines found in both islands. Keys are given to aid in the identification of the larvæ and adult insects. It is doubtful whether the key to the Culicine genera of the world should have been included, for its use requires considerable expert knowledge not likely to be possessed by those for whom the book is primarily intended.

The third part contains many helpful suggestions for work in the field and in the laboratory; for example, a device for keeping creosote in small glass bulbs in insect store-boxes, methods of mounting mosquitoes on celluloid strips, the rearing of [illegible]yæ in captivity, and the mounting of parts of [illegible]væ, pupæ, and adults as microscopic specimens. [illegible] of th[illegible] pages are devoted to suggestions for anti-[illegible]laria and anti-mosquito surveys and for mos-[illegible]uito control.

The Plant Lice or Aphididæ of Great Britain. By Fred V. Theobald. Vol. 2. Pp. v + 411. (Ashford, Kent, and London: Headley Bros., 1927.) 30s.

Entomologists will welcome the appearance of the second volume of Mr. Theobald's invaluable book on the British aphides. This volume follows on the same lines as the previous one. It deals with the remaining genera and species of the tribe Aphidini, and in addition certain members of the tribe Callipterini. Altogether 26 genera and about 150 species are dealt with, and of the latter 64 and 36 respectively belong in the genus Aphis and Anuraphis. The remaining genera contain only from one to eight British species.

The labour entailed by this monumental work is evident from a study of the complex synonymy of many common species, and we are deeply indebted to the author for the way in which he has straightened out the chaotic tangle in which many important species have been struggling in the past. It is clear that the habits and behaviour of many economic species vary considerably in different countries.

The inevitable change of the specific name of well-known species may trouble the economic entomologist for a time, but the correct name will have the value of permanency. In this respect it is to be hoped that the type of the genus Aphis will be soon definitely agreed upon by the acceptance of the latter as a *genus conservandum*.

We do not understand why *Aphidella secreticauda* Theob. (gen. et sp. nov. 1923) should become *Aphidiella secretocauda* in the present volume, as we are not aware of any published note explaining the change and the name in its original form has already passed into the literature.

With these two volumes now available, it is evident that this authoritative work will be welcomed by entomologists, not only in Britain but also throughout the world. James Davidson.

Faune de France. (Fédération française des Sociétés de Sciences naturelles: Office centrale de Faunistique.) 15: *Diptères (Nématocères), Chironomidæ, Tanypodinæ.* Par M. Goetghebuer. Pp. 83. 18 francs. 17: *Diptères (Brachycères). (Asilidæ.)* Par E. Séguy. Pp. 191. 35 francs. (Paris: Paul Lechevalier, 1927.)

The appearance of volumes of the "Faune de France" series has frequently been noticed in these columns. No. 15, by M. Goetghebuer, of Ghent, deals with the little studied group of midges comprising the subfamily Tanypodinæ, and his account is the only comprehensive one dealing with the European forms. No. 17, by M. E. Séguy, of the Natural History Museum of Paris, is devoted to the Asilidæ or robber flies and is profusely illustrated with 384 figures. His contribution is particularly interesting, as the prey of each species are listed wherever known, and there is a useful account of the metamorphoses based largely upon the recent work of Melin. Both volumes are well up to the standard of their predecessors and will unquestionably prove of real assistance to students of the British species in the groups reviewed. The Office Centrale de Faunistique concerned with the publi-

cation of those monographs is to be congratulated on their excellence and the general uniformity of treatment that is being maintained in this truly admirable series.

Thysanoures, dermaptères et orthoptères de France et de la faune européenne. Par Prof. C. Houlbert. (Encyclopédie scientifique: Bibliothèque de zoologie.) Tome 2. Pp. iv + 357. (Paris: Gaston Doin et Cie, 1927.) 32 francs.

THE first volume of the above work was published in 1924, and the appearance of the second completes the account of the Orthoptera. The latter are treated under two sub-orders—the Dictyoptera, which include the Blattidæ and Mantidæ, and the Euteliopter a, which embrace the remaining families. The descriptions given of the various species are concise and clear, while the numerous illustrations are useful aids to identification. These features, together with the handy pocket size of the book, should make it a serviceable companion for the field naturalist in many parts of Europe. There is a considerable bibliography at the end of the book,, and most of the chief works dealing with Orthoptera are listed.

Pages of History.

Avicennæ de Congelatione et Conglutinatione Lapidum: being Sections of the Kitâb Al-Shifâ. The Latin and Arabic Texts edited with an English translation of the latter and with Critical Notes. By E. J. Holmyard and D. C. Mandeville. Pp. ix + 86. (Paris: Paul Geuthner, 1927.) n.p.

THE authors show that the Latin treatise "De congelatione et conglutinatione lapidum," which is printed in early alchemical books as a work of Avicenna's, is a translation of part of Avicenna's book, "The Book of the Remedy (*Kitâb al-Shifâ*)," and is therefore one of the few medieval translations from Arabic for which the original text dealing with alchemy is available. The work has been attributed to Aristotle, but is clearly a part of the treatise of Avicenna written as a commentary on Aristotle about A.D. 1022. In the Latin translation the work is divided into three parts, the last two having the titles "De causa montium" and "De quatuor speciebus mineralium." The work contains some very interesting geological speculations on the formation of stone, rock, and mountains, on the nature of minerals, and an adverse criticism of the alchemists. The authors consider that it probably represents opinions arrived at by Avicenna late in life, and that at an earlier period he probably composed books in favour of alchemy.

It is interesting to see these Latin translations of Arabic works, until a short time ago airily dismissed as 'forgeries,' brought into relation with their authentic originals, and we may hope that before long others may be added to the list. Messrs. Holmyard and Mandeville have made a very interesting and useful contribution to the history of chemistry.

An Introduction to the Study of Experimental Medicine. By Claude Bernard. Translated by Henry Copley Greene. With an Introduction by Prof. Lawrence J. Henderson. Pp. xxi + 226. (New York: The Macmillan Co., 1927.) 12*s*. 6*d*. net.

STRIKING evidence of the growing interest in the history of medical science is furnished by the recent appearance of this translation of the great French physiologist's classical work, which was first published more than sixty years ago. The translation is preceded by an introduction by Lawrence J. Henderson, professor of biological chemistry at Harvard University, who attributes the insufficient recognition which Bernard's writings have received to their having been overshadowed by the growth of bacteriological research. The introduction is followed by a translation of an appreciation of Claude Bernard by Paul Bert, who was his favourite pupil and successor at the Sorbonne.

Bernard's work consists of three parts. In the first, which deals with experimental reasoning, he emphasises the importance of the experimenter being at once a theorist and a practitioner, and maintains that physiological and pathological states are controlled by the same forces but differ only because of the special conditions under which the vital laws manifest themselves. In the second part, which is devoted to experimentation on living beings, the case for vivisection is luminously set forth. The third part contains applications of the experimental method to the study of vital phenomena, as illustrated by Bernard's own investigations.

The translator is to be congratulated on his excellent rendering of the French text.

School Science.

Readable School Biology. By O. H. Latter. (Bell's Natural Science Series.) Pp. xii + 143. (London: G. Bell and Sons, Ltd., 1927.) 2*s*. 6*d*.

THE publishers are to be congratulated upon the production of what should prove a popular addition to their Science Series, and the veteran naturalist and science master of Charterhouse upon the astounding range of biological fact and theory which he has concentrated into less than 150 pages. Well printed and containing 48 figures (many of them original), the book is very good value for money. The author has struck the distinctively modern note in biological teaching by emphasising the physiological aspect of his subject; so that the general reader will not be tired by tedious descriptions of types or by long lists of unfamiliar names. There is, indeed, a section on 'classification'; but here the reader is directed to general principles, the evolutionary scale, and the mind is left with an impression of living organisms rather than of museum specimens in jars correctly labelled.

The endeavour to live up to the title "Readable" has inveigled the author into some rather strained anthropomorphic analogies; that on p. 136 is particularly unfortunate in that it gives entirely

erroneous conceptions both of the behaviour of the chromosomes during meiosis and of their relation to inheritance. A number of Mr. Latter's colleagues will not be disposed to accept his assertion that "with classes taking Biology as part of their *general education*, personal practical work by the pupils themselves is sheer waste of time and money"; this need not, however, prevent even such from using his book, which is eminently readable.

Elementary General Science. By J. B. Jenkins. (Bell's Natural Science Series.) First Year's Course. Pp. viii + 149. Second Year's Course. Pp. vii + 171. (London: G. Bell and Sons, Ltd., 1927.) 2*s*. each.

THE arrangement of the subject matter of this introduction to physics and chemistry is unusual. Each volume is divided into three parts. In the first, very full instructions are given for carrying out a series of experiments, and each experiment is followed by a list of questions to assist the pupil to make the correct observations and inferences. In the second, the results of each experiment are discussed, and the third deals with the applications of the facts acquired.

Part I. is reminiscent of a cookery book, and it is disappointing to find that right to the end of the two years' course it is necessary to ask a question to ensure an observation or an inference. "Is the test-tube still intact?" follows the bursting of a test-tube by filling it with water and freezing the water! The electric bell would afford a valuable lesson but for the diagram and explanation, which 'give the show away.' Many of the experiments are more suitable for demonstration than for individual work.

There is something to be said for separating Parts II. and III., as a pupil frequently remembers the application but forgets the fact or principle, because the former made a vivid impression before the latter had been grasped.

Smith's Inorganic Chemistry. Revised and rewritten by Prof. James Kendall. Pp. xxvi + 1030 + 15 plates. (London: G. Bell and Sons, Ltd., 1927.) 12*s*. 6*d*. net.

IN this new edition of a well-known text-book, Prof. Kendall has been able to preserve the general plan and spirit of the original and at the same time to incorporate a considerable amount of new material. Of the many new topics dealt with, special mention may be made of the new views on the ionisation of strong electrolytes, which are very skilfully explained in simple language. The book is one of very modern conception and gives an excellent account of the elements of inorganic chemistry, with sections on physical chemistry and the organic chemistry of everyday life.

Elements of Chemistry. By Prof. Harry N. Holmes and Louis W. Mattern. Pp. xi + 519. (New York: The Macmillan Co., 1927.) 7*s*. 6*d*. net.

HOLMES and Mattern's book is chiefly noteworthy for the many excellent illustrations of chemistry in its applications to industry and daily life. There are more than 250 illustrations, many of them from photographs, and they certainly convey a most vivid picture of the ramifications of chemistry in all parts of modern life. For this feature alone the book is well worth inclusion in a school library. The text contains many references of interest to industrial processes, and teachers of elementary chemistry should find the book useful and stimulating.

Classified Problems in Physics. Part 1: *Mechanics and Hydrostatics.* By Dennis Brook Briggs and M. Briggs. Pp. viii + 128. 3*s*. Part 2: *Magnetism and Electricity.* By Dennis Brook Briggs. Pp. viii + 128. 3*s*. Part 3: *Heat, Light, and Sound.* By Dennis Brook Briggs. Pp. viii + 183. 3*s*. 6*d*. (London: Sidgwick and Jackson, Ltd., 1928.)

IN addition to some hundreds of problems, mostly numerical, of the standard of the school certificate examination, these books contain definitions, proofs of formulæ, and worked examples. The purpose they serve is difficult to see. They are not text-books, and as supplements they are, or should be, unnecessary. The pupil who solves more than a small fraction of the problems is learning arithmetic rather than physics. The teacher might find the problems useful, but would not need the other portions of the book.

Miscellany.

Coal in Great Britain: the Composition, Structure, and Resources of the Coalfields, Visible and Concealed, of Great Britain. By Dr. Walcot Gibson. Revised and enlarged edition. Pp. viii + 334 + 8 plates. (London: Edward Arnold and Co., 1927.) 21*s*. net.

THE fact that a new edition of Dr. Walcot Gibson's well-known book "Coal in Great Britain" has been called for seven years after the original publication of the book is evidence that the work has filled, and has filled satisfactorily, a want in coal mining literature. The new edition follows quite closely the arrangement of the previous one, but some of the material in the first edition has been expanded, so that the new volume contains 334 pages as against 311 in the earlier edition. A brief chapter has been added on the origin and composition of British coalfields; the chapters dealing with the coalfields of North Staffordshire, Yorkshire, and Nottinghamshire have been somewhat enlarged, and have been brought up-to-date by the light of recent investigations. This is perhaps particularly true of the great Yorkshire, Nottinghamshire, and Derbyshire coalfield, where development has been proceeding very actively during recent years, although there is still room for much investigation, seeing that the author himself admits that "the northern, eastern, and southern productive limits of the concealed basin remain conjectural." Full advantage has been taken of recent publications on the coalfields of Scotland, although these are still dealt with in one chapter, whereas the material available would readily have warranted a considerably more extended description. Perhaps the most disappointing chapter in the book is that dealing with the

East Kent coalfield, in the description of which advantage does not appear to have been taken of the most recent information. The new edition remains, however, as was the first, the best brief comprehensive survey that we possess of the coalfields of Great Britain.

Wireless Direction Finding and Directional Reception. By R. Keen. Second and enlarged edition. Pp. vii + 490. (London: Iliffe and Sons, Ltd., 1927.) 21*s.* net.

THIS work was first published in 1922 under the title "Direction and Position Finding by Wireless." In the interval, the wireless direction-finder, both in its application to navigation and as a useful instrument for scientific research, has developed to a considerable extent; and it is not surprising, therefore, to find that a second edition of Mr. Keen's book has been called for. The book has been revised in a thorough manner and considerably enlarged, while its scope has been usefully extended to include directional reception for communication purposes.

The earlier chapters deal in a clear and simple manner with the fundamental theory of directional receiving aerials, whether of the closed loop type used in direction-finding, or the extended open type used for beam communication. A description is then given of the various practical types of direction-finder used for aerial and marine navigation, and in the case of the Bellini-Tosi system, detailed working instructions are given for the choice of site, erection and calibration of the direction-finder on ship or shore. The navigational side of the subject is dealt with in three chapters, containing details of the special maps and charts which are required and the necessary instruction in field and nautical astronomy. Modern research is summarised in a chapter on the phenomena of night errors and coastal refraction, and the relation of these to the propagation of electromagnetic waves is explained.

A most valuable portion of the book is the bibliography of 374 references, which have been well chosen and are arranged chronologically in an excellent manner. The book is well illustrated by a large number of diagrams and photographs, and the production leaves nothing to be desired. It should undoubtedly be in the possession of everyone interested in the subject of directional wireless.

R. L. SMITH-ROSE.

A Survey of the Social Structure of England and Wales: as Illustrated by Statistics. By A. M. Carr-Saunders and D. Caradog Jones. Pp. xvii + 246. (London: Oxford University Press, 1927.) 10*s.* net.

THE compilation of accurate statistical data for public edification is a twentieth-century phenomenon. It is a logical outcome of the demand of the reasonable for facts upon which to base action and opinion. The facts which have emerged have been of incalculable assistance to social reformers, whose appetite has grown until at the present time a varied and abundant but somewhat indigestible fare is available for consumption. This volume is a praiseworthy effort to assist the public in its task of assimilation. It gives form and coherence to the vast accumulated mass of statistics from official and unofficial sources which bear on the various aspects of the social life of the community. Even more valuable still, it points out the existing gaps in the statistical data available.

By virtue of its presentation of facts without prejudice, the judicial calm with which the many defects in our social structure are noted and commented on, this volume can be commended to all serious students of social science. But those who expect to find prescriptive remedies for our social ills or a general social theory will be disappointed. The authors are content to give the outlines of the problems confronting society, such as those connected with the numerical preponderance of women, the effect of heredity, environment, and education on quality of population, the distribution of wealth, and the social aspect of the methods adopted by various sections of the community for the protection or improvement of their position in society. It merits the closest attention of scientific workers because of its suggestiveness and the clarity with which it blazes the trail for others in this fascinating, if perplexing, field of research. A. G. C.

Pitman's Dictionary of Industrial Administration: a Comprehensive Encyclopædia of the Organisation, Administration, and Management of Modern Industry. Edited by John Lee. Complete in about 30 fortnightly Parts. Part 1. Pp. xv + 48. (London: Sir Isaac Pitman and Sons, Ltd., 1928.) 1*s.* 3*d.* net each Part.

WITH the present trend towards amalgamation and co-operation of effort in industry with the view of improving the organisation of production and marketing effort, this work should be specially welcome to those now actually engaged in the organisation, administration, and management of modern industry, or those who hope to attain positions of importance in the future. In America and Germany nearly every industry has its authoritative work of reference; and while there are several text-books in Great Britain devoted to single aspects of the problem of scientific management, this dictionary is, so far as we are aware, the first attempt to cover the whole subject in comprehensive fashion. A reference to the first part shows that every subject and problem that are likely to arise in a well-organised undertaking are dealt with briefly, and without the over-theorising from which many similar treatises, written from the academical rather than from the practical point of view, suffer. The student and practical man will find articles on production, administration, marketing, insurance, finance, welfare, accident prevention, hygiene, transportation, power, and other aspects of the one big problem of efficient management. Unlike some other similar works, the dictionary is generously cross-referenced to enable the student to find the information he is seeking with the minimum of trouble. A really full index in the last volume should still further enhance the value of the work.

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Technology.

G. Bell and Sons, Ltd.—Old English Porcelain. A Handbook for Collectors, W. B. Honey. *Ernest Benn, Ltd.*—Modern By-Product Coking Practice, E. Bury and S. J. Morgan; Textile Microscopy, L. G. Lawrie. *Chapman and Hall, Ltd.*—The Cleaning of Coal, Dr. W. R. Chapman; Ice Cream Plant and Manufacture, R. G. Reid; Quantity Surveying for Builders, W. L. Evershed, new edition; Bells Thro' the Ages; The Founder's Craft and Ringer's Art, J. R. Nichols; Photographic Art Secrets, W. Nutting; The Problem of Fermentation: the Facts and Hypotheses, Dr. M. Schoen, translated by H. L. Hind; Artificial Silk, Dr. F. Reinthaler, translated by Prof. F. M. Rowe; Horology: the Science of Time Measurement, and the Construction of Clocks, Watches, and Chronometers, J. E. Haswell. *C. Griffin and Co., Ltd.*—Paint Technology, F. Noel Heaton. *Iliffe and Sons, Ltd.*—Moving Coil Loud Speakers, F. H. Haynes. *Crosby Lockwood and Son.*—Modern Furniture Veneering, E. W. Hobbs; Masonry: a Practical Guide to the Art of Stone Cutting, W. R. Purchase, new edition. *Longmans and Co., Ltd.*—The Science and Practice of Confectionery, Prof. D. Ellis and D. Campbell. *Macmillan and Co., Ltd.*—The Finishing of Jute and Linen Fabrics, T. Woodhouse, new edition. *Methuen and Co., Ltd.*—The Technical Arts and Sciences of the Ancients, A. Neuburger, translated by Dr. H. L. Brose.

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ornaments in glass paste. Finally, small beads of glass paste lying in masses show a pattern worked in colours, probably part of a garment, a new feature in Mycenæan art. Pottery dates the tomb at about 1300 B.C. No human remains were found, and Prof. Persson suggests that the tomb may have been the cenotaph of a chief. This would agree with the great attention known to have been paid to the dead by the Mycenæans and with practices suggested in several Homeric passages.

The Boyden Station of the Harvard College Observatory, which was situated at Arequipa, Peru, from 1890 until 1927, has now been re-established near Bloemfontein in the Orange Free State. Photographic work with two telescopes was resumed in September 1927, using the temporary quarters provided by the city of Bloemfontein while the permanent station is under construction on a low kopje a short distance south of Mazel's Poort, the power station settlement of the city. Bloemfontein is providing the permanent site for the new observing station, and making roads and other improvements for the Harvard Observatory. Under the former director, Prof. E. C. Pickering, and the present director, Prof. Harlow Shapley, the Harvard Observatory has maintained for forty years a very active interest in the southern sky, and nearly one-half of the great collection of astrographic plates at Harvard were made at its Boyden Station. The observing conditions at Arequipa were excellent for about eight months of the year, but a prolonged cloudy season from November to March badly hampered the systematic observations. The cloudy weather at Bloemfontein is more evenly distributed through the year, and at the same time the transparency and seeing are extraordinarily good. The transfer of the station and its enlargement were made possible through gifts by the International Education Board and by Harvard University. A new 60-inch reflecting telescope, to be the largest instrument in operation in the southern hemisphere, is being constructed for the Boyden Station. Other instruments that will be in operation are photographic doublets of eight inches and twenty-four inches aperture, a 10-inch photographic triplet, the 13-inch Boyden refractor, and photographic cameras of one, three, and five inches aperture. The problems under investigation include extensive studies of variable stars, extra-galactic nebulæ, globular star clusters, proper motions, and spectral classification and analysis. The transfer and erection of the station are under the immediate supervision of Dr. J. S. Paraskevopoulos.

The *Annual Report* of the Committee of Management of the Lewis Evans Collection of Scientific Instruments at Oxford has just been published. It records the restoration of the main exhibition room in the Old Ashmolean Museum to its original condition, and the unveiling by Viscount Cave, as Chancellor of the University, of the memorial windows to Dr. Plot and to Sir Christopher Wren. All the astrolabes in the collection have now been photographed in preparation for an illustrated catalogue; important memoirs on the subject of the astrolabe have been published by Dr. R. T. Gunther, the curator of the collection. Among recent accessions are a 6-in. reflecting telescope made by Sir William Herschel, and the fine silver microscope made by G. Adams for George III. The telescope has been presented by Dr. Herbert N. Evans, of Exeter College, himself a cousin of Dr. Lewis Evans; it was formerly in the possession of Archdeacon Nathaniel Jennings, who had a small private observatory on the north side of Regent's Park, London. The George III. microscope, apart from its interest as an example of the silversmith's art, admirably illustrates the advance made in one century from the instrument designed by R. Hooke, of Christ Church, in 1665. Among other accessions are a 'thunderhouse' and a frictional electric machine, both of which are associated with Joseph Priestley. The Report ends with a reference to the finances of the collection, which in spite of liberal gifts from the great City Companies and other public bodies both within and without the University, cannot yet be said to be on a satisfactory footing.

Prof. A. Labbé's work on copepods in the saline waters of Croisic, and his claims to have established an evolution from one genus to another, have been discussed by Mr. R. Gurney and Mr. A. G. Lowndes in the columns of Nature (Sept. 4, Oct. 16, 1926; Aug. 27, 1927). These 'allomorphs,' or transition forms, he affirms may be produced by slight alteration in the environment, both in the laboratory or, within a longer period, naturally in the marshes themselves. Thus in eight stages, during seven years he claims to have transformed Canthocamptus into Cyclops, and similarly many forms have been changed from one genus to another. Mr. Gurney's criticisms are based, first, on the incomplete evidence given, Prof. Labbé himself admitting that his aquaria were not absolutely free from contamination by other species, and giving no exact details of his experiments so that the evidence can be weighed; and secondly, on the wrong identification of his forms, some of the new genera being apparently identical with those already known, and the figures themselves inaccurate. Mr. Lowndes attacks the problem from another quarter, questioning the results on the grounds of the impossibility of such small increases in the pH being capable of producing such momentous results, and referring to his own work on freshwater Cyclops which retain their individual characters within a wide pH range.

We have now a communication from Prof. Labbé in support of his own observations, upholding the identifications in spite of criticisms, his contention being that Mr. Gurney could not possibly prove that forms were identical which he did not see. He suggests sending to Mr. Gurney a lot of the copepods for analysis; an offer which we hope will be accepted. Secondly, in answer to Mr. Lowndes he agrees that freshwater copepods can often bear a much greater range of pH than those in salt water, but holds that variation in pH will not necessarily bring about morphological variation. Thus the quoted Artemia

showed no change, whatever the variation in pH. On the other hand, with small change in surroundings alteration may take place. As he says, "Allelogenesis is likely to succeed only under proper conditions of equilibrium between *inner* and *outer* pH." To find such conditions "is the fundamental problem of allelogenesis, which I have not yet solved." Prof. Labbé quotes his previous work on the cycles of Dunaliella as suggesting some solution of the problem of internal adjustment, and finally states that he will carry on his researches 'quite undisturbed.' It is to be hoped that he will bring forward more exact descriptive and experimental evidence in support of his interesting and revolutionary statements.

WE much regret to announce the death on Mar. 4, at the age of seventy-five years, of Sir Aubrey Strahan, K.B.E., F.R.S., lately Director of the Geological Survey of Great Britain, and of the Museum of Practical Geology, London.

THE Council of the British Association will nominate Sir Thomas Holland, rector of the Imperial College of Science and Technology, as president of the Association for the meeting to be held in South Africa in July and August 1929. Mr. O. J. R. Howarth, Secretary of the Association, expects to proceed to South Africa in May next to confer with authorities there on arrangements for the meeting.

MR. W. L. HICHENS, chairman of Messrs. Cammell, Laird and Co., and well known for his work in scientific administration and industry, has been elected a member of the Athenæum Club under Rule II., which provides for election by the Committee of "persons of distinguished eminence in science, literature, or the arts, or for public services."

THE following officers were elected at the annual general meeting of the Geological Society of London, held on Feb. 17: *President*, Prof. J. W. Gregory; *Vice-Presidents*, Dr. F. A. Bather, Prof. E. J. Garwood, Dr. E. Greenly, and Mr. H. W. Monckton; *Secretaries*, Mr. W. Campbell Smith and Dr. J. A. Douglas; *Foreign Secretary*, Sir Arthur Smith Woodward; *Treasurer*, Mr. R. S. Herries.

DR. W. ROSENHAIN, Superintendent of the Metallurgy Department of the National Physical Laboratory, Teddington, since 1906, has been elected president of the Institute of Metals for 1928-29. Dr. Rosenhain is a graduate of the University of Melbourne, Australia, whence he came to England in 1892 with a research scholarship of the Commissioners of the 1851 Exhibition. He has carried out a large amount of metallurgical research both on non-ferrous metals and on iron and steel, and is also well known in connexion with glass technology.

DR. HERBERT E. IVES, who recently received the John Scott medal and premium for his contributions to electrical telephotography and television, has given the amount of the premium (1000 dollars) to the Optical Society of America, to found and endow a medal. This medal, to be awarded every two years for distinguished work in optics, is to be named "The Frederic Ives Medal," in honour of the donor's father.

A CONFERENCE on "Malting Barley" will be held at the Rothamsted Experimental Station at 11.30, on Thursday, Mar. 15. The subjects of the addresses to be delivered are "What the Barley Buyers Want"; "The Influence of Season on the Yield and Quality of Barley"; "Cultivation and Treatment of Barley grown for Malting in the Vale of Taunton"; "Cultivation and Treatment of Barley grown for Malting on the Lincolnshire Heath"; "Malting Barley: Old and New Varieties"; and "Five Years' Experiments on Malting Barley."

AT a meeting of the Royal Society of Edinburgh held on Mar. 5, the following were elected fellows of the Society: Dr. E. A. Baker (Edinburgh), Prof. G. B. Barbour (Peking), Mr. H. W. Brown (Edinburgh), Rev. Dr. W. S. Bruce (Banff), Prof. A. J. Clark (Edinburgh), Dr. A. Couttie (Edinburgh), Dr. W. Murdoch Cumming (Glasgow), Mr. W. R. Dawson (London), Mr. E. W. Fenton (Edinburgh), Dr. James Forrest (Dundee), Prof. J. Fraser (Edinburgh), Dr. K. Fraser (Carlisle), Mr. W. G. Harding (Oxford), Mr. A. D. Hobson (Edinburgh), Mr. W. V. D. Hodge (Bristol), Dr. A. Hunter (New York), Mr. P. J. Johnston-Saint (London), Prof. R. W. Johnstone (Edinburgh), Dr. T. J. Jones (Liverpool), Mr. T. L. MacDonald (Glasgow), Prof. T. J. Mackie (Edinburgh), Prof. G. Matthai (Lahore), Dr. J. E. Nichols (Edinburgh), Dr. C. H. O'Donoghue (Edinburgh), Dr. G. H. Percival (Edinburgh), Mr. R. S. Pilcher (Edinburgh), Mr. C. E. Price (Edinburgh), Mr. O. F. T. Roberts (Aberdeen), Mr. R. Senior-White (Kasauli, India), Mr. A. D. B. Smith (Edinburgh), Mr. A. M. Watters (Hawick), Mr. J. M. Whittaker (Edinburgh), Dr. J. Williamson (St. Andrews).

THE fifth International Botanical Congress will be held at Cambridge on Aug. 16–23, 1930, with excursions during the following week. As at present arranged, the Congress will be organised in the following sections: Palæobotany, morphology (including anatomy), taxonomy and nomenclature, plant geography and ecology, genetics and cytology, plant physiology, mycology and plant pathology. For each of these sections a British sub-committee has been appointed, by which the programme will be arranged. The chairmen of these sub-committees and their addresses are as follows: Palæobotany, Prof. A. C. Seward, Botany School, Cambridge; morphology (including anatomy), Prof. F. E. Fritsch, Danesmount, Tower Hill, Dorking, Surrey; taxonomy and nomenclature, Dr. A. W. Hill, Royal Botanic Gardens, Kew, Surrey; plant geography and ecology, Prof. A. G. Tansley, Department of Botany, The University, Oxford; genetics and cytology, Sir John Farmer, Imperial College of Science and Technology, London, S.W.7; plant physiology, Dr. F. F. Blackman, Botany School, Cambridge; mycology and plant pathology, Dr. E. J. Butler, Imperial Bureau of Mycology, 17 Kew Green, Kew, Surrey. Communications made to the Congress by means of papers or by participation in the general discussions will be permissible in English, French, or German. An executive committee of British botanists has been appointed, with Prof. Seward as chairman,

to make the necessary arrangements; Dr. A. B. Rendle is acting as honorary treasurer, and Mr. F. T. Brooks, 31 Tenison Avenue, Cambridge, and Dr. T. F. Chipp, Royal Botanic Gardens, Kew, are honorary secretaries of the Congress.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A teacher of woodwork and geometry at the Walthamstow Technical College—The Clerk to the Governors, 1 Selbourne Road, E.17 (Mar. 12). An assistant master for mathematics and science at the Acton and Chiswick Polytechnic Junior Technical School—The Principal, The Polytechnic, Bath Road, Chiswick, W.4 (Mar. 16). A principal and head of the metallurgical department of the County Technical College, Wednesbury—The Director of Education, County Education Offices, Stafford (Mar. 23). A full-time teacher of engineering subjects at the Shrewsbury Technical College—The Secretary to the Committee of Management, Guildhall, Shrewsbury (Mar. 27). A biochemist and a protozoologist at the Medical Research Institute in Nigeria—The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, Whitehall, S.W.1 (Mar. 31). Inspectors of agriculture under the Department of Agriculture and Forests of the Sudan Government—The Controller, Sudan Government, London Official, Wellington House, Buckingham Gate, S.W.1 (April 7). A professor of organic chemistry in the Central College, Bangalore, University of Mysore—The Registrar, University of Mysore, Mysore, India (April 25). A junior assistant in the Research Department, Woolwich (under the directorate of Explosive Research)—The Chief Superintendent, Research Department, Woolwich, S.E.18.

ERRATUM.—In NATURE of Mar. 3, p. 315, col. 2, lines 20 and 24, it was stated that Prof. A. V. Hill had calculated that the Woolworth Building in New York could be climbed in eight seconds, and that it had been done in nine seconds. These times should be eight minutes and nine minutes respectively.

Our Astronomical Column.

COMETS.—After the discovery of Reinmuth's comet, an examination was made of earlier plates taken at Königstuhl, with the result that the following position of the comet was derived: Jan. 29·10757 U.T.; R.A. $9^h\ 23^m\ 35^s{\cdot}6$; N. Decl. 17° 41′ 19″; from this position, combined with those of Feb. 22 and 25, Dr. A. C. D. Crommelin has derived the following elliptical orbit (the position for Feb. 22, on revision of measures, was given as $9^h\ 15^m\ 7^s{\cdot}5$, N. Decl. 21° 44′ 55″):

$$\begin{array}{ll} T & 1928 \text{ Feb. } 1{\cdot}6502 \text{ U.T.} \\ \omega & \left.\begin{array}{l} 9^\circ\ 26'\ 37'' \\ 124\ \ 53\ \ 11 \\ 8\ \ \ 0\ \ 16 \end{array}\right\} 1928{\cdot}0 \\ \Omega & \\ i & \\ \phi & 30\ \ \ 2\ \ 13 \\ \log a & 0{\cdot}5701080 \\ \log q & 0{\cdot}2685923 \\ \text{Period} & 7{\cdot}164106 \text{ years.} \end{array}$$

The following ephemeris is for 0 h. U.T.:

	R.A.	N. Decl.	log r.	log Δ.
Mar. 8	$9^h\ 14^m\ 31^s$	23° 8′	0·2748	9·9889
16	9 16 44	23 31	0·2778	0·0132
24	9 20 54	23 35	0·2814	0·0402

The orbit does not closely resemble that of any comet in the catalogues, but there is a distant resemblance to that of Denning's comet, 1894 I. It is of interest that the aphelion point of the above orbit lies close to the perihelion point of comet Schwassmann-Wachmann, and the two comets were close together in the middle of 1924, if the orbit of Reinmuth is near the truth; it represents within 2½′ an observation made at Milan on Feb. 28.

Mr. James Young obtained a photograph of Encke's comet, Feb. 6·7708 U.T., from which he derives the following position: R.A. $22^h\ 49^m\ 54{\cdot}5^s$, N. Decl. 0° 18′ 55″. This gives Feb. 19·829 for the date of perihelion, which is 3 hours later than Matkiewicz's predicted date, Feb. 19·6984, rather an unexpectedly large discordance. The acceleration of this comet, which formerly attracted so much attention, seems to have completely died away. This renders it difficult to explain the acceleration by resisting medium, as such a medium could scarcely have been present in the last century and absent now.

Mon. Not. Roy. Astro. Soc. for January contains reproductions of the drawings of Skjellerup's comet by Mr. Chidambara Aiyar on Dec. 15, when it was about 2° from the sun.

THE DRAYSON PARADOX.—This paradox had its sole basis in a carelessly written paragraph in Sir J. Herschel's "Outlines of Astronomy." It asserts that the pole of the equator moves around a centre that is 6° distant from the pole of the ecliptic, so that the obliquity varies between 23½° and 35½°; the ice-ages are asserted to have occurred at the epochs of maximum obliquity. Drayson also erroneously claimed that the proper motions of stars were merely an effect of this movement of the earth's axis.

The observational evidence against the Drayson theory, and its lack of a dynamical basis, have been frequently brought before the public during the last half-century, but it still claims adherents. Mr. A. H. Barley, its principal advocate, has recently brought out a pamphlet, "The Ice Age" (W. E. Baxter, Ltd., Lewes, Sussex), in which the old assertions of Drayson are repeated, and the further claim made that the very small errors in the predictions concerning the recent solar eclipse (spoken of as 'serious errors' in the pamphlet) were due to the non-acceptance of Drayson's views. The argument here is a repetition of that used by Mr. E. J. Stone in several papers between 1883 and 1892; he ascribed the errors of Hansen's lunar tables to a change in the ratio of mean to sidereal time, brought about by the substitution of new solar tables in the *Nautical Almanac*. He was correct in asserting that some such change took place, but he multiplied its effect by 365; Sir G. Airy showed in a letter to the *Observatory* in May 1883 that sidereal time, from the manner in which it was derived, could not be in error by the amount that Stone asserted.

Prof. de Sitter discussed the errors of the lunar tables in NATURE of Jan. 21, p. 99, and gave the evidence in favour of the conclusion that they are due to small variations in the earth's rate of rotation, not to changes in the direction of its axis.

Research Items.

Hawaiian Jaws and Teeth.—Mr. H. G. Chappel has examined the collection of Hawaiian mandibles, both those attached to crania and those without crania, and mostly dating from before the coming of the white man, in the Bernice P. Bishop Museum, Honolulu, with a view to the study of the teeth and dental disease. The results are published in *Memoirs of the Bernice P. Bishop Museum*, vol. 9, pt. 3. The teeth show comparatively little irregularity, only 9·9 per cent. Only 17·2 per cent. have the incisor knocked out as a sign of grief for a relative. This custom was more prevalent among the men than the women, and on Hawaii than on the other islands. There is little caries owing to developmental faults. From forty to sixty years of age it increases considerably, and is more prevalent in mandibular than in the maxillary teeth. Alveolar abscesses grow more prevalent as age advances, as does pyorrhea; between forty and sixty years of age only 6·57 per cent. are free from it. As regards the jaws, there are more orthognathous females than males and little prognathism in either sex. The majority of males and females show a greater height and width of the ramus of the mandible on the left side and a greater height of the body of the mandible on the right side. The males of the island of Hawaii show a greater bigonal width than those of the other islands.

Cancer Statistics.—The Ministry of Health has issued two further reports on cancer. One of these (*Reports on Pub. Health and Med. Subjects*, No. 46) deals with cancer of the rectum, and is based on an examination, by the Departmental Committee, of the records of rather less than 6000 cases of this disease. It is found that, on an average, the patients did not come to operation until twelve months after the occurrence of the first symptoms, and that rather less than half the patients when seen by the surgeons were considered to be operable. Of those operated on, about one-sixth died as the result of such operation, sepsis being the cause of half these deaths, but two out of every five were alive three years afterwards. The other report (*ib.*, No. 47) deals with the treatment of cancer of the uterus at the Samaritan Free Hospital, and has been prepared by Dr. Janet Lane-Claypon and Mr. W. M'K. H. M'Cullagh. Again the same fact emerges that something like half the patients are inoperable when they present themselves, and that the first symptoms were noticed six months previously. The operative mortality in cancer of the cervix was only about 6–7 per cent., and the number surviving five years after hysterectomy was about 34 per cent. for the vaginal, and 44 per cent. for the abdominal operation. For cancer of the body of the uterus, the number surviving five years after operation was 61·5 per cent. It has long been recognised that childbirth is a predisposing cause of cancer of the cervix, and the data here collected suggest that there is also a definite association of the disease with early miscarriage before the fœtus is viable. Many other details have also been analysed in the two reports, such as the earliest symptoms of the disease noticed by the patients, the mortality of various operative procedures and the chief causes of death therefrom, and the duration of life without operation.

Harmful Noise.—The Engineering Section of the National Safety Council, at its sixteenth annual congress, held at Chicago on Sept. 26-30 last, reports the results of a research committee set up to deal with the elimination of harmful noise. The report begins by attempting to define noise, but admits that the line of demarcation between musical sound and noise cannot be sharply drawn. The interest in noise elimination is widespread, and many articles have appeared throughout America during the year. Dr. E. E. Free made a noise survey of the city of New York, and Mr. R. F. Novis of Chicago. Such surveys, however, cannot be utilised as a basis for determining which noise should be eliminated and which may be tolerated. People who are ill can tolerate only a minimum of noise, but no one knows what noises are harmful, or how much noise is harmful to people who are not ill. Several attempts have been made to measure the effect of noise upon the human organism, but so far the data for formulating a definition of harmful noise are not available. The report suggests that the services of physiologists, neurologists, otologists, psychologists, and physicists should be enlisted in order to investigate the problem. Prof. John J. B. Morgan, of Northwestern University, has made a preliminary study of the effects of noise by comparing the electrocardiograph records of subjects in a quiet and in a noisy environment. The noises were produced by Western Electric audiometers, the sound being amplified and given to the subjects through a loud-speaking telephone. Prof. Morgan's tentative conclusions are (1) that the heart action is modified by the noise, but that the effect is more apparent in the irregularity of the action than in the average rate; (2) that subjects vary in the way they respond and that different sounds have different effects; (3) that the suggestion of a 'horrible din' to a hypnotised subject quickens the pulse, thus indicating that the emotional attitude towards the sound may be of greater significance than the quality of the sound itself. The report concludes that the method indicates a way of approach to the very difficult problem of harmful noise.

Zoological Studies of Central Asia.—The Commission for the Study of Natural Resources of the Russian Academy of Sciences has just published a list of literature on animals of Turkestan, compiled by M. M. Ivanova-Berg, under the editorship of Prof. Leo Berg. The list comprises a volume of large size, 235 pp. in all, and covers all literature on animals of Central Asia, both wild and domestic. Central Asia is given wide limits, and includes the Kirghiz steppes, Turkestan, Dzhungaria, Kashmir, N.W. India, Afghanistan, and northern Persia, but the literature on the fauna of the Caspian Sea is not included, except that dealing with fisheries on the eastern coast. Russian literature is dealt with very exhaustively, but it is not claimed that foreign papers are fully represented. The total number of entries is 4894. Titles are classified; first are quoted systematic, zoogeographical, and similar papers on each group; then a section on pests of agriculture follows; another special section on locusts (more than 800 entries); then fisheries; animal breeding generally and by branches; bee-keeping; silkworm industry. Two supplements bring the bibliography practically up to the end of 1927. Two indexes, one of geographical names mentioned in titles, another of species of animals, conclude this volume, which will be found very useful by anyone working on scientific or economic problems of Central Asia.

Polyzoa from the Adriatic and Mediterranean.—Dr. Antonia Neviani ("La *Schizotheca serratimargo* Hks. sp. nell' Adriatico e suoi ospiti." *Memorie della Pont. Accademia delle Scienze—I nuovi Lincei*, Ser. 2, vol. 10) redescribes this interesting species, first discovered by Hincks in 1886 from the Adriatic,

and, although only fragments were then obtained, attributed by him to the genus Schizoporella. Dr. Neviani, having succeeded in finding several fine specimens in the Mediterranean, gives a detailed account of these, together with other encrusting polyzoa growing on them. *Schizotheca serratimargo*, as it is now called, is a calcareous polyzoon living in the coralline zone attached to various stones, shells, madrepores, and nullipores from the Mediterranean and the Adriatic Seas, the Suez Canal, and the coast of Morocco, also occurring fossil in the Pliocene and post-Pliocene of Italy. A full list of records is given, showing that from 1909, when it was recorded by Waters from the Red Sea, it was not again mentioned until 1925, when Canu and Bassler included it in their list of Bryozoa from Morocco and Mauritius. It is unfortunately exceedingly delicate to handle and breaks up at the slightest touch. The 'guests' or animals growing upon it include Spirorbis and serpulids and five species of calcareous polyzoa, all belonging to different genera.

Parasites of the European Corn Borer.—*Circular No. 14* (Oct. 1927) of the United States Dept. of Agriculture embodies a résumé of the present status of imported parasites of the European corn borer. The authors, Messrs. D. W. Jones and D. J. Caffrey, mention that since native parasites do not effectively attack this insect, it has been deemed necessary to import certain species which parasitise it in its original habitat in France, Belgium, Italy, and Hungary. Twelve different species of parasites have been introduced into the United States between 1920 and 1927, numbering more than 355,000 individuals. All these were sent to the Corn Borer Laboratory at Arlington, Mass., and from there distributed, after they had mated, among infested areas. A certain number of parasites were kept back in order to build up an increased stock before liberation, and in this way 1,535,000 additional parasites were obtained. Systematic collections and observations in the vicinities where these liberations took place, have resulted in the recovery of six of the species concerned in circumstances indicating that they have become established in the United States, and that they are actually preying upon the corn borer. Although strenuous efforts are being made to import, breed, and establish these various parasites in corn borer infested areas, it is too early at present to decide whether they will prove effective aids in controlling the pest. Judging from the experience with similar parasites imported to aid in controlling other foreign pests, several years will elapse before any important effect can be expected. In the meantime, every effort to control the corn borer by other methods needs to be assiduously maintained.

Genetics of Cherries.—In a study of the genus Prunus, including the plums and cherries, Mr. C. D. Darlington (*Jour. of Genetics*, vol. 19, No. 2) finds that 8 is the basal number of chromosomes and that many of the species and varieties are polyploid. The chromosome number runs so high as 48, and some varieties have chromosome numbers which are aneuploid (not an even multiple). Self-sterility is prevalent and hybridisation has occurred between different forms. This has created a swarm of hybrid forms which render impossible any clear demarcation between species with the same number of chromosomes. Homologous series of variations also occur in Prunus, which are attributed to crossing and segregation among related types. The sweet cherries (*P. avium*) have some trivalent chromosomes, the total number of chromosomes being $2n = 17$–19. The sour and Duke cherries (*P. cerasus*) are tetraploid ($2n = 32$), and the bivalent chromosomes are often grouped in pairs at meiosis. The sweet cherries are of ancient cultivation, but the Duke varieties, developed largely in the seventeenth century, are regarded as aberrant $4n$ segregates from diploid gametes of sweet cherries, perpetuated by grafting. Tetraploidy also has the effect of removing the bar to self-fertility. It is found that cherries which are diploid, or nearly so, can produce tetraploid seedlings, and vice versa.

Mendelian Genes and Development. — The Amphipod *Gammarus chevreuxi* has provided useful material for genetic study. Messrs. E. B. Ford and J. S. Huxley (*Brit. Jour. Exptl. Biol.*, vol. 5, No. 2) have made an analysis from a developmental point of view of the factors controlling eye-colour. The normal black-eyed type gives rise to various mutational eye-colours, such as red, which may differ not only in the final adult colour, but also in the rate at which pigment is deposited. Segregation for slow or rapid development of the pigmentation may occur in a simple mono-hybrid ratio, but in certain families an apparent failure to segregate was found to be due to accessory rate-factors. Many of the facet-colour genes therefore influence the time relationships governing the deposition of melanin, all coloured eyes passing from colourless through scarlet; later they may darken to black by the addition of melanin. Graphs for developmental rates of different factors are given, and conditions which may bear a similar interpretation in various other animals are discussed. It is suggested that a multiple allelomorph series may represent the developmental curves of a single substance, differing in rate of formation of the substance, time of beginning deposition, and equilibrium position finally reached.

New Carboniferous Pelecypoda.—An important little paper on certain Carboniferous Pelecypoda, or, as he prefers to call them, lamellibranchs, has just been published by Mr. J. Wilfrid Jackson of the Manchester Museum (*Mem. and Proc. Manchester Lit. and Phil. Soc.*, vol. 71, No. 10: reprinted as *Notes from the Manchester Museum*, No. 31). The genera dealt with are Pterinopecten, Posidonomya, and Posidoniella. The author shows that more than one form has been included in the first-named genus as *P. papyraceus* (Sow.) and distinguishes five species. The differences between them depend on surface ornamentation, and occur on specimens from different horizons, but are not so marked as those exhibited by contemporary Goniatites, nor are the various species of equivalent value to the Goniatites for zonal purposes, mainly owing to the scarcity of well preserved specimens. Two new species of Posidoniella are also described. The paper is illustrated by three very good plates.

Crystalline Carnotite.—The usual carnotite deposits of the plateau region of Utah and Colorado are impregnations in sandstone formed when the rocks were first exposed to the percolation of meteoric waters. Geologically this date has been placed in the Eocene, and the lead-ratios indicate a numerical age of at least 42 million years, in good agreement. A discovery of crystalline carnotite has now been made in a situation near the upper end of the Grand Canyon, where the date of formation would be considerably later in the Tertiary. This unique material is thoroughly described by F. L. Hess and W. F. Foshag in the *Proc. U.S. Nat. Mus.*, vol. 72, art. 12, 1927. Lead is present, as shown by spectroscopic tests, but in quantities too small to be determined chemically in the limited samples available. However, the age was estimated from a measurement of the proportional radioactivity. The radium–uranium

ratio was found to be only 68 per cent. of the normal ratio, corresponding to an age of 6·8 million years, which agrees well with the geological indications. With further investigations of this kind it will become possible to date the various stages in the history of the Grand Canyon from the Eocene to the present day.

SURVEY WORK IN THE UNITED STATES.—Among the many accomplishments of the United States coast and geodetic survey for the year ending June 1927, the *Annual Report* directs particular attention to three of importance. The first is the completion of the field work necessary to make a readjustment of the first order triangulation west of the ninety-eighth meridian. The second is the investigation of the first order level net of the United States. The adjustments started from Galveston and were carried to the Pacific and Atlantic coasts. This levelling shows that mean sea-level on the Atlantic coast is more than a foot above mean sea-level on the Pacific coast. The third notable achievement was of a different nature, namely, the construction of a light movable steel tower for use in triangulation in flat regions. The use of this improved tower is expected to reduce the cost of first order triangulation in level lands as much as 25 per cent. A further advance in survey methods is the adoption by all the vessels of the survey of echo-sounding apparatus. After extensive tests and modifications, a satisfactory apparatus has been developed. The *Report* contains key maps of the state of various surveys.

ARE AURORÆ ACCOMPANIED BY NOISES?—Reports of swishing sounds accompanying auroral displays are common, but are still regarded with doubt, because of the difficulty of reconciling the production of such sounds at low levels with the extreme rarity and altitude (about 100 km.) at which auroræ appear. There have, however, occasionally been reports of auroræ being seen at much lower levels; some years ago, in a letter to NATURE, Dr. G. C. Simpson discussed various cases of the kind, including some instances in which he was able personally to investigate the report on the spot; his conclusion was that in these cases the effect was an optical illusion. Another report of a low level aurora, by Mr. J. H. Johnson, appeared in the December (1927) issue of the *Publications of the Astronomical Society of the Pacific.* "A singular aurora—an array of dancing streamers having prismatic colours," accompanied by swishing sounds, was seen at Eagle, Alaska, 64° 47′ N., 141° 10′ W. in front of a bluff half a mile away, which rises to a height of 1200 feet above the town. There seems to be no reason to doubt that a remarkable luminous phenomenon occurred not far from the observer, and at less than 1000 feet above ground level; but it must have been of a very different character from that usually called an aurora. Even the top of the streamers did not appear above the summit of the bluff, and no mention is made of the presence, at the same time, of high-level aurora properly so-called.

NEW RESULTS WITH SOFT X-RAYS.—In a recent paper in the *Journal de Physique* (vol. 8, p. 484) J. Thibaud and A. Soltan have directed attention to differences between their measurements of wave-lengths between 40 A. and 80 A., made with a ruled grating, and those made by Dauvillier with a crystal. The latter, if calculated directly from the Bragg formula, are always too high, apparently because the index of refraction of the material used differs from unity by as much as 0·01 in this region. Their own results include new values for the K lines of nitrogen and boron, and for the N and O rays of several heavy elements, and have enabled them to find the energies of the L level for the lighter elements. The N rays examined consist of regular doublets. In a later note in *Comptes rendus*, it is reported that continuous spectra are also present in association with the characteristic soft X-rays, if heavier currents are passed through the generating tubes (NATURE, Mar. 3, p. 321).

A NEW SEPARATING FUNNEL.—In the *Chemiker Zeitung* for Jan. 25 is a description of a new form of separating funnel, consisting of a combination of two stoppered pear-shaped bulbs, between which is inserted a 3-way stop-cock. Each of the bulbs carries an elongated hollow stopper of special design. The new funnel, which offers considerable advantages over the older type, is in use in the technological laboratory of the Chemical Institute at Buda-Pesth.

MEASUREMENT OF THE CONCENTRATION OF DILUTE SOLUTIONS.—The accurate determination of concentrations of dilute solutions of organic compounds is a matter of considerable difficulty when the usual methods of analysis are employed. It is possible to utilise the interference refractometer for this purpose to obtain rapid and accurate measurements, and some of the difficulties encountered in the calibration of the Zeiss interferometer are discussed by R. Macy in the *Journal of the American Chemical Society* for December 1927. A greater degree of accuracy is attainable with solutions of aromatic than with solutions of aliphatic compounds, and the reading for two substances in the same solution is very nearly the sum of the separate readings for each.

ADSORPTION OF OXYGEN ON CHARCOAL.—Using four different types of charcoal, A. F. H. Ward and E. K. Rideal have investigated the adsorption and heat of adsorption of oxygen, the rate of autoxidation, the area of methylene blue adsorption, the ash content, the true and apparent bulk densities, and the particle size, and an account of their work is contained in the *Journal of the Chemical Society* for December 1927. In the case of a charcoal with a large ash content, the initial heat of adsorption for oxygen was very high and the carbon surface appeared to be unstable. For the other charcoals, the areas of the active portions were found to be proportional to the rates of autoxidation and were of the same order as when determined from the poisoning of autoxidation by amyl alcohol. The results obtained do not support the supposition of Keyes and Marshall that the high initial heat of adsorption corresponds to the establishment of a unimolecular layer and that the lower subsequent heats are due to the building up of thicker oxygen films.

THE REACTIONS BETWEEN OXYGEN AND COAL.—An investigation of the spontaneous combustion of coal is being carried out by the Safety in Mines Research Board, and some of the results obtained are described by Messrs. W. Francis and R. V. Wheeler in the *Journal of the Chemical Society* for December 1927. The amounts of oxygen fixed by the vitrain portion of newly won coal and by vitrain from the same seam after prolonged atmospheric oxidation at 150° C. were measured at various temperatures, and the quantities of the products of the reaction determined. The oxidation of coal appears to take place by the formation of unstable oxygenated groupings, which are carboxylic in character and ultimately cause the ulmin portion to become soluble in alkalis. The reaction seems to depend upon the presence of an adsorbed layer of oxygen, which is continually renewed so long as oxygen enters into combination. The oxygenated groupings are decomposed into water and oxides of carbon and the coal 'revivified' by heating in a vacuum.

Medical Research.

THE thirteenth annual report of the Medical Research Council[1] gives, as usual, a summary of research work covering a very wide field; some of the more important aspects of this work only will be referred to here. At the end of the year under review Sir Frederick W. Andrewes and Sir Cuthbert S. Wallace retired from the Council, their places being taken by Sir Hugh K. Anderson and Prof. T. R. Elliott. The work of the Council has suffered by the deaths of Dr. John Brownlee, Director of the Statistical Department, of Dr. T. S. P. Strangeways, well known for his work on the artificial culture of cells and tissues, and of Prof. E. H. Starling, who was chairman of the committee on the physiology of muscular work, under the Industrial Fatigue Research Board. As in previous years, reference is made to the effective augmentation of the resources of the Council by the facilities provided by the universities and other centres of research throughout Great Britain to research workers who are advancing knowledge under grants provided by the Council. Payments towards the cost of particular investigations have also been made by the Miners' Welfare Fund, the Dental Board of the United Kingdom, the Empire Marketing Board, the Distemper Research Council of the *Field* newspaper, the British Empire Cancer Campaign, the trustees of the late Sir William Dunn, and by an anonymous donor for a microscope designed by Mr. J. E. Barnard.

During the year the Council has worked in close co-operation with many Government departments, with the Development Commission, the Department of Scientific and Industrial Research, and the newly constituted Colonial Medical Research Committee. The Report points out that it should now be recognised that medical science is one and indivisible, and that laboratory investigations into tropical diseases may be more usefully carried out in a temperate climate, whilst observations on measles or tuberculosis may be more fruitful of results when made in the tropics. It is hoped that eventually an 'Imperial Research Service' may be built up by which problems of nutrition or disease may be readily investigated wherever it is convenient and the results applied wherever they are required.

BIOLOGICAL STANDARDS.

During the year the Therapeutic Substances Act 1925 came into operation, and standard preparations are now required for the assay of diphtheria and tetanus antitoxins, antidysentery serum (Shiga), old tuberculin, insulin, pituitary (posterior lobe) extract, arsenobenzene, novarsenobenzene, and sulpharsenobenzene. Standard solutions of the antitoxins and of the serum are distributed at regular intervals to all licensees for the manufacture of these substances under the Act; standard preparations of insulin and of pituitary posterior lobe have similarly been distributed. The standards of the arsenical derivatives are held at the National Institute for Medical Research, where also the routine testing of all batches of these drugs is carried out. The standards agree with those accepted or recommended by the health organisation of the League of Nations in all cases in which an international standard has been adopted. At the present time an international investigation is proceeding into the potency of scarlatina streptococcal toxin and antitoxin, with a view to the eventual creation of a standard and the definition of acceptable units. The demand for standard agglutinable cultures and sera, prepared at the Standards Laboratory at Oxford under the direction of Prof. G. Dreyer, has continued to increase; the Council has decided that the whole cost of the laboratory cannot be met from its funds, and during the year the system of making charges for such standard preparations was adopted, without greatly affecting the demand for them.

BASIC CONSTITUENTS OF THE TISSUES.

In recent years it has became clear that a number of different bases can be extracted from normal tissues. Some have been known for a long time, but only recently has any evidence been obtained as to their possible functions; others have only recently been isolated, and their physiological properties have still to be investigated. In last year's report the successful synthesis of spermine

$$(NH_2 \cdot (CH_2)_3 \cdot NH \cdot (CH_2)_4 \cdot NH \cdot (CH_2)_3 \cdot NH_2)$$

by Dudley and Rosenheim was referred to; from the current report it is seen that the same authors, working with W. W. Starling, have isolated, identified, and synthesised a new base, spermidine

$$(NH_2 \cdot (CH_2)_3 \cdot NH \cdot (CH_2)_4 \cdot NH_2),$$

which is present in the tissues together with spermine. Although the latter was first discovered in sperm, it appears to be a constituent of most tissues and not to bear any particular relationship to the reproductive processes; it is, in fact, absent from bull's semen, eggs, and milk.

The most abundant and the longest known of the nitrogenous extractives of muscle is creatine, but until the past year we held no clue as to its function. It has now been shown by P. Eggleton to exist during life in the form of an unstable compound with phosphoric acid in equimolecular proportions which is broken down in contraction and resynthesised during subsequent rest in the presence of oxygen; it can be isolated from rabbit muscle in the form of a barium salt. Hence the creatine complex plays a part in the chemical processes accompanying contraction, as well as the glycogen and lactic acid; it is connected apparently with the velocity of contraction. The next most abundant base in muscle is the peptide carnosine; Dudley and Thorpe have prepared a large quantity of it, and are at present investigating its properties and reactions. This work was undertaken following an examination of muscle for the base histamine, after Best, Dale, Dudley and Thorpe had extracted it from both liver and lung; it was found that muscle also contained it. Histamine, together with choline, appears to be responsible for the depressor effect of all tissue extracts (except those from the suprarenal and pituitary glands, which are pressor), upon the blood pressure; its effect in this respect is due to its dilating the capillaries; at the same time it stimulates most smooth muscular tissues and thus produces also constriction of the arteries, but the former effect is the more important, since it is produced by much smaller doses.

Particular importance has been lent to this identification of histamine in many tissues by the work of Sir Thomas Lewis and his collaborators on the reactions of the blood-vessels of the skin in man to injury. These investigators have brought forward much evidence to show that almost all forms of injury or irritation act in a similar way by causing the liberation of a chemical substance allied to histamine (or quite probably histamine itself), to which the reddening and swelling of the skin are due. After the application of various stimuli or of histamine, these cutaneous blood-vessels contract imperfectly or not at all to adrenalin or pituitary extract, and also become

[1] Committee of the Privy Council for Medical Research. Report of the Medical Research Council for the Year 1926-27. (Cmd. 3013.) Pp. 152. (London: H.M. Stationery Office, 1928.) 3s. net.

refractory to histamine itself. It is possible that the collections of small dilated blood-vessels which appear on the face as age advances or following much exposure to the weather, are also caused by over-stimulation of the skin, since they are refractory to the stimulus of these different hormones. If these conclusions can be extended from the skin blood-vessels to those of the deeper tissues, they should influence considerably our conception of the reactions of different organs to injury or to nervous stimulation.

THERAPEUTICS.

The year 1927 saw the centenary of the publication by Richard Bright of his observations on kidney disease. A. A. Osman, applying modern methods of biochemistry to the study of Bright's disease, has found that administration of alkalis is of great benefit in treatment and in prophylaxis, and has been able, further, by means of simple tests, to demonstrate the type of case likely to suffer from nephritis as a complication of other diseases, especially scarlet fever. Thus the incidence of nephritis and albuminuria in 316 untreated cases of scarlet fever was 5·5 per cent., but in 620 cases treated by alkalis it was only 0·6 per cent. Again, alkalis can effectively prevent the onset of anuria under conditions in which this symptom may occur, and also the appearance of nephritis in metallic poisoning, or in poisoning with general anæsthetics or after exposure to infection. The after-effects of nephritis have also been studied in a group of more than 10,000 patients who suffered from this disease during the War. In many of them the original kidney lesion has cleared up, leaving behind, however, as sequelæ, cardio-vascular impairments with high blood pressure. This study may throw light on the origin of certain cases of high blood pressure for which at present no definite cause can be found.

During the year a report by J. G. Forbes has been published dealing with the prevention of diphtheria; susceptible individuals can be detected by the Schick test and protected against the disease by toxoid-antitoxin immunisation. An important step forward in the control of this disease appears to have been taken.

King and his colleagues have continued their syntheses of substances likely to have a chemo-therapeutic action; about 50 colourless compounds, closely related to complex dyes, have been examined for trypanocidal activity by Miss Durban and Miss Marchal, and a relationship has been found between the appearance and intensification of curative action on one hand and of affinity for cotton fibres on the other. King and Balaban have also examined some gold and mercury derivatives of the thioglyoxalines. One of the gold compounds, containing 58 per cent. of the metal in soluble combination, appears to have some curative action in experimental tuberculosis (Douglas). In human patients suffering from tuberculosis, another gold compound, sanocrysin, exerts, in selected cases, a favourable influence; in animals it appears to be effective only in those having enough resistance to enable them to exploit the temporary advantage, whatever it may be, given by the drug.

Cohen and Browning have examined the trypanocidal properties of aminostyrylquinoline and amino-anilquinoline compounds. In connexion with this work it has been shown that substances which are retained in the body and exert their therapeutic action slowly, are effective by killing only a few of the parasites, products from which stimulate the tissues to produce antibodies which destroy the remainder. Further, if a subtherapeutic dose of a chemotherapeutic substance such as crystal violet be given a short time before a curative dose of an arsenical compound, etc., the injection of the latter may be ineffective; this observation has an obvious and important bearing on practical therapeutics.

Colebrook and Hare have found that by proper spacing of the doses of organic arsenical compounds it is possible to produce and maintain a bactericidal potency of the blood against streptococcal infections. These authors have also made the interesting observation that the white blood corpuscles of patients suffering from severe streptococcal infections are much more sensitive to the toxic action of arsenical compounds than those from healthy individuals.

PATHOLOGY.

In investigations into tuberculosis, A. S. Griffith has shown that the bovine bacillus is the chief cause of the disease in domestic mammals; it was, in fact, the only type found in the horse, cat, and goat. In sheep, and especially in swine, the avian type of the bacillus is also found. The human type occurs in the dog, and also in wild animals kept in captivity. In man a high proportion of tuberculosis is directly due to the bovine bacillus, conveyed chiefly through the medium of infected milk, emphasising the importance of the elimination of this disease from dairy cattle.

Hill and Brad have continued their investigations into the effects of diet upon reproductive power and liability to cancer in mice. The natural span of life appears to be about three years. Five diets have been used: grain and green food; cooked meat, vegetables, pudding, tinned fruit, and salt; white bread, margarine cakes, biscuits and a little milk; a low protein diet and the same diet with one-third browned by frying. Breeding is good except on the third (or white bread) diet. Cancer occurs fairly frequently in the older mice; in the females its incidence may reach 50 per cent.; the commonest sites are the mammary gland and the lung. The important point, however, is that mice on all diets are about equally affected; no evidence has been found that the first diet protects against this disease or that the others predispose to it.

Work on the filter-passing viruses has been continued during the year, without, however, leading to any striking advance; the chief difficulty at the moment is to discover some method by which they can be grown in artificial culture. As regards canine distemper, it is now possible to immunise dogs successfully, but the methods at present in use can only be employed successfully in a specialised laboratory.

APPLIED PHYSIOLOGY.

J. A. Campbell has now completed his experiments on acclimatisation to low oxygen pressures. He found that this is due to the tissues, especially the heart muscle, becoming tolerant of the low oxygen pressure. Estimation of the tissue oxygen and carbon dioxide tensions, by injecting nitrogen into the tissues and then withdrawing samples for analysis, showed that the local oxygen tension remained low after acclimatisation. In the same way, exposure to increased oxygen pressures led to a marked rise in the oxygen tension in the tissues. It appears, then, that the tissue oxygen tensions depend directly upon that of the inspired air.

In conclusion, reference may be made to the work carried on by H. M. Vernon and his collaborators on industrial fatigue. A great variety of subjects has been investigated, including hours of work, accident causation, machine design, ventilation and heating, rest pauses and illumination. Practical application of the results obtained should lead to the greater comfort and efficiency of the industrial worker.

Association of Technical Institutions.

IN the unavoidable absence of the president for 1928 (Sir Alfred Mond), Lord Riddell gave an address at the opening session of the annual general meeting of the Association of Technical Institutions, held at Stationers' Hall, London, on Feb. 24 and 25. Since he had been president of the Association during 1927, Lord Riddell was able to give some of the impressions of technical education he had gathered from his examination of its problems. He commented on the great work and scholarship of the staffs of the institutions: he noted the widespread recognition which is now being accorded to the liberal quality of technical education: he stressed the necessity of developing day classes. At present, he said, there are about 850,000 pupils in technical institutions; of these 750,000 attend evening classes. Yet when one considers the numbers of young persons in England and Wales between the ages of fourteen and twenty-five, it is obvious that 100,000 day pupils does not represent the maximum of day work which ought to be possible. Finally, Lord Riddell presented a vigorous defence of modern young people against what are practically perennial charges of slackness and deterioration. This defence, Lord Riddell said, was necessary and opportune, since Sir John Reith, of the British Broadcasting Corporation, had recently implied such charges. He had, however, asked Sir John to come and address the meeting.

Sir John Reith's short address was not only devoted to the points referred to by Lord Riddell. As an engineer, he criticised the present training of engineers, and made a plea that greater cultural qualities should be given in that training. It would appear, however, that Sir John's views concerning the cultural qualities he urges are not a little confused. To illustrate the engineer's lack of them he related a story. With a friend he ascended a steep road. When they reached the top a marvellous panorama of the countryside was unfolded to their view. Deeply moved by its beauty, Sir John turned to note the effect of it all upon his companion. The latter, however, appeared to ignore it. "Listen to that traction engine coming up the road," he said; "it is knocking abominably!" It may have been a disappointing remark, but it was not evidence that appreciation of beauty was lacking. There are obscenities of sound as well as of sight: John Masefield's "dirty British coaster with a salt-caked smoke-stack, butting through the Channel in the mad March days" may be different from the "stately Spanish galleon dipping through the tropics," but it possesses its own qualities of beauty.

Col. Ivor Curtis's paper on education in the Royal Air Force was the very interesting story of an educational experiment: an experiment which had to be made for a branch of the Service which was without tradition. A central problem was to overcome the scepticism of the Service and to make it a working partner. The experiment has succeeded. The nature of the Royal Air Force makes it essential that all work should lead to the development of individual resource. In connexion with the actual scheme as it now exists (one-third of the Royal Air Force is obtained through the apprenticeship scheme and two-thirds from men recruited after the age of eighteen), the success of libraries at scattered centres has been particularly marked.

In view of the present tendency to investigate the qualifications and examinations of builders and architects, papers on the training of the architect and on technical education for the building trades by Messrs. T. P. Bennett and F. E. Drury respectively were greatly appreciated.

The report of the Council for the year contained an excellent record of work done in connexion with the University of London Bill, Matriculation (University of London), libraries in technical institutions, Architects' Registration Bill, the Emmott and Malcolm committees on education and industry, and examinations for part-time students.

The Indian Science Congress.

THE fifteenth session of the Indian Science Congress was held in Calcutta on Jan. 2, 1928. In the absence through illness of His Excellency the Viceroy, who had intended to preside at the inaugural meeting in the Senate House of the University on Jan. 2, the proceedings were opened by His Excellency Sir Stanley Jackson, the Governor of Bengal. This is the third time the Congress has been held in the second city of the Empire, the first occasion being in 1914, when the first meeting was held, the second in 1921. To commemorate the fact that Calcutta was the birthplace of the Congress, and to bring out the rapid growth of this movement, the original *Proceedings* of the 1914 meeting were reprinted and distributed to the members. In fourteen years the space taken in recording these proceedings has increased seventeen-fold.

It was fitting that Dr. J. L. Simonsen, one of the two originators of this movement and the man to whose self-sacrificing labours as honorary secretary the Science Congress owes its origin and steady growth, should have been elected president for this meeting. The difficulties in starting an organisation which required the co-operation of so many autonomous bodies, such as the universities, a number of research institutes, as well as the many independent Government departments which deal with applied science in a continent the size of India, were considerable. The task of steering an unofficial movement past the many difficulties which were encountered during the early years was still greater. For this piece of public service India owes a great debt to Dr. Simonsen. The Congress is now firmly established and fulfils a very useful function in providing an annual meeting ground for men of science in India and in breaking down the barriers imposed by distance, by race, and by that condition which, for want of a better word, may be described as departmentalism.

In his presidential address, Dr. Simonsen first gave a short history of the origin and progress of the Congress, and directed attention to the services rendered thereto by a number of distinguished men of science, among whom Sir Sidney Burrard and the late Sir Henry Hayden took a prominent place. The Asiatic Society of Bengal from the beginning also did much to foster the movement. Dr. Simonsen then dealt with the growth of the research spirit in the Indian universities, and passed on to the present academic standing of these bodies. While the former is in a satisfactory condition and shows definite signs of progress, the general academic standing of the universities of India is being steadily lowered. This latter manifestation was attributed partly to the fact that the control of these universities is now largely in the hands of laymen, and partly to the circumstance that a university degree in India is regarded as a stepping-stone to Government

employ. Two reforms were advocated to meet the situation—the control of the curriculum and of the examinations should be placed in the hands of the professional staff; admission to the various Government departments should be based on Civil Service examinations conducted by an impartial authority. The last portion of the presidential address dealt with the importance of the study of natural products (see NATURE, Feb. 11, p. 216).

Much useful work was accomplished in the various sectional meetings. Among the most successful was that of the Section of Mathematics and Physics, where as many as eighty-one papers were presented. In his address, Dr. J. de Graaf Hunter gave a sketch of the results of studies of the figure of the earth from the earliest times. A spheroid has been used latterly as a reference figure and the geoid has been exhibited in relation to it. By this means determinations of the spheroids which best fit the geoid in India and the United States have been made on the basis of isostasy and without. In the case of India, isostasy does not account for the geoidal anomalies, and large areas appear to have density anomalies larger than has recently been considered probable. The study of the geoid, combined with pendulum results, promises to yield further information about these crustal anomalies and may possess an industrial value.

The Section of Chemistry as usual attracted many members, and one hundred and forty-four papers were contributed. In his sectional address, Prof. S. S. Bhatnagar, of the University of Lahore, dealt with the progress of physico-chemical research in India and gave an interesting review of the past history and present position of this branch of science.

Another address which attracted a good deal of notice in the local press was that given by Dr. Michael P. West in the Section of Psychology. Two diametrically opposed types of educational psychology were contrasted, one emphasising the type, the other individual growth. Stress was laid on the need of a new type of institution which would give the child the means and opportunities for developing its own peculiar interests.

In the Section of Botany, Prof. M. O. Parthasarathy Iyengar gave an interesting review of various aspects of the study of algæ and emphasised the need for a handbook of Indian algæ as a means of stimulating research. This section, which was well attended and in which the discussions often reached a high level, reflected the great attention which has been given to botany in recent years by the Indian universities and the vastly improved teaching in this subject.

The other sections represented in the Congress were Agriculture, Anthropology, Zoology, and Geology. Owing to the recent session in Calcutta of the Far Eastern Association of Tropical Medicine, the Medical Section of the Indian Science Congress did not meet in 1928.

Three evening lectures, all of which were well attended, were given in the Senate House of the University: on radiations and their uses, by Prof. G. R. Paranjape; on applications of chemistry in modern warfare, by Prof. J. C. Ghosh; and on inheritance in plants and animals, by Prof. M. A. Sampathkumaran.

A very full programme of excursions was arranged by the local secretaries, and much hospitality was shown both by individuals and by public bodies. The University of Calcutta placed the Senate House and the other University buildings at the disposal of the Congress. Visits were arranged to the various research centres in Calcutta, such as the School of Tropical Medicine, the Bose Institute, and the Indian Museum.

University and Educational Intelligence.

BIRMINGHAM.—At the annual meeting of the Court of Governors, held on Founder's Day, it was announced that Mr. and the Hon. Mrs. Anstruther-Gough-Calthorpe had most generously made to the University a free gift of 40 acres of land adjoining the site of the University buildings at Edgbaston. It is hoped that this gift will allow of the provision of more playing fields in the near future and will give ample room for extension of the University for many years to come. It may be recalled that the site of the present buildings was also a gift of the Calthorpe family.

CAMBRIDGE.—Dr. N. J. T. M. Needham, Gonville and Caius College, has been appointed University demonstrator in biochemistry.

Sir J. J. Thomson gave the First Founder's Memorial Lecture at Girton College on Mar. 3 on the subject "Beyond the Electron."

LONDON.—Mr. Bernard Ashmole, who, since 1925 has been Director of the British School at Rome, has been appointed as from Aug. 1 to the Yates chair of archæology tenable at University College.

Prof. Robert Robinson has been appointed as from Aug. 1 to the University chair of organic chemistry tenable at University College. Prof. Robinson studied at the University of Manchester, where he obtained the D.Sc. degree in 1910. He has occupied professorial chairs at Sydney, Liverpool, St. Andrews, as well as at Manchester, and has had considerable experience in industrial chemistry with the British Dyestuffs Corporation. He is the author of numerous papers mainly on the constitution of the colouring matters, brazilin and hæmatoxylin, on the isoquinoline alkaloids, and on the alkaloids gnoscopine, harmine, and strychnine.

MANCHESTER.—Honorary degrees to be conferred on Founder's Day, May 23, include the following—LL.D.: Right Hon. Sir Alfred Mond, Bart.; D.Sc.: Prof. David Hilbert, professor of mathematics in the University of Göttingen, and Prof. C. T. R. Wilson, Jacksonian professor of natural philosophy, Cambridge. It is expected that Dr. Richard Willstätter, who was unable to be present last year, will receive the honorary degree of D.Sc. at the same ceremony.

NEWCASTLE-ON-TYNE.—At a meeting of Armstrong College Council held on Mar. 5, the resignation, as from Sept. 30, of Prof. J. J. Welch, professor of naval architecture since 1907, was accepted with regret.

The following new appointments were made as from Oct. 1: (1) Prof. T. H. Havelock, at present professor of applied mathematics in the College, to be professor of mathematics and director of the Department; (2) Dr. G. R. Goldsbrough, since 1919 lecturer in applied mathematics and reader in dynamical astronomy, to be professor of mathematics. Prof. Havelock, who is a graduate in science of the University of Durham and was for a time fellow of St. John's College, Cambridge, was appointed to the College as lecturer in applied mathematics in 1906, and promoted to the professorship in 1914. Since that date the Department of Mathematics (under Prof. Jessop) and the Department of Applied Mathematics (under Prof. Havelock) have been separate. Prof. Jessop having now reached the retiring age, the two departments will be combined and Prof. Havelock will take charge.

OXFORD.—Prof. David M. Watson, Jodrell professor of zoology and comparative anatomy in University College, London, has consented to deliver the Romanes Lecture for 1928 in Oxford on May 4 at 5 P.M. The subject chosen is "Palæontology and the Origin of Man."

Calendar of Customs and Festivals.

March 11.

ST. SOPHRONIUS.—Patriarch of Jerusalem at the time of its capture by Omar in A.D. 638. When the Mosque erected by Omar on the site of Solomon's temple fell in the night, the Jews told the Caliph that it would not stand until the True Cross was removed from Calvary, which the Caliph then ordered to be done. It is Sophronius who records that it was the custom at mid-Lent for the Cross to be taken out of its case to be reverenced.

March 12.

ST. PAUL OF LEON, A.D. 573; son of a Welsh prince who migrated to Brittany at the age of sixteen, where he remained for the rest of his life, travelling about the country and finally being invested with the see of Leon, much against his will, by King Childeric. In art he is represented either with a bell or with a cruse of water and a loaf of breaf, or driving a dragon into the sea to signify that he expelled the Druidical superstition out of Brittany. Popular legend incorporated in his life also credits him with the origin of megalithic monuments, for the avenue known by his name on an island in Morbihan is said to be composed of rude stones which grew from the pebbles with which his sister marked a path on the sands when the island was enlarged in answer to their prayers. The saint was the first to teach the people to domesticate wild bees and wild pigs. The bell, a familiar object in Christian antiquities of the Celtic period, is prominent in his legend. A bell was refused him by King Mark—in those days, it is said, seven bells were rung before each of the King's meals; but much later in life God sent him one "after many years of wishing and longing." The people called it by a special name because it was "green and oblong," obviously a bronze bell of a familiar type. In popular belief the bell is an effective protection against the spirits of evil and would be peculiarly appropriate to a missionary engaged in expelling Druidism with its magical practices from the country.

ST. GREGORY THE GREAT, elected pope on the death of Pelagius II. in 590; one of the greatest figures in the Church, and responsible for the mission to Britain under St. Augustine which established Christianity in England. Many miraculous relations have been associated with him, of which the best known is that the Host visibly changed into the appearance of Christ enduring His passion in response to his prayers in order to convince a woman who disbelieved that the bread was flesh. On another occasion when disbelief was expressed in the efficacy of a cloth with which the relics of a saint had been wiped, as was then usual to save the relics from harm by touching, the cloth was cut at his behest, and blood poured from it as from the living body of the saint.

The processions at Rome on the festival of St. Mark, known as the 'Greater Litanies' or the 'Black Crosses,' were instituted by St. Gregory at a time of plague to avert the wrath of God from the city.

March 13.

ST. MOCHOEMOG, ABBOT OF LIATHMOR.—Of this Irish saint who lived in the middle of the seventh century, many marvellous happenings are related, but not least remarkable are the circumstances of his birth. His father, Beoan, married a beautiful damsel named Nessa of the race Nan-desi. In recompense for building, for his wife's sister, St. Ytha, a beautiful convent, he was promised a son; but before the promise could be fulfilled he was killed and decapitated in battle. His wife found his head and took it to her sister, reproaching her for the non-fulfilment of the promise. Nessa, following the instructions of St. Ytha, joined the head to the body and restored her husband to life. A son was born who was brought up by St. Ytha in the service of God, and later became the saint. The resemblance of the story of Beoan to incidents in Irish pagan legend needs no emphasis.

March 16.

ST. FINIAN LOBHAR, OF THE LEPER; a descendant of Alild, king of Munster. A remarkable legend relates that St. Ruadanus had a miraculous tree in his cell which dropped a liquor into a bowl from nine o'clock to sunset that sufficed to dine him and his brotherhood every day. St. Finian visited him to persuade him to live like other people, and marked the tree with a cross so that the liquor ceased to flow. Ruadanus, on discovering what had happened, bade his servant fill a vessel with common water from a fountain. This he did, and it was at once changed into the marvellous liquor which had filled the bowl. Finally, St. Finian, after turning some of the liquor sent to him back into water, persuaded St. Ruadanus to live like other people and not to work any more miracles.

The emphasis in this story on the difference in mode of life suggests that it records not so much an encounter between two monks as a contest between a Christian missionary and a pagan magician, or even one of the fairy folk, *ruadh*, red, being one of the epithets most frequently associated with fairies.

March 17.

ST. PATRICK, born about 387.—His place of birth is uncertain, variously said to be Kilpatrick, Cornwall, Pembrokeshire, or Boulogne. At the age of sixteen he was carried off from Boulogne to Antrim by Niall of the Nine Hostages, returning home and entering the church six years later. He came back to Christianise Ireland in 432 and died in 465. Popular lives of the saint attribute to him the performance of many marvels. It is well known that he drove all snakes, toads, and noxious beasts out of Ireland; less familiar, that no spider will come near King's College, Cambridge, because it is built of Irish wood. It is not surprising to find him associated with the Celtic cross. He placed a cross at the head of every Christian buried outside a burial ground. There may also be a vague recollection of sun worship in the story of the fingers of St. Patrick affording a bright light when a horse was lost in the dark, and when at his death there was no night for twelve days. Tradition says that it was at a sun festival coinciding with Easter, after a solemn vigil when no fire had been lit for days, that St. Patrick preaching to the pagans made that symbolic use of the shamrock through which it became the national emblem worn on the saint's day at a time of universal rejoicing. But just as the saint's day may preserve the memory of the sun festival, the shamrock may possibly represent the traditional Celtic feeling for the group of three which is seen in the old Welsh triads, where the occurrence of groups of famous threes of a kind is celebrated endlessly.

Societies and Academies.

LONDON.

Royal Society, Mar. 1.—**A. E. H. Tutton**: (1) The hexahydrated double sulphates containing thallium. Thallium salts corresponding to the potassium, rubidium, cæsium, and ammonium salts of the isomorphous series $R_2M\left(\begin{smallmatrix}S\\Se\end{smallmatrix}O_4\right)_2 . 6H_2O$ have been prepared. Four of them are double sulphates containing thallium as the R-metal, and magnesium, ferrous iron, manganese, or copper as the M-metals; six are double selenates. (2) The hexahydrated double selenates containing thallium. The six salts are those in which R is thallium and the M-metal is magnesium, nickel, cobalt, ferrous iron, manganese, or copper. The results of the whole investigation (both papers) agree in showing that, as previously proved, potassium, rubidium, and cæsium salts of the great series invariably show crystal forms and properties which vary regularly with the atomic number of the alkali metal. The ammonium members, while showing no relation to atomic numbers or weights, resemble the corresponding rubidium salts containing the same M-metal so closely as to be practically iso-structural. Thallium salts invariably occupy a position well within the limits (as regards angles and constants) of potassium and cæsium salts. Thallium salts, however, have one strikingly outstanding property, that of very high optical refraction, occasionally exceeding even that of monobromonaphthalene and yet more so that of carbon disulphide.

W. H. J. Childs: The distribution of intensity in the band spectrum of helium: the band λ4650. Measurements of the intensity distribution in the helium band λ4650 (first of the main series) show that the predicted distribution is of the correct type, but agreement with observation is by no means complete. Notably the P and R' branches are much stronger, relative to the Q branch, than theory indicates. An expression of the form $ie^{-E/kT}$ where i is a linear function of j', is adequate to describe the observed distribution. As with many other bands, the temperature obtained by assuming that distribution of angular momentum is governed by the Boltzmann factor is much higher than the true temperature of the gas. In this case effective temperatures of approximately 750 A. and 1000 A. are found, depending on conditions of excitation. A higher temperature is obtained from the Q branch than from the P and R branches. Examination of Doppler width of band lines shows, however, that there is a distribution of translational velocities corresponding to true temperature.

M. C. Johnson: Studies in the behaviour of hydrogen and mercury at the electrode surfaces of spectrum tubes. The proportion of a hydrogen positive ray spectrum which is due to the neutralisation of protons is decreased by a temporary admission of mercury vapour. The accompanying domination of the spectrum by mercury can be delayed and weakened by the substitution of nickel for aluminium as the cathode material. The resistance at electrodes of different sensitivities to mercury contamination is not altered by that contamination if the tube is filled with hydrogen, but is sensitive to a change from hydrogen to air. Mercury is only liberated from a contaminated cathode during discharge. A solid mercury cathode can be made to disintegrate under bombardment in a manner different from its thermal evaporation, but the excessive disintegration product of the contaminated aluminium is from aluminium. The hypothesis is put forward that the increased cathode disintegration is the secondary effect of the removal of a surface layer of oxygen, allowing disintegration afterwards by ordinary proton bombardment, and allowing escape of hydrogen from the aluminium structure. The spectrum changes are then consequences of the mass and critical potentials of mercury.

W. E. Curtis: The structure of the band spectrum of helium. Details are given of three new helium bands which have the final electronic level $2P$ in common. Two of them are due to the vibrational transition $1 \longrightarrow 1$, the initial electronic levels being $3S$ and $4S$. The other has an initial electronic level of effective quantum number 2·96, but its term type is uncertain. The rotation terms have been accurately evaluated for the three new bands and for three others previously described which also have the final level $2P$. The new evidence presented favours the view that the helium and hydrogen molecules are structurally similar.

H. A. Wilson: The Saha theory and the conductivity of flames containing alkali metal vapours. Noyes and Wilson have shown that the equilibrium constants for the reaction $M = M^+ + e$ (where M denotes atom of alkali metal and e electron) can be deduced from measurements of the electrical conductivity of flames at about 2000° K, and that equilibrium constants so obtained agree approximately with those calculated by the Saha theory. This assumes that all salt sprayed into the flame is reduced to metal vapour and that all negative carriers are free electrons. It is now shown that these assumptions may be omitted without affecting the equation. Bennett's results on the conductivity of rubidium in flames give a value of the equilibrium constant nearly equal to that given by Saha's theory; Gouy's results on light emitted by sodium flames require the fraction of sodium reduced to metallic state to be independent of the concentration of sodium, and hence the fraction of ions which are electrons must be independent of concentration.

R. G. Lunnon: Fluid resistance to moving spheres. By timing the falls of metal spheres in water, through distances up to two metres, the resistance of a fluid at high speeds has been measured both for accelerated and for uniform motion. During accelerated motion, the resistance is increased in a regular way, which can be described approximately in terms of a carried mass, varying from one-half to twice the mass of the displaced fluid.

N. F. Mott: The solution of the wave equation for the scattering of particles by a Coulombian centre of force. The solution splits up into incident wave, representing on-coming electrons, and scattered wave; the quantum theory result agrees exactly with that of classical theory. The analysis is applicable to α- and to β-particles.

G. H. Briggs: A redetermination of the velocities of particles from radium-C, thorium-C and -C′. A redetermination by the magnetic deflexion method of $H\rho$ for α-particles from radium-C gives $3{\cdot}993 \times 10^5$ E.M. units. Using the theoretical value of e/m deduced from electrochemical data, the velocity is $1{\cdot}923 \times 10^9$ cm. per sec. The corresponding values found by Rutherford and Robinson were $3{\cdot}983 \times 10^5$ and $1{\cdot}922 \times 10^9$. Velocities for thorium-C and -C′ were found to be $1{\cdot}704 \times 10^9$ and $2{\cdot}053 \times 10^9$.

Physical Society, Feb. 10.—**Allan Ferguson** and **Eric J. Irons**: A simple graphic method for the determination of galvanometer and fluxmeter constants, with a note on the measurement of intense magnetic fields. The paper deals with methods for evaluating the principal construction constants of moving coil instruments by the graphical treatment of observations of logarithmic decrement and its variation with circuit resistance.—**J. C. Hudson**: The application of electrical resistance measurements to

the study of the atmospheric corrosion of metals. The procedure is suited for quantitative field tests on the atmospheric corrosion of metals, and is based on the determination of the change produced on exposure in the electrical resistance of wire specimens. The method is capable of great accuracy. In the case of copper, the percentage resistance change due to corrosion is inversely proportional to the diameter of the wire; it is thus possible to use the method as an 'acceleration test' by conducting experiments on relatively thin wires, which are appreciably affected by corrosion within a few weeks.—**C. J. Smith**: On a method of constructing the caustic curve formed by refraction at a plane surface. The method depends on the properties of an ellipse which cuts the rays orthogonally.

Royal Meteorological Society, Feb. 15.—**L. F. Richardson** and **R. E. Munday**. Memoir No. 2 (published 1926): The single-layer problem in the atmosphere and the height-integral of pressure. Atmospheric tides are supposed to be such that a single vector suffices to specify the momentum of a whole column of air. Are ordinary weather disturbances of the same sort, or must each column be regarded as two or more layers moving independently? The answer to this question is extracted from the international collection of the records of registering balloons. It is found that Laplace's equations for *free* tidal oscillations are a very bad description of ordinary disturbances of the European atmosphere; in other words, the 'dynamic height' of the atmosphere is extremely variable.—**L. F. Richardson, D. Proctor**, and **R. C. Smith**. Memoir No. 4 (published 1926): The variance of upper wind and the accumulation of mass. Using the pilot-balloon observations made during the War, Durward's study of the variation of wind between two places at the same time is continued, by working up specially simultaneous observations at short distances (11 to 28·5 km.), and, surprisingly, the variation is found to be greater. Paired times at the same place are also investigated. The mathematical study of smooth functions accustoms us to the idea that accuracy is to be obtained by proceeding to the limit of smallness; but the wind seems not to possess the required kind of smoothness.—**J. Glasspoole**: The distribution over the British Isles of the average number of days with rain during each month of the year. While the east is the dry side of Great Britain and of Ireland, in the case of the number of days with rain the increase is more pronounced from the south-east to north-west of the British Isles. Actually, the average number varies from 150 along the Thames Estuary to 270 in the Outer Hebrides. There are only 10 days with rain on the average along the Thames Estuary in June, July, and September, and 26 in December in the north-west of Scotland and in the mountains of Kerry, Connemara, and Donegal. June is the month of fewest days with rain over the British Isles generally, namely 14, while December has most with 20. May also has less days with rain than either July or August, so that the popular call for early holidays is well supported by rainfall statistics. The amount of rain per rain-day is greater during the last six months of the year than the first six months, so that on the average May and June are again more favourable for holiday makers than July and August.

CAMBRIDGE.

Philosophical Society, Jan. 16.—**N. Feather** and **R. R. Nimmo**: The ionisation curve of an average α-particle. Systematic photometry of the track images from a cloud expansion chamber made possible the calculation of the variation of the light scattering power of an α-particle track over the last two centimetres of its length in standard air, and the variation of this quantity was finally identified with the variation of ionisation along the track. In air, helium, and hydrogen, the maximum ionising efficiency of the α-particle occurs when it possesses the velocity appropriate to the distances 3·0, 2·55, and 2·25 mm., respectively, from the end of its path in standard air. —**F. L. Arnot**: The interference of light in a wedge. When white light from a very narrow slit is reflected from a thin wedge, and then analysed in a spectroscope, interference bands are seen in the spectrum provided the edge of the wedge is parallel to the slit-source and to the slit of the spectroscope. Under certain conditions, the bands become clearer and more sharply defined as the width of the source is increased. These conditions are (1) that the light is incident on the wedge from the direction of its thick edge, and (2) that the distance between the wedge and the spectroscope has a certain value depending upon the angle of incidence of the light on the wedge.

PARIS.

Academy of Sciences, Jan. 30.—The president announced the death of Félix Henneguy.—**E. Goursat**: The rôle of the double characteristics in the problem of the deformation of surfaces.—**Hadamard**: The ergodic principle.—**A. Rateau**: The number of specific turns and the specific power of motor turbines.—**C. Sauvageau**: The Adelopyceæ of the Litosiphon.—**René Maire** and **Louis Emberger**: General view of our phytogeographical knowledge of Morocco: the regions, domains, and sectors.—**A. Khintchire**: The law of large numbers.—**S. A. Janczewski**: Homogeneous differential systems of the fourth order.—**Rolf Nevanlinna**: Complements to the theorems of unicity in the theory of meromorph functions.—**Paul Dumanois**: Concerning the theory of antidetonants. The hypothesis that antidetonants, such as lead tetraethyl, act by accelerating combustion is regarded as disproved by the experimental work of Moureu, Dufraisse, Chaux, Pigrot, Aubert and Villey, Egerton and Gates, Dumanois and Lafitte. The suggestion that antidetonants act by preventing the formation of peroxides (Moureu, Dufraisse, and Chaux) during compression is more in accord with the known facts.—**Pierre Dive**: The rotation round an axis of a heterogeneous fluid mass with ellipsoidal stratification.—**Émile Belot**: The origin of satellites with inverse revolution and the velocity of the primitive nebula.—**Nicolas Kryloff**: The variational algorithm and the fundamental problem of mathematical physics.—**J. Nageotte**: The study of myeline vesicles with the ultra-microscope.—**C.** and **H. Gutton**: The high frequency electrical discharge. The potential at which discharge (in hydrogen) takes place is measured as a function of the pressure, at wave-lengths of 3 to 5620 metres. —**J. Aicardi**: A new method of alinement by Hertzian waves. A description of a method of radio signalling by the use of which a ship or an aeroplane can follow a definite route during fog.—**Jean Thibaud**: Absorption discontinuities in the intermediate domain (K bands of carbon, nitrogen, and oxygen).—**G. Balasse**: Study of the continuous emission spectrum produced by the electrodeless discharge. The theory suggested in a previous communication leads to the conclusion that a continuous emission spectrum must be produced for all elements. This has already been proved experimentally for the elements cadmium, potassium, lead, calcium, mercury, and phosphorus, bismuth, sulphur, and iodine have now been added. Since these nine elements are distributed in five different columns of the periodic table, it may be considered that the continuous emission spectra produced by the electrodeless discharge is a general phenomenon extending to all elements.—**A. Couder**: The con-

struction and trial of a telescope mirror of a particular form in Pyrex glass. The mirror is made in the form of a cylindrical tube closed at one end. The surface of the end is worked into a parabolic mirror of 136 cm. focus. The deformations produced by flexure are discussed: owing to the low coefficient of expansion of Pyrex glass, the thermal deformations have proved to be negligible.—**Y. Rocard** and **Ph. de Rothschild**: The absence of enlargement of spectral lines after reflection. It is concluded from the results of the experiments described that the enlargement of the lines by reflection on a mirror, the atoms of which possess thermal agitation, and might be expected to result in a considerable lowering of the order of limiting interference, does not exist.—**Néda Marinesco**: The molecular weight and association of chlorophyll in solution. The molecular weight determinations are based on the diffusion coefficient and the viscosity (Einstein equation). For sufficiently dilute solutions (less than 0·053 gram per litre) the molecular weight of chlorophyll is about 800, corresponding to the 817 for one atom of magnesium: for higher concentration there is evidence of the presence of associated molecules.—**G. Denigès**: The direct micro-estimation of the phosphoric ion by ceruleomolybdimetry in liquids from the animal organism, natural waters, fermented drinks, etc.—**Paul Dop** and **F. Duffas**: The water-bearing calyx of Clerodendron.—**S. S. Kharbush** and **Mlle. Panca Eftimiu**: The phenomena of chromatic reduction in the family of the Erysiphaceæ.—**Maurice Fontaine**: The reactions, at high pressures, of the pneumogastric of the frog immersed in a hypotonic solution.—**C. Motas**: A new Hydracarus collected at the Grand Lautien (Var).—**Y. Manonélian** and **J. Viala**: Nerve cells and the virulence of the suprarenal capsules.—**E. Rouboud**: The unfitness of *Plasmodium præcox* for development during the winter in *Anopheles maculipennis*, and its epidemiological consequences for northern Europe.

Geneva.

Society of Physics and Natural History, Dec. 15.—**Aimé Pictet** and **H. Vogel**: The synthesis of milk sugar. An equimolecular mixture of β-glucose and β-galactose heated to 175° C. in a vacuum gives lactose. The reaction takes place in two phases,

$$C_6H_{12}O_6 = C_6H_{10}O_5 + H_2O$$
$$\text{and } C_6H_{10}O_5 + C_6H_{12}O_6 = C_{12}H_{22}O_{11} \text{ (lactose).}$$

—**E. Briner** and **A. Morf**: Some new addition compounds of phenols with ammonia. Ammonia in the presence of β-naphthol, α-naphthol, α-oxyanthraquinone, salicylic acid, pyrocatechol, resorcinol, hydroquinone, or pyrogallol has given in each case one or two addition compounds corresponding to fixed conditions of temperature and pressure.—**E. Briner** and **G. Lunge**: The reactions between nitrogen peroxide and sulphur dioxide. These two substances in the liquid state give the compound $S_2O_9N_2$, containing six normal acid functions. It may be regarded as an anhydride of nitrosylsulphuric acid.—**R. Wavre**: The field of gravity in the interior of the planets.—**Raoul Pictet**: Integral transformation into motive power of the heat furnished to a gas. According to the author, who does not accept the second law of thermodynamics, it should be possible to convert the whole of the heat furnished to a gas into work.

Rome.

Royal National Academy of the Lincei, Nov. 20.—**G. Scorza**: Fundamental sub-groups of a group.—**L. Tonelli**: An observation on derivation by series.—**U. Cisotti**: The solenoidal character of Ricci's tensor for ternary forms.—**S. Franchi**: Tectonic enigmas in the mountains of Valdieri and along the valleys of Gesso, Stura, and Vermenagna.—**S. Baglioni** and **L. Settimj**: The nutritive value of the nitrogenous substances of certain types of preserved foods. Experimental investigations on albino rats. The nitrogenous matter contained in the dilute acid extract of cheese, dried stockfish, and dried edible fungi, and that contained in the part of cheese, stockfish, casein, and commercial hydrolysed casein which is insoluble in dilute acid, is capable not only of maintaining in equilibrium the nitrogen balance of albino rats, but also of allowing an accumulation of nitrogen and an increase in body-weight. The highest percentage increase in body-weight is obtained by means of a mixed diet composed of hydrolysed casein, the insoluble part of stockfish, and the soluble part of the fungi. The nitrogenous matter of that portion of the fungi which is insoluble in water is incapable of maintaining in equilibrium either the nitrogen balance or the weight of albino rats.—**D. Graffi**: Functions of vectorial variety.—**Cristina Eula** and **Odoardo Franceschi**: Projective study of surfaces.—**R. Caccioppoli**: A class of surfaces admitting of quadrature.—**U. Crudeli**: A category of stationary motions of (heavy) viscous liquids between two vertical cylindrical (round) tubes.—**A. Masotti**: The contact between lines of flux and lines of current in the motions of fluids.—**A. Rosenblatt**: Energy flux in the exceptional case of Kutta-Joukowski's theorem.—**B. Caldonazzo**: Viterbi motions and the triple orthogonal systems of surfaces determined by them.—**L. Fernandes**: The resolution of an absorption band regarded as common to praseodymium and neodymium. At a temperature approximating to that of liquid air, the line of wave-length 469 A. of the absorption spectra of praseodymium and neodymium is resolved into thin, sharp lines, the intensities and wave-lengths of these differing considerably with the two metals.—**A. Ferrari** and **A. Baroni**: The crystalline structure of the double cæsium cadmium chloride $CsCdCl_3$: considerations on the monometric structure of the type $A[BX_3]$. This salt exhibits a monometric lattice, with an elementary cell with the side 5·20 A. The ion $CdCl_3^-$ has dimensions lower than those given by the sum of the dimensions of the component ions Cd^{++} and Cl^-; this property appears to be general for complex ions. The crystallographic analogy between cadmium and mercury is emphasised by the identity in structure between the salts $CsCdCl_3$ and $CsHgCl_3$.—**G. Natta** and **M. Freri**: X-ray analysis and crystalline structure of cadmium–silver alloys. For the α-phase of the system cadmium-silver, representing solid solutions of cadmium (up to 44 atomic per cent.) in silver, the length of the side of the elementary cell varies linearly with the composition, increasing from the value 4·07 A. for pure silver to 4·14 A. for the alloy containing 31 atomic per cent. of cadmium. For the β-phase, corresponding with the compound AgCd and with solid solutions of cadmium in this, the photograms are of quite different appearance, the few lines present being arranged easily according to a body centred cubic lattice of the cæsium chloride type, and the calculated intensities agreeing well with the experimental values. Petrenko and Fedorow observed that at 460° the compound AgCd undergoes a transformation, which they interpreted as a decomposition of the unstable β-alloy into the neighbouring α- and γ-phases. The results now obtained show, however, that this consists of a polymorphic transformation, since all the lines of the photograms conform well with a hexagonal or rhombohedral lattice with the axial ratio 1·62; the side of the cell is $a = 3·01$, and the elementary cell contains one molecule of AgCd, the calculated density being 9·57.—**G. Piccardi**: Relations between the ionisation potentials of the first and second order of homologous elements.—**R. Savelli**: Fruits of two varieties borne by the same plant.

Official Publications Received.

BRITISH.

Indian Physiologist. Edited by Prof. Nibaran Chandra Bhattacharyya No. 1, January. Pp. 52. (Calcutta: Chuckervertty, Chatterjee and Co. Ltd.) 8 annas.

Dominion of Canada. Report of the Department of Mines for the Fiscal Year ending March 31, 1927. (No. 2142.) Pp. v+59. (Ottawa: F. A. Acland.) 15 cents.

Transactions of the Royal Society of Edinburgh. Vol. 55, Part 3, No. 25: The Anatomy of a Fœtal African Elephant, Elephas africanus (Loxodonta africana). Part 2: The Body Muscles. By Dr. Nellie B. Eales. Pp. 609-642+5 plates. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 6s.

Association of Technical Institutions. Agenda Paper and Report of Council (1927) for the Annual General Meeting to be held on Friday, February 24th, and Saturday, February 25th, 1928, at the Stationers' Hall, London, E.C.4. Pp. 64. Paper read at the Annual General Meeting, February 24th and 25th, 1928, on Education in the Royal Air Force. The Story of an Educational Experiment. By Col. Ivor Curtis. Pp. 27. Draft of Paper to be read at the Annual General Meeting, February 24th and 25th, 1928, on Technical Education for the Boot and Shoe Industry. By F. W. Roberts. Pp. 10. Draft of Paper to be read at the Annual General Meeting, February 24th and 25th, 1928, on Part-time Courses in Commerce in Small Schools. By Principal S. Carter. Pp. 16. Draft of Paper to be read at the Annual General Meeting, February 24th and 25th, 1928, on the Co-operation of Education with Industry and Commerce. Commercial Education. By Principal G. H. Austin. Pp. 16. Draft of Paper to be read at the Annual General Meeting, February 24th and 25th, 1928, on The Training of the Architect. By T. P. Bennett. Pp. 16. (London.)

University of Leeds. Twenty-third Report, 1926–27. Pp. 192. (Leeds.)

Ministry of Health. Seventh Report of the Advisory Committee on the Welfare of the Blind to the Minister of Health, 1926–27. Pp. 38. (London: H.M. Stationery Office.) 6d. net.

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending June 30th, 1927. (New Series 16.) Edited by Prof. Alexander Meek. Pp. 57. (Cullercoats.) 5s.

Pharmaceutical Society of Great Britain: Pharmacological Laboratories. Second Annual Report, 1927. Pp. 23. (London.)

Government of the Gold Coast. Report on the Survey Department for the period April 1926-March 1927. Pp. 34+2 plates+4 maps. (Accra: Colonial Secretariat; London: The Crown Agents for the Colonies.) 2s.

Transactions of the Optical Society. Vol. 28, 1926-27, No. 5. Pp. 225-304+xii. 10s. Vol. 29, 1927-28, No. 1. Pp. 48. 10s. (London.)

Department of Agriculture, Ceylon. Bulletin No. 81: Notes on the Cultivation of Sisal, with special reference to Ceylon. By G. Harbord. Pp. 15+11 plates. 40 cents. Bulletin No. 82: Field Experimentation with Rubber (Hevea brasiliensis). By L. Lord and L. Abeyesundera. Pp. 21. 40 cents. (Peradeniya, Ceylon.)

FOREIGN.

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 596-F: Laboratory Tests on Physical Properties of Waterbearing Materials. By Norah Dowell Stearns. (Contributions to the Hydrology of the United States, 1927.) Pp. iv+121-176+plates 11-13. Bulletin 795-F: The Gilbert District, Nevada. By Henry G. Ferguson. (Contributions to Economic Geology, 1927, Part 1.) Pp. ii+125-145. 5 cents. Professional Paper 141: Upper Triassic Marine Invertebrate Faunas of North America. By James Perrin Smith. Pp. iv+262+121 plates. 1.50 dollars. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Forty-eighth Annual Report of the Director of the Geological Survey to the Secretary of the Interior for the Fiscal Year ended June 30, 1927. Pp. ii+77. (Washington, D.C.: Government Printing Office.)

Proceedings of the United States National Museum. Vol. 72, Art. 7: Redescription of Types of American Muscoid Flies in the Collection of the Vienna Natural History Museum, with Incidental Notes. By J. M. Aldrich. (No. 2703.) Pp. 35. (Washington, D.C.: Government Printing Office.)

New York Academy of Sciences. Scientific Survey of Porto Rico and the Virgin Islands. Vol. 11, Part 1: Insects of Porto Rico and the Virgin Islands. Diptera or Two-winged Flies. By C. H. Curran. Pp. 118. (New York City.)

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Second Series (Geology), Vol. 10, No. 4: On *Hipparion Richthofeni* Koken. By Hikoshichirô Matsumoto. Pp. 59-75+plates 29-32. (Tôkyô and Sendai: Maruzen Co., Ltd.)

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 28: An Electrical Indicator for High-speed Internal-Combustion Engines. By Jûichi Obata and Yahei Yosida. Pp. 397-408+plates 21-25. 0.50 yen. No. 29: On Preparation of Lead Tetraethyl. By Yoshio Tanaka and Tsutomu Kuwata. Pp. 409-420. 0.22 yen. No. 30: Theoretische Untersuchungen über die Querruderwirkung beim Tragflügel. Von C. Wieselsberger. Pp. 421-447. 0.55 yen. (Tôkyô: Kôseikai Publishing House.)

Proceedings of the American Academy of Arts and Sciences. Vol. 62, No. 7: The Viscosity of Mercury under Pressure. By P. W. Bridgman. Pp. 187-206. 50 cents. Vol. 62, No. 8: The Compressibility and Pressure Coefficient of Resistance of Ten Elements. By P. W. Bridgman. Pp. 207-226. 50 cents. (Boston, Mass.)

The Carnegie Foundation for the Advancement of Teaching. Twenty-second Annual Report of the President and of the Treasurer. Pp. vi+168. (New York City.)

University of California Publications in American Archaeology and Ethnology. Vol. 23, No. 5: Achomawi Geography. By Fred B. Kniffen. Pp. 297-332+plates 55-59+2 maps. 45 cents. Vol. 23, No. 6: Pitch Accent in Hupa. By Pliny Earle Goddard. Pp. 333-338. 25 cents. (Berkeley, Cal.: University of California Press.)

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism. (Reprinted from Year Book No. 26 for the Year 1926–27.) Pp. 165-216. (Washington, D.C.: Smithsonian Institution.)

Agricultural Experiment Station, Michigan State College of Agriculture and Applied Science. Technical Bulletin No. 85: Studies in the Etiology of Roup and Allied Diseases of Fowls. By Edwin P. Johnson. Pp. 20. Circular Bulletin No. 107: The Mexican Bean Beetle. By R. H. Pettit. Pp. 8. (East Lansing, Mich.)

CATALOGUES.

Australasia: Books, Maps, Original Water Colour Drawings, Oil Paintings and Coloured Plates relating to Australia, Tasmania, New Zealand and the Islands of the Pacific Ocean. (Catalogue No. 505.) Pp. 92. (London: Francis Edwards, Ltd.)

Wild-Barfield Electro-Magnetic Furnaces for the Automatic Hardening of Steel. (Section A.) Pp. 20. (London: Automatic and Electric Furnaces, Ltd.)

Meteorological Instruments. (Catalogue No. 548.) Pp. 84. (London: C. F. Casella and Co., Ltd.)

Diary of Societies.

FRIDAY, MARCH 9.

ROYAL ASTRONOMICAL SOCIETY, at 5.—R. W. Gurney: Particles of High Velocity in the Chromosphere.—Dr. H. Jeffreys: Possible Tidal Effects on Accurate Time-keeping.—M. C. Johnson: Absorption by Nebulosity and the Temperature and Luminosity Sequences of Novæ. —Dr. H. Spencer Jones: The System of Procyon.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Sir J. J. Thomson: Electrodeless Discharge through Gases (Guthrie Lecture).

INSTITUTE OF METALS (Sheffield Local Section) (in Non-Ferrous Section, Applied Science Department, Sheffield University), at 7.30.—W. R. Barclay: Special Alloys in relation to the Corrosion Problem.

SATURDAY, MARCH 10.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Transformation of Matter (I.).

MONDAY, MARCH 12.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—T. Hay: Some Topography of the English Lakes.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.—Lieut.-Col. E. Cowell: The Pathology and Treatment of Traumatic Wound Shock.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. E. Schrödinger: Wave Mechanics (III.).

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—R. R. Dobson: Report of an Enquiry into the Attitude of Local Authorities towards Mental Tests.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Centre) (at Queen's Hotel, Birmingham), at 7.—G. L. Ensor: Notes on the Single Sleeve-Valve Principle.

INSTITUTION OF ELECTRICAL ENGINEERS (at Armstrong College, Newcastle-upon-Tyne), at 7.—T. N. Riley and T. R. Scott: Insulating Oils for High-Voltage Cables.

CERAMIC SOCIETY (at North Staffordshire Technical College, Stoke-on-Trent), at 7.30.—J. Williamson: A New Type of Tunnel Kiln Suitable for the Firing of Pottery.

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—Annual General Meeting.

INSTITUTE OF CHEMISTRY (Leeds Area Section) (at Leeds).—Dr. H. S. Houldsworth: The Expert Witness and the Law of Evidence.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Swansea).

TUESDAY, MARCH 13.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. I. Bennett: Some Problems of Nephritis (Goulstonian Lectures) (I.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: The Behaviour of Animals (IV.).

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Lieut.-Col. S. J. M. Auld: The Natural Gas of South Persia, Process Development and Exploitation.

ILLUMINATING ENGINEERING SOCIETY (at Holophane, Ltd., Elverton Street, S.W.1), at 6.30.—Dr. S. English: The Manufacture and Properties of Glass and their Application in Illuminating Engineering.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—G. R. Hutchinson: Recent Developments in Propelling Equipment Practice of Reciprocating Engined Steamers.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Annual General Meeting.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Burnley Section) (at Burnley Municipal College), at 7.15.—W. H. Meadowcroft: Foundry Conditions.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at North British Station Hotel, Edinburgh), at 7.30.—F. H. Rosencrants: Practice and Progress in Combustion of Coal as applied to Steam Generation.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—T. H. Savory: Spiders and their Environment.

PHARMACEUTICAL SOCIETY, at 8.—Dr. H. H. Dale: Some Reactions of Pharmacology on Pharmacy.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases, Psychiatry, Neurology, and Balneology Sections), at 8.30.—Special Discussion on Neuroses in the Tropics.

WEDNESDAY, MARCH 14.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. E. Schrödinger: Wave Mechanics (IV.).

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-Section of Proctology), at 5.30.—C. Dukes: Demonstration of the Pathology of Obstruction due to Tumours of the Bowel.—W. B. Gabriel: Intestinal Obstruction following Colostomy.—Dr. A. F. Hurst: The Recognition, Cause, and Treatment of Megacolon in Adults.—Sir Charles Gordon-Watson: A Method of Removing Adenomata of the Sigmoid through the Rectum.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.30.—H. M. Pearson: The Belgian Railways.

INSTITUTION OF ENGINEERS-IN-CHARGE (at St. Bride Institute, Bride Lane, E.C.4), at 7.30.—G. A. Hughes: Wells and Well Boring.

INSTITUTE OF METALS (Sheffield Local Section) (jointly with Kindred Societies) (in Department of Applied Science, Sheffield University), at 7.30.—*Electrical Engineering Lecture.*

ROYAL SOCIETY OF ARTS, at 8.—H. G. Brown: The Lead Acid Cell: Its Place in Modern Industry

LANCASTER ASTRONOMICAL AND SCIENTIFIC ASSOCIATION (at Storey Institute, Lancaster), at 8.—Prof. H. E. Armstrong: Sir Edward Frankland, a Great Lancastrian.

EUGENICS SOCIETY (at Royal Society), at 8.30.—Dr. W. R. K. Watson: Brixton Mental Tests.

INSTITUTE OF CHEMISTRY (Manchester and District Section) (at Manchester).—F. Twyman: Absorption Spectrography and some of its Applications in Chemistry.

THURSDAY, MARCH 15.

ROYAL SOCIETY, at 4.30.—Intense Magnetic Fields. Communications will be made by Sir Ernest Rutherford and Dr. P. Kapitza, and a general discussion will follow.—*To be read by title only*:—J. D. Cockcroft: The Design Coils for the Production of Strong Magnetic Fields.—D. Jack: The Band Spectrum of Water Vapour.—R. d'E. Atkinson: Statistical Experiments on the Motion of Electrons in Gases.—Lord Rayleigh: The Light of the Night Sky: its Intensity Variations when Analysed by Colour Filter III.

LINNEAN SOCIETY OF LONDON, at 5.—Dr. S. W. Kemp: Whaling Researches and the Work of the *Discovery* Expedition.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. I. Bennett: Some Problems of Nephritis (Goulstonian Lectures) (II.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. J. J. Fox: Optics and Chemistry (II.).

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Prof. J. Dover Wilson: The Literature of Childhood from Isaac Watts to De La Mare.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—W. T. Townend: Some Considerations of the Economics of Electric Power Production.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Dr. Rudorf: Testing of Materials used in Aircraft Construction.

INSTITUTE OF METALS (London Local Section) (at 83 Pall Mall), at 7.30. W. Lambert: High Tensile Bronze.

CHEMICAL SOCIETY, at 8.—H. Burton and Prof. C. K. Ingold: Mobile-anion Tautomerism. Part I. A Preliminary Study of the Conditions of Activation of the Three-carbon System, and a Discussion of the Results in Relation to the Modes of Addition to Conjugated Systems.—Prof. T. M. Lowry, C. A. H. MacConkey, and H. Burgess: Studies of Dynamic Isomerism. Part XXVII. The Absorption-spectra of Prototropic Compounds. Physical Properties of the Enolic and Ketonic Forms of Benzoylcamphor.—J. J. Etridge and S. Sugden: The Parachor and Chemical Constitution. Part IX. Boron Compounds.—E. S. Hedges: Observations on the Passivity of Metals.

HARVEIAN SOCIETY OF LONDON (at Paddington Town Hall), at 8.30.—Sir William Willcox: Toxicology in its Application to Medical Practice.

INSTITUTION OF MECHANICAL ENGINEERS (Birmingham Branch).—C. J. T. Billingham: Hydraulic Power.

INSTITUTION OF MECHANICAL ENGINEERS (Leeds Branch).—Informal Discussion: Payment by Results.

FRIDAY, MARCH 16.

BIOCHEMICAL SOCIETY (Annual General Meeting) (in Department of Physiology and Biochemistry, University College), at 4.30.—R. Robison and W. T. J. Morgan: A New Phosphoric Ester obtained by the Aid of Dried Yeast.—R. F. Corran and W. C. M. Lewis: The Influence of Normal and Cancerous Blood Serum on Pancreatic Lipase Action and the Effect of Ionic and Colloidal Lead.—J. G. Davis and W. K. Slater: The Anaerobic Metabolism of (*a*) The Cockroach, (*b*) The Earthworm.—E. Boyland and A. D. Ritchie: The Lactic Acid Production of Cardiac Muscle.—J. T. Irving: The Glucose Metabolism of Kidney Tissue *in vitro*.—D. Burk: The Free Energy of Glycogen-lactic Acid Breakdown in Muscle.—R. K. Cannan and G. M. Richardson: Observations on Iron-thiol Complexes.—A. Shore and R. K. Cannan: The Creatine-creatinine System.—H. D. Kay: Observations on the Phosphatases of Mammalian Tissues.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Variations and Anomalies of the Cervical and Costal Series of the Vertebral Column and their Application in Diagnosis and Treatment.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 6.—Annual Meeting.—W. Doran: Recent Developments in Micro-chemical Technique.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Capt. H. P. M. Beames: The Reorganisation of Crewe Locomotive Works.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (in Chamber of Commerce, Birmingham), at 7.—Dr. W. M. Hampton: Coloured Glasses.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—F. Judge: Bromoil Lithography.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. M. Hurrell: An Outline of Petroleum Distribution (Chairman's Address, illustrated by Slides and a Film entitled The Persian Oil Industry).

OXFORD UNIVERSITY JUNIOR SCIENTIFIC CLUB (in Department of Biochemistry and Physiology, Oxford), at 8.15.—G. Stoney: Modern Practice in Steam Turbines.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (Laboratory Meeting) (at Royal Army Medical College, Millbank, S.W.1), at 8.15.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—A. E. H. Pinch: The Present Position of Radium Therapy.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. E. T. Whittaker: The Quantum and Relativity Theories of Light.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section) (at Manchester).—Short Papers by Members.

SATURDAY, MARCH 17.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students' Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—J. F. C. Friend: Coal Cleaning.—W. R. Brown: Explosives Accidents.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: *The Transformation of Matter (II.).*

PHYSIOLOGICAL SOCIETY (at University College).

PUBLIC LECTURES.

SATURDAY, MARCH 10.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—C. Daryll Forde: The First Metal Workers.

MONDAY, MARCH 12.

LEEDS UNIVERSITY, at 5.15.—Prof. W. J. Sollas: A Geological Contribution to Human History.

GRESHAM COLLEGE (Basinghall Street), at 6.—G. P. Bailey: Modern Science and Daily Life: The Conquest of the Air.

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—W. Brunton: Rotation Grazing.

TUESDAY, MARCH 13.

MEDICAL SCHOOL, GUY'S HOSPITAL, at 5.—Sir William Bragg: The Structure of an Organic Crystal (Fison Memorial Lecture).

BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at Royal Society of Arts), at 8.15.—Dr. C. Delisle Burns: Ethics and Industry.

WEDNESDAY, MARCH 14.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.30.—Dr. R. Donaldson: Bacteriology in connexion with Foreign Medicine.

THURSDAY, MARCH 15.

EAST LONDON COLLEGE, at 5.—Prof. W. N. Haworth: The Structure of the Carbohydrates.

LEEDS UNIVERSITY, at 8.—A. N. Shimmin: Economics in Everyday Life: The Spending of Money.

FRIDAY, MARCH 16.

KING'S COLLEGE, at 5.30.—S. Smith: Babylonian Sculpture.

INSTITUTION OF PROFESSIONAL CIVIL SERVANTS (at Royal United Service Institution), at 5.30.—Major J. S. Buchanan: The Development of High Speed Aircraft.

SATURDAY, MARCH 17.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. Harcourt: Food and Famines in India.

CONFERENCES.

THURSDAY, MARCH 15.

ROTHAMSTED EXPERIMENTAL STATION, HARPENDEN, at 11.30.—Malting Barley.

R. V. Reid: What the Barley Buyers Want.
J. Stewart: The Influence of Season on the Yield and Quality of Barley.
J. Joyce: Cultivation and Treatment of Barley grown for Malting in the Vale of Taunton.
G. H. Nevile: Cultivation and Treatment of Barley grown for Malting on the Lincolnshire Heath.
W. H. Parker: Malting Barley: Old and New Varieties.
Sir John Russell: Five Years' Experiments on Malting Barley.

MARCH 28 TO 31.

GERMAN BALNEOLOGICAL CONGRESS (at Baden, near Vienna).

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SATURDAY, MARCH 17, 1928.

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NO. 3046, VOL. 121]

Industrial Research Laboratories.[1]

THE National Research Council of the National Academy of Sciences, Washington, has recently published the third edition (revised and enlarged) of a bulletin on the industrial research laboratories of the United States, including consulting research laboratories. The original publication, compiled in 1920, listed about 300 industrial laboratories; the first revision, in August 1921, included 526 laboratories; and the present revision contains data for 1000 laboratories. The survey does not include laboratories connected with Federal, State, or municipal governments, or with educational institutions, and it is limited to the laboratories rather than organisations supporting research. It is claimed not that the present compilation represents a complete list of the industrial research laboratories, but that it probably gives a "fair survey of industrial research" in the United States. Under each entry there are given: the name and address of the company and address of the laboratory if different from that of the company; the name of the director of research and the number of his staff; and the chief lines of research work. In addition to the alphabetical list of laboratories, there are a subject classification and a geographical classification.

The value and quality of the information given in the bulletin must, of course, depend largely on the method of compilation. It is stated that all the information has been obtained directly by correspondence. Moreover, no investigation was made to ascertain the character of any laboratory listed nor the quality of the work done. *Questionnaires* were sent to about 1500 firms, and the information given is based mainly upon the replies received to these *questionnaires*. It will be realised that the answers supplied in this way must vary in quality and accuracy. The conscientious firm will be careful not to include, in its enumeration of research staff, employees who are little better than technical craftsmen engaged in routine testing, and will be scrupulous to distinguish between genuine industrial research and the mere checking of works products. On the other hand, the less conscientious firm, anxious to make some sort of a 'splash' in a comprehensive record of national research agencies, will be inclined to include employees who can only by a long stretch be brought into the category of research workers, and to look upon mere repetitive

[1] *Bulletin of the National Research Council, No. 60:* Industrial Research Laboratories of the United States, including Consulting Research Laboratories. Third edition, revised and enlarged. Compiled by Clarence J. West and Ervye L. Risher. Pp. 153. (Washington D.C.: National Academy of Sciences.) 1 dollar.

testing as being, in a sense, industrial research. Nothing is said in the bulletin as to whether the *questionnaire* sent out indicated the criteria by which a firm was to decide whether it had, or had not, a veritable industrial research laboratory, meet for inclusion in the list.

Bearing in mind these qualifying considerations, we must, nevertheless, admit that the publication affords remarkable evidence of the variety and extent of the industrial research being prosecuted in the United States, the firms enumerated ranging from such a body as the Bell Telephone Laboratories, Incorporated, with its staff of 2000 full-time research workers, to firms claiming only a single research worker who—it is occasionally admitted—is engaged "intermittently" on research problems. One gets a picture—perhaps not more than a flashlight picture—of a thousand industrial laboratories engaged in the task of winning the scientific knowledge and elucidating the scientific principles involved in many hundreds of varied industries; and in devising ways of applying to industrial practice the science so acquired, so as to cheapen or improve existing materials, to find new materials, to discover new processes and, generally, to raise the level of production in quantity, quality, and variety, while lowering its cost. If we envisage this scientific work associated with the contemporaneous movement, organised on a national scale, for the elimination of waste, and with corresponding developments in business organisation, scientific management, advertising efficiency, and methods of distribution, we shall understand—without taking into account the favourable monetary position of the United States—what formidable competitors in international trade American firms and corporations as a whole must be.

A few salient features of the bulletin may be noticed. In glancing through it we meet, as we should expect to meet, abundant evidence of the provision made for industrial research by those industries which have, as it were, sprung from the loins of science—for example, the chemical, electrical, and optical industries. What is significant is the evidence of a growing application of scientific research to industries hitherto largely empirical, with little or no scientific tradition behind them—industries that, like Topsy, simply 'growed.' To take a few examples only, we find industrial research laboratories dealing with baking, flour and foods, canning and preserving, fruit and fruit products, building materials, fur products, laundering and milk. There are a few laboratories maintained by the co-operation of several firms in the same industry organised as research associations; but, for the most part, the laboratories enumerated are parts and parcels of the industrial organisations of individual firms and corporations. Their number is significant of the extent to which science is gaining domicile within the industrial units.

The Mellon Institute of Industrial Research, at the University of Pittsburgh, is in a class by itself. Its work is carried on under the Industrial Fellowship System of Robert Kennedy Duncan. Individual firms or groups of firms provide the funds for the maintenance of one or more industrial fellows whose full time is given to the investigation of technological problems that require protracted periods—a year or longer in each case—for their satisfactory solution. The industrial fellows at present comprise 79 chemists, 10 ceramists, 10 engineers, and 3 biologists, and they are engaged upon sixty different lines of scientific investigation.

It is probably true that the greater part of the scientific work done in these industrial research laboratories, taken as a whole, is directed to the immediate problems of the respective firms or industries; but, even so, it must involve some, perhaps much, fundamental research. In the laboratories of the larger firms or corporations a great deal of fundamental research—research in pure science—is deliberately planned and undertaken on broad lines, irrespective of any prospect of immediate industrial benefits, because it is realised that such scientific research is the fountain from which the streams of applied science must flow.

We need a similar compilation of industrial research laboratories for Great Britain, so that we may see in some measure how we stand. Are the individual industrial firms in this country calling in science to redress the balance of international competition? No doubt the big industrial corporations are devoting considerable expenditure and human effort to scientific investigation, and the modern tendency towards greater industrial aggregations, by the combination of smaller firms, will increase the facilities for more extensive scientific research. But a great area of British industry is occupied by small or medium-sized firms, directed by strongly individualistic owners, where the industrial units are too small to enable industrial research, on any adequate scale, to be carried on individually. Much has been done to provide the industrial research needed in this area by the establishment of the research associations formed under the ægis of the Department of Scientific and Industrial Research. These associations are like

the research associations in the United States, in that they are financed on a co-operative basis, but they differ from the American associations in that they are partly financed by grants-in-aid from the Government and they are more numerous and cover a wider and more diversified industrial field. For this area of numerous and varied medium-sized or small firms, they constitute probably the only practicable scheme for securing the prosecution of scientific research in the closest association with industrial effort—for getting the relevant industries saturated with science—and their future existence and development is a matter of national concern.

The census of production, imperfect though it be, has already been of great industrial value in enabling us to appreciate our economic position. A most useful supplement to such a census would be the publication of a conspectus of all the industrial research laboratories in Great Britain, especially if it could be ensured that only laboratories and workers engaged in veritable industrial research were included. Such a return, though it might disturb our complacency, would be likely to quicken our sense of the leeway to be made up, in this matter of applying science to industry, if we are to meet in the open markets of the world our chief foreign competitors—notably the United States and Germany—on at least equal terms.

J. W. WILLIAMSON.

A Record of a Dying People.

The Arunta: a Study of a Stone Age People. By Sir Baldwin Spencer and the late F. J. Gillen. In two volumes. Vol. 1. Pp. xxviii + 390 + 87 plates. Vol. 2. Pp. xvi + 391-646 + 64 plates. (London: Macmillan and Co., Ltd., 1927.) 36*s*. net.

NO anthropological book has had so favourable a reception or given rise to such voluminous discussions as "The Native Tribes of Central Australia," by Prof. Baldwin Spencer and F. J. Gillen, on its publication in 1899. Twenty-eight years later, Sir Baldwin Spencer has issued a new edition under the title of "The Arunta." The first edition was the result of several years' work; in the new edition is embodied the record of later investigations down to 1926, and thus the accounts of imperfect or partly understood native ceremonies and beliefs have been amplified and rectified. Comparison between the two editions will show, however, that a great deal has remained unchanged, because the earlier contained careful descriptions of what the authors actually observed, and being a record of facts, must remain valid for all time. It is in such matters that the anthropologist has the advantage over most scientific men, for observations in the field when made, as in the case of the Australian, on a vanishing people, cannot be repeated by future students, and therefore researches of this kind will never become out-of-date. The impossibility in many cases of subsequent checking of his statements thus imposes on the anthropological observer a grave responsibility. Sir Baldwin Spencer was a scientifically trained zoologist when he began to study the natives of Central Australia, and we can rely entirely on his account of what he witnessed. The late Mr. Gillen had for a long time gained the confidence of the natives and was thus an indispensable colleague.

The discussions alluded to above necessitated a reconsideration of certain interpretations and a new inquiry into some of the statements previously made and into the belief of the natives. Sir Baldwin has done his best to clear up these matters. Not long after the publication of the first edition, the investigations made by the late Rev. C. Strehlow were published in a series of papers in the *Veröffentlichungen aus dem Städtischen Völker-Museum*, Frankfurt-am-Main, and these were accepted as authoritative by German anthropologists, and most English students took them very seriously. The earlier parts were edited by the late M. F. von Leonhardi, who in the 'Vorrede' to the 1910 issue strongly supported Strehlow against his critics. Certain discrepancies between the observations of the German and English investigators have been ascribed in part to their working among different sections of the great Arunta tribe. It also seems that there were definite limitations attached to the researches of Strehlow, so that, despite his mastery of the language, he was unable to partake in personal experience of the ceremonial life of the natives which the lay investigators were able to obtain. It is, moreover, a common experience that for obvious reasons missionaries cannot always persuade natives to disclose their secret and sacred beliefs and practices. Sir Baldwin has discussed, in foot-notes and appendices, some of the points in which the two accounts varied or differed. We have, therefore, in this book the matured judgment of the author on subjects that required elucidation.

It will be noted that in the new book there has been a slight rearrangement of certain sections, and some have been enlarged, such as that on "Social Organisation," though in this section allusions to the social organisation of neighbouring tribes has been omitted. The earlier discussion

following the account of "knocking out of teeth" has been greatly abbreviated, and the comparison with other tribes has been omitted, but, fortunately, references to the customs of neighbouring tribes are usually retained elsewhere. Attention should also be directed to the fact that there are a few alterations in the spelling of native words, or even in the words themselves. It will be necessary for all those who have made notes for lecture or other purposes to go over these carefully with the new book, as throughout this work there are many modifications, more especially in the account of religious beliefs. The description of the stone implements has been greatly enlarged and more fully illustrated, and improvements have been made in the parts dealing with material culture and decorative art. There are nearly twice as many illustrations in the new book as there were in the old, and so, being of excellent quality and carefully printed, they add very greatly to the value of the book.

As occurs elsewhere in Australia and also in parts of Melanesia, physical differences are said to characterise the two moieties; here one is supposed to have straight and the other curly hair (vol. 1, p. 42). Forty samples of hair were collected and given to Dr. O. W. Tiegs for examination; his report is reprinted in Appendix E, in which he says he cannot confirm the aboriginals' belief, though from blood tests on South Australian natives there is evidence to show that a mixture of 'blood' has occurred. "This suggests that the widespread idea of the aboriginal that he is composed of two distinct races, still recognisable by their straight and wavy hair, is a tradition which has descended from a past age, when a wavy- and a straight-haired race existed, and that these two races have now largely fused" (vol. 2, p. 599).

In the earlier discussions on the Arunta, emphasis was laid by some on their very primitive character; indeed, some regarded them as the most primitive of all people, and this in face of the elaborate ceremonies, complicated social system, and the fact that "the traditions of the tribe recognise four more or less distinct periods in the Alcheringa" ("The Native Tribes of Central Australia," p. 387). The periods and the cultural innovations which characterised them were also summarised (*l.c.* p. 421). The evidence in the new book confirms this. Except for a few objects of material culture, the Andamanese, to take but one people, are much 'lower' than the Arunta or any Australian tribe.

In the far distant Alchera time, a few superhuman beings called Nŭmbăkŭlla brought elements of culture to the Inapătuă creatures (*i.e.* incomplete human beings), whom we may regard as being the very backward aboriginal population; these were made into men, doubtless through the instrumentality of initiation ceremonies. The culture-bearers brought the *churinga* and reorganised social relations. There is thus traditional evidence of cultural movements which ultimately affected the whole of Australia—just as in New Guinea and Melanesia we find analogous cultural drifts. Migrations of culture are due (1) in some cases simply to the borrowing of elements of culture from neighbours; (2) in others, there is a definite introduction of culture by means of a limited number of persons who appear to be more advanced members of the same race as the recipients, or at all events closely related; (3) in a few cases there is evidence that the immigrants belong to an alien race. In Australia, the evidence seems to point to the first and second of these alternatives, as it does in New Guinea as a whole. There is also good reason to believe, as indeed is most probable, that this cultural drift came from New Guinea.

A. C. Haddon.

Geology of the Alps.

(1) *The Structure of the Alps.* By Prof. Léon W. Collet. Pp. xii + 290 + 12 plates. (London: Edward Arnold and Co., 1927.) 16*s.* net.

(2) *Die Deckentheorie in den Alpen* (*Alpine Tektonik, 1905–1925*). Von Prof. Dr. Franz Heritsch. (Fortschritte der Geologie und Paläontologie, herausgegeben von Prof. Dr. W. Soergel, Band 6, Heft 17.) Pp. iv + 75-210. (Berlin: Gebrüder Borntraeger, 1927.) 8 gold marks.

NOT the least fascinating of the many aspects of Alpine studies is that of the geological history and growth of the elevated region from which the peaks as we see them have been carved. With good cause has it been claimed that the synthesis of the Alps is that of the mountain-mass in general. In the two books before us the authors have set forth the latest views of Alpine tectonics, particularly those of recent developments of the theory of *nappes* or *Decken*. In the Alps, between two rigid massifs of rocks, folded and metamorphosed in Palæozoic and possibly pre-Palæozoic times, is found a zone of well-bedded Mesozoic and Cainozoic sediments. Movement of the southern massif towards the northern caused buckling in the intermediate region, and the folds thus developed were overturned and finally squeezed out and expelled north-westwards as great overlapping sheets (*nappes de recouvrement, Deckfalten*).

More than twenty of these nappes can be recognised: they lie one above another, folded and rippled in their upper portions, but drawn-out, sheared, and torn in their lower limbs. Different nappes may be folded with or may envelop one another. The later folds deform the older and, like waves, break and splash north-westwards over them. In places the upper nappes, by their forward movement, are supposed to have set in motion the lower and less extensive sheets. Where resistance to movement varied (as, for example, in the area between the Mont Blanc and Aar massifs), the nappes, retarded laterally, may swell forward into arcs or festoons of arcs, and exhibit fold 'virgation.' From the brow of a nappe in the north or north-east to its roots in the south or south-east, the translation of the rocks may amount to more than 100 km.

Such is the fascinating conception of the theory of nappes or Decken. In Prof. Collet's book, which will be welcomed as the first exposition in English of these views, Alpine problems are considered almost (if not exclusively) from the viewpoint outlined above. Prof. Heritsch's work, however, goes much farther than its title might suggest; it summarises the evidence for and against views of Alpine tectonics which seem irreconcilable.

(1) There is no question that Prof. Collet's book will serve a very useful purpose in attracting the interest of travellers to the geology of the Alps; students in universities and schools will doubtless also be grateful to him for his lucid treatment of a difficult subject. At the outset, the author introduces the reader to the fundamental conception of the Alpine geosynclines or large basins of deposition, and their intermediate geanticlines or ridges. The margins of the basins yielded the autochthonous sequences and the deeper parts supplied the rock-successions of nappes. These principles are applied to the elucidation of various regions in turn. In the Mont Blanc area the granite is thrust northwards over the sedimentary zone of Chamonix and is separated by it from the ancient mass of the Aiguilles Rouges. The Aar Massif and High Calcareous Alps, with their autochthonous and parautochthonous rocks (the latter term not being defined except by implication), are illustrated by excellent descriptions of the districts of Kandersteg and Grindelwald, of Jungfrau, Mönch, etc.

These accounts are given in a form which will enable visitors to the Alps to search out the evidence for themselves, especially if they are also provided with the excellent geological guides of the Swiss Alpine Club; we cannot therefore grudge the space devoted to them, particularly as they embody the results of much of the excellent and arduous investigations of Prof. Collet himself. Some readers, however, may wish that the space occupied by 24 pages on the Jura Mountains had been at any rate in part devoted to the expansion of the account of the Glarus Alps or the wonderful Klippen (nappe-outliers) of the Pre-Alps of northern Switzerland.

The Pennine Nappes, the piling-up of which has produced the Valais Alps, are interpreted in the light of Argand's work, and are so described that geological study may be combined with climbing and sightseeing at such resorts as Arolla, Zermatt, and the Upper Engadine. Eastwards, the great half-window of the Swiss Alps is closed on the famous 'Rhine-line' from Constance to Chur, for the Aar massif and older nappes plunge beneath the later sheets which form the Eastern Alps (the Austrides of R. Staub). Prof. Collet makes a praiseworthy effort to render clear the succession and relationship of the nappes of the Eastern Alps, according to the view of Termier, Kober, R. Staub, and others, but the necessarily condensed form of the account and the absence of detailed locality-maps will render this section difficult for students.

Prof. Collet writes with such freshness and vigour that we fear the reader may forget that the Decken theory in its wider implications is but a theory. In a book of this size it is perhaps difficult for an author to separate evidence from speculation. It is a little tantalising, however, to be told, without being informed of the evidence, that the Alps provide "a great support to Wegener's theory" (p. 22), or that (p. 246) "We shall see, later on, that the higher Prealps . . . represent a small part of Africa resting on Europe." Unfortunately, Africa is not mentioned again in the book. True, it is postulated that the northward-drifting of Africa (or Gondwanaland) closed the geosyncline (the Tethys of Suess), the sediments of which were forced upwards and forwards to build the Alps, the underlying sima being injected as basic intrusions in the Pennine nappes. The existing Mediterranean area is then regarded by Argand and Staub as due to distension produced by the drift of Europe away from Africa. But this is hypothesis, albeit brilliant.

The extensive bibliographies form a valuable feature of the book. A glossary, with an explanation of the terms as ordinarily used in Britain, would also help non-geological readers.

(2) Prof. Heritsch's review of the progress of investigation of the Alps is a publication of an entirely different character. It is a compilation

certain to be of the utmost service to those who wish to undertake a serious study of Alpine tectonics and to appraise the evidence leading up to the different interpretations of the complicated structures. Its bibliographical details alone are of great value. Prof. Heritsch himself has done much original and valuable work in the Eastern Alps, but although he calls himself an opponent of the Decken theory so far as that region is concerned, he spares no trouble to set out the views of its various supporters, paying frequent tributes to the publications of Albert Heim, Rudolf Staub, and other exponents of it. He traces the history of Alpine investigation and the development of the 'mushroom,' overthrust and Decken theories. To make clear his later discussion he gives an admirable account of the terminology and rationale of the Decken theory. A brief description of the structure of the Swiss Alps forms a prelude to a comparison with the Eastern Alps. A detailed account of the tectonics of the latter and an exposition of the conflicting views constitutes the greater part of the book. Incidentally, the character of the famous 'window' of Hohe Tauern is discussed in some detail.

Finally, the age of the several phases of the mountain-building movements, the cause of the diastrophism and the difficulties of determining the age of the glyptogenetic stages, are set forth. Throughout the book the author insists on the view of the East Alpine geologists that the movements were not a unified and continuous series, but phases of crumplings separated by time-intervals. The present position in the study of Alpine tectonics may therefore be summarised by saying that, between the views of the extremists of the Swiss school on one hand and many of the Austro-Alpine geologists on the other, there is a great gulf fixed, no less deep and significant than the Tethys of Suess itself. P. G. H. Boswell.

The Electron, the α-Particle, and the X-Ray.

Handbuch der Physik. Herausgegeben von H. Geiger und Karl Scheel. Band 24: *Negative und positive Strahlen, zusammenhängende Materie.* Redigiert von H. Geiger. Pp. xi + 604. (Berlin: Julius Springer, 1927.) 49·50 gold marks.

THIS important book is divided into six chapters, each of which is written by an authority on his subject; the whole is edited by Prof. Hans Geiger. Dr. Bothe gives an informed and comprehensive account of the work on the passage of electrons through matter, their velocity and ionising power, their absorption in and scattering by substances, and on the secondary rays to which the electrons give rise. The second chapter, by Prof. Rüchardt and Prof. Baerwald, deals with the passage of canal-rays through gases and solid objects; special attention is directed to the importance of the Doppler effect in canal-rays. The editor is responsible for the chapter on the passage of α-particles through matter, a subject which in the hands of Sir Ernest Rutherford and his pupils has been one of the most revealing in modern physics. This chapter, which is an excellent account of all the physical properties of the α-particle, is perhaps the best in the book.

A chapter on the absorption of γ- and X-rays by matter, which one would expect to follow the first three, is not included in this work. Instead, the subject of absorption is dropped in favour of two chapters on the structure of matter as revealed by X-ray analysts. These chapters comprise nearly half the contents of the book. The first, by Prof. Ewald, describes in detail experimental work, and covers the whole field of contemporary activity; the second, by Prof. Born and Dr. Bollnov, deals with the theoretical aspects of the structure of solid objects and includes a section on the thermodynamics of solid substances. These two chapters are without doubt the best description of the investigation of crystal structure by X-rays that has been penned. In the concluding chapter we are introduced to a third subject, that of the relation between the properties of simple chemical substances and their atomic and molecular structure; this is the work of Prof. Grimm.

The book should make a wide appeal to all physicists who wish to follow the extraordinarily interesting and varied work which has resulted from the discoveries of the electron and α-particle, and the methods of X-ray analysis in recent years. Indeed, all but the first chapter could be read with real profit by physical chemists also. Neither physicists nor chemists will find all of this book easy reading; the subjects discussed cannot of necessity be described in terms of simple ideas; but the different authors have done their best to make their subjects intelligible. They have not been content to extract from the literature the more important work and to leave it uncritically to the reader's notice; they have made a determined attempt to convey to the reader by words and diagrams what the best workers on the subject at the present time regard as most important.

Too many works of reference at the present

time give experimental results without a description of the more important methods by which these results have been obtained. In this book, with its 374 illustrations, which, although never elaborate, are always adequate, the methods of investigation are fully described. In this respect, in its comprehensiveness, in the care which both contributors and editor have given to the various chapters, and in the printing, this book is in the best German manner. A. S. R.

Social Science.

(1) *The Task of Social Hygiene.* By Havelock Ellis. New edition. Pp. xix+414. (London: Constable and Co., Ltd., 1927.) 6s. net.

(2) *Heredity and Human Affairs.* By Prof. E. M. East. Pp. ix+325. (New York and London: Charles Scribner's Sons, Ltd., 1927.) 16s. net.

(3) *The Foundations of Social Life.* By Prof. H. P. Fairchild. (Social Science Series.) Pp. vii+287. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1927.) 13s. 6d. net.

(4) *The Science of Society.* By Prof. W. G. Sumner and Prof. A. G. Keller. (Published under the Auspices of the Sumner Club on the Foundation established in Memory of Philip Hamilton McMillan, of the Class of 1894, Yale College.) Vol. 1. Pp. xxxii + 734. Vol. 2. Pp. xxii + 735-1481. Vol. 3. Pp. xxi + 1483-2251. (New Haven: Yale University Press; London: Oxford University Press, 1927.) 18s. net each vol.

(1) "THE Task of Social Hygiene" was first published fifteen years ago. It very well deserves the place which it has won, and a new edition needs no recommendation here. There can be few books of that date dealing with social problems of the moment which on re-reading at the present time would not seem stale. But such is the breadth and sympathy of Mr. Ellis's treatment, so illuminating is his presentation, that the book fully maintains its freshness. Mr. Ellis must be counted among the most inspiring teachers of his time, and the next generation will be fortunate if it finds someone with his depth and variety of scientific knowledge and his diversity of gifts to review its problems.

(2) Mr. Ellis may be said to be concerned with the broad problem of the right use of our growing knowledge to 'make and remake life.' Prof. East, in "Heredity and Human Affairs," is concerned with the application of our rapidly increasing knowledge of one branch of biology to the betterment of human affairs, and he has written a very readable book on this theme. It need scarcely be said that his scientific credentials to discuss problems of heredity are unimpeachable. It appears further that, unlike some of his fellow workers, he does not abandon his scientific attitude when he touches social questions, and as a result he has produced as good a book on eugenics for the general reader as exists to-day.

(3) Prof. Fairchild, in "The Foundations of Social Life," has essayed a difficult task. He has felt the need for a treatment of certain fundamental facts with which in his opinion students of any social science should be acquainted, and has therefore attempted in a short book to sketch the biological characteristics of man, his reaction to the environment, the nature of society, and the possibilities of rational control. It may perhaps be doubted whether success in so small a compass is possible, but if the attempt is to be made, it would be difficult to improve the plan of the present work. The execution of the plan is not so satisfactory. The author tends to talk down to his readers and the phrasing is sometimes loose. We may sympathise with Prof. Fairchild's desire to broaden the student's interests and to lead him to see the relation of what is to be his own special line of study to other problems. But is this the way to do it? There is certainly a danger in beginning with what is of necessity a very sketchy and inexact treatment of vast problems.

(4) There is a certain impertinence in reviewing in a few hundred words a work in three volumes containing close upon a million words that has cost one of the two authors a quarter of a century's work and his colleague a great part of the last ten years of his life. It seems that the idea of the book took shape in 1899, and that Prof. Sumner's "Folkways," published in 1907, was a development of part of the original scheme. Having treated this section in a separate work, he returned to the main task. He died in 1910, and Prof. Keller, who had been associated with him for a great number of years, has now brought the task to a conclusion, though there remains a final volume containing a case-book, bibliography, and index. The volumes are a monument of painstaking labour. The authors have spared no trouble in their search for facts, and the amount of literature consulted is immense. They present ample evidence for their generalisations. But, nevertheless, the impression left is one of disappointment. Why is this?

Let us first give in their own words the authors' intention in this work.

"In general we seek the sense of societal customs and institutions. That means to us their expediency as adjustments in living, whether or not we can come to any conclusion as to their origin. Nor do we regard it as enough merely to exhibit them as adjustments, so proved because of their survival; we hope to show also how and to what adjustment has been made."

The arrangement of the book is to describe and discuss customs and institutions classed in the following manner: (1) those having to do with self-maintenance, including (*a*) industrial organisation, (*b*) property, (*c*) regulative organisation, and (*d*) religion; (2) those having to do with self-perpetuation, including marriage and the family, and those having to do with self-gratification. The authors embark upon their immense labour with this programme and carry it through with devotion in some million words. But it fails to grip. The reader feels out for a guiding thread to lead him through the maze. There is no thread such as a truly scientific or purely descriptive treatment would have provided. The authors assume adaptation. They treat groups of customs and institutions as adaptations. They move a little way back and a little way forward by means of generalisations as they deal with each group, and then they pass on.

In many ways the treatment is reminiscent of Herbert Spencer's sociology, though the use of facts and the avoidance of grandiose generalisations render the present authors' work greatly superior. Is not the fundamental mistake this clinging to the conception of adaptation? Unless it is analysed, it is a truism of little value. In a sense every institution shows adaptation. But when the term is analysed it is found to cover many different conditions. Without analysis it is a vague and unsatisfactory conception. Upon analysis it leads to problems that demand a treatment quite other than that given in this book. Furthermore, however scientific may be the attitude of the authors in their reliance upon facts and their freedom from preconceived theory, no truly scientific treatment can begin from such a starting-point.

Thus we are led to regard the plan as misconceived. Nevertheless, the book is a mine of accurate information, and in it other students can dig. But they will not dig with profit unless they study method. Methodology in social science is the most urgent study in this field to-day.

Our Bookshelf.

The Natural History of Wicken Fen. Edited by Prof. J. Stanley Gardiner. Part 4. Pp. 267-383 + plates 7-9. (Cambridge: Bowes and Bowes, 1928.) 6*s*. net.

INCLUDED in this part are an article by the editor on Wicken Fen, and accounts of the fossil vertebrates, protozoa, planarians, cladocera, copepoda, diplopoda and chilopoda, and insects—Collembola, Coleoptera, Hemiptera-Heteroptera (Part II.), Orthoptera, Neuroptera, and sawflies. For many of the species recorded notes are added on the biology and ecology. In the account of the Coleoptera a list is given of the species which occurred in the fen districts of Cambridgeshire before 1854, but which are now not taken (26 spp.) or are less readily found, and another list of species which are now taken but were never recorded by the old collectors. Mr. Lowndes records that the same species of copepods are found living under the most varied conditions and in widely separated districts, but that these individuals do not exhibit greater differences than do those that live in any single pond. The *p*H was found not to have any direct influence on *Cyclops langvidus*—a result differing from that reached by Labbé.

Prof. Stanley Gardiner emphasises the interest of Wicken Sedge Fen as an area that has not only never been cultivated, but also has never been deliberately drained, and thus constitutes a real bit of the old fenland. Except for bush growth, the Sedge Fen is much as Ray knew it in 1660, but some plants common then are rare now. Prof. Gardiner rightly claims that Wicken Fen is not only a "place of historic interest and of natural beauty," but also is the one place from which the history of the changes in the fauna and flora of the wet lands of England can be deduced with reasonable exactness. We congratulate him and his co-workers on these further results of their investigations, which are not only of great interest in themselves, but will also afford trustworthy information to our successors for comparison with conditions in their time.

Ministry of Agriculture and Fisheries. Fishery Investigations. Series 2, Vol. 9, No. 2, 1926. *Plaice-egg Production in 1920–21, treated as a Statistical Problem, with Comparison between the Data from 1911, 1914 and 1921.* H. J. Buchanan-Wollaston. Pp. 36 + 11 charts. (London: H.M. Stationery Office, 1926.) 8*s*. 6*d*. net.

QUANTITATIVE studies of living organisms in their natural habitats have a biological and mathematical interest far beyond the technical purposes for which they are usually made. The study of plaice-egg productions treated as a statistical problem by H. J. Buchanan-Wollaston affords a good example both of the interest and of the difficulties of such research. The report deals with egg counts of samples taken with the Hensen net in 1920–21, and comparison of the egg distributions inferred from these and earlier methods

for 1911, 1914 and 1921. The mathematical methods are explained in a series of interesting appendices. These methods have a somewhat home-made appearance, and should not yet be regarded as standardised. Applied intelligently, and with a constant effort to keep in touch with the realities to be represented, they seem well suited to the immediate problem.

The statistical terminology is not always happy; terms like 'datum solid' used when 'frequency surface' seems to be intended, tend to obscure the essential contrast between *data* and *quæsita*. Much mathematical work will evidently be necessary before an adequate procedure is evolved, since the observations are necessarily sparse and are not simultaneous. The reviewer would judge that the full value of the observations will not be made available until the distribution problems involved are treated by methods of fitting rather than by methods of interpolation. R. A. F.

A Course of Modern Analysis: an Introduction to the General Theory of Infinite Processes and of Analytic Functions; with an Account of the Principal Transcendental Functions. By Prof. E. T. Whittaker and Prof. G. N. Watson. Fourth edition. Pp. vi + 608. (Cambridge: At the University Press, 1927.) 40*s*. net.

WITH the exception of certain corrections and additions, the fourth edition of this comprehensive work differs in no material respect from the third edition published in 1920. "Whittaker and Watson" has entered and held the field as the standard book of reference in English on the applications of analysis to the transcendental functions. This end has been successfully achieved by following the sensible course of explaining the methods of modern analysis in the first part of the book and then proceeding to a detailed discussion of the transcendental functions, unhampered by the necessity of continually proving new theorems for special applications. In this way the authors have succeeded in being rigorous without imposing on the reader the mass of detail which so often tends to make a rigorous demonstration tedious.

The book is admirably printed. The only faults which have been noticed are the omission of the upper and lower bar in the definitions of the 'upper' and 'lower' Riemann Integral (§ 4·11) and the omission of the line in the fraction on the right of the first identity in § 13·14. These are insignificant defects in a fine work which makes accessible a continuous account of methods recorded in a scattered series of memoirs. L. M. M.-T.

Blut und blutbildende Organe menschlicher Embryonen. By Dr. W. Knoll. (Denkschriften der Schweizerischen Naturforschenden Gesellschaft, Band 64, Abl. 1.) Pp. ii + 81 + 9 Tafeln. (Zürich: Gebr. Frets A.-G., 1927.) n.p.

OPPORTUNITIES for the examination of fresh human tissues are of such rare occurrence that the present monograph will be greeted with interest by cytologists and medical hæmatologists. Dr. Knoll has been fortunate enough to collect human embryos in a living condition by surgical removal of the uterine contents through an abdominal incision, in twenty-eight interrupted pregnancies. He has undertaken a detailed examination of the various cellular structures in human embryonic blood, not only in permanent sections of the rapidly fixed embryo, but also in blood films prepared by the more modern hæmatological methods; especially interesting is the examination of fresh embryonic cells in hirundinised plasma. The physical characters and staining affinity of the various types of cells are analysed and also the oxidase reaction studied. Dr. Knoll's technique is presented in detail; for the oxidase reaction he uses a mixture of 1 per cent. α-naphthol in normal saline and 1 per cent. di-methyl-para-phenylene-diamine base.

The work is well illustrated and contains nine magnificently reproduced plates in colour presenting the details of the blood cells and stages in their development.

Coup d'œil sur la théorie des déterminants supérieurs dans son état actuel. Par Maurice Lecat. Pp. viii + 100. (Bruxelles: Maurice Lamertin, 1927.) 16 francs.

THE matrix in *n*-dimensions was originated by Cayley and Sylvester. It is quite possible that this purely algebraic conception may find a physical application in space of more than two dimensions. The contributions of M. Lecat to our knowledge of this subject are many, and the present summary is a forerunner of a treatise in three volumes to be published shortly, in which the original researches of the author will be more fully treated. The symbol of Kronecker which figures largely in the exposition is not defined. It may help the reader to note that this symbol $\delta_{i,j}$ is equal to unity if $i=j$ and is zero if $i \neq j$.

Physics for School Certificate (Heat, Light and Sound): a Revision Course. By W. Littler. Pp. 231. (Exeter: A. Wheaton and Co., Ltd., 1927.) 3*s*.

THIS is frankly a revision course. It contains the information required by the examiners in a reasonably small compass, and should prove useful in any school in which the chief object of including physics in the curriculum is to provide another subject for the school certificate examination. That there is a demand for such books is a serious criticism of the relative functions of schools and examinations.

Examen des différentes méthodes employées pour résoudre les problèmes de géométrie. Par G. Lamé. Pp. xii + 124 + 2 planches. (Paris: J. Hermann, n.d.) 21 francs.

A SIMPLE reprint, without introduction or notes, of an early work on algebraic geometry, first published at Paris in 1818. It is important historically as being the first book in which it was remarked that all curves (or surfaces) of order n which pass through the points common to two, $f=0$ and $g=0$, of this order, are represented by equations of the form $f+\lambda g=0$.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Origin of the Nebulium Spectrum.

IN a letter to NATURE of Oct. 1, 1927, p. 473, Mr. Bowen has announced the very interesting relationship that some of the lines of unknown origin which are found in the nebulæ and in the Wolf-Rayet stars and were so long attributed to a hypothetical element nebulium, are really due to ionised light elements like O^{++}, N^{++}, O^{+}, N^{+} . . . ; they do not arise from the transitions usually allowed, but are due to transitions which are usually prohibited. Prof. A. Fowler has also lent his support to this hypothesis. The object of this note is to discuss the nature of these transitions.

Mr. Bowen finds that the following well-known trio of nebulium lines are due to O^{++}, and due to transitions shown below:

5006·84	$^3P_2 - {}^1\bar{D}_2$
4958·91	$^3P_1 - {}^1\bar{D}_2$
4363·21	$^3P_1 - {}^1\bar{S}_0$

The structure diagram of O^{++} is shown below:

$$O^{++} \ldots 2K\, 2L_1\, \underset{2}{L_2}$$

$$M_1 \longrightarrow M_2 \longrightarrow M_3.$$

$2L_2(p^2)$ gives us $^3P_{0\,1\,2}$, $^1\bar{D}_2$, $^1\bar{S}_0$.

All other four-valence elements, namely, C, N^+, O^{++}, . . . and C, Si, Ge, Sn, Pb have similar ground levels due to the electron-configuration p^2, that is, two electrons in p- (or L) orbits. The lines arise from transitions between metastable levels as pointed out by Bowen. It is interesting to note that though such transitions are not found in the spectra of light elements, they are of frequent occurrence in the spectra of heavy elements. In the spectrum of Pb, which is analogous to that of O^{++}, the values of the fundamental levels are

$^3P_0$	$^3P_1$	$^3P_2$	$^1\bar{D}_2$	$^1\bar{S}_0$
59821	52004	49173	38365	30355

Dr. Sur (*Phil. Mag.*, vol. 2, p. 623; 1926) in this laboratory found that the following lines exactly analogous to the above-mentioned nebulium lines are obtained in the heavy arc of lead. They are not present in the usual arc:

$$^3P_1 - {}^1\bar{D}_2 = \nu 13637, \quad \lambda = 7330 \text{ A.}$$
$$^3P_1 - {}^1\bar{S}_0 = \nu 21649, \quad \lambda = 4618 \text{ A.}$$

Other elements of the same group, namely, C, Si, Ge, Sn, can theoretically give similar lines, as the following Table shows, but a scrutiny of the existing literature shows that they have not yet been obtained. Whether they can be obtained in the heavy arc is yet to be seen.

$^3P_1 - {}^1\bar{S}_0$ for	C	?
	Si	ν15317
	Ge	ν15810
	Sn	ν19101

Let us now consider the nature of violation of the selection principle. I have shown that in the case of complex spectra the selection principle can best be explained not in terms of the different quantum numbers, but in terms of *electron transition*. Thus $pp \longrightarrow ps$ or $pp \longrightarrow pd$ transitions are allowed (one electron changing from the p-orbit to the s-orbit, or the d-orbit, corresponding to $\Delta k = \pm 1$ where k = azimuthal quantum number), but $pp \longrightarrow pp$ transitions are not allowed ($\Delta k = 0$). In terms of the structure diagram, this means that only those transitions are allowed in which the total number of electron transitions is odd. Hence the transition involved in the origin of the nebulium lines really violates the selection principle $\Delta k = \pm 1$; we have here $\Delta k = 0$, and in addition $\Delta n = 0$ (change of total quantum number $n = 0$).

It is well known from the experiments of Koch on helium and other subsequent experiments, as well as from theoretical considerations, that such violations take place when the region where the spectrum is produced is traversed by a big electric field, or in regions where the free charge density is high. In heavy elements, the principle is easily violated, because the central atomic field deviates largely from the radial. A big external electric field, or free electric charges, would help the process, where such internal fields are not present, as in light elements, or are insufficient. Such, in fact, is the interpretation to be put on Dr. Sur's results. Similarly, in other heavy elements, namely, Bi, Th, Au, prohibited transitions of this type are very frequent.

Bowen's interpretation of the nebulium lines as being due to prohibited transitions in light elements therefore implies that unusually big electric fields are present in nebulæ and Wolf-Rayet stars. This can be explained, because, owing to the extremely high temperature, matter must be in a very highly ionised state, and large fluctuations of electrical density, owing to accumulation of charges of one sign, must be very frequent. Bowen further finds that besides these lines, lines due to the transitions $L_2M_1 \longrightarrow L_2M_2$ and $L_2M_2 \longleftarrow L_2M_3$ of O^{++} are obtained in these stars. The fact that the electron, while returning from the higher excited group of orbits (due to L_2M_2), appears to linger too long in the less stable $^1D_2$ of the L_2L_2 combination, is to be attributed to this big electric field.

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Fluorescence of Mercury Vapour.

AN experiment with a double bulb of quartz containing mercury *in vacuo* and heated to a constant temperature, which showed fluorescence under illumination by the light of an aluminium spark only when one of the bulbs was cooled by an air blast, has been cited by one of us as proof that only distilling mercury vapour exhibits the phenomenon. This has been denied by Niewodnizanski, who obtained brilliant fluorescence in stagnant vapour.

We have re-examined the matter and find that the effects observed with the double bulb are due to traces of water vapour, the distillation carrying them over into the cooler bulb and leaving only pure mercury vapour in the warmer one. We have prepared bulbs which could be made to fluoresce in either way. A double bulb fairly well degassed by long heating and pumping, when sealed from the pump, shows brilliant fluorescence at constant temperature; if superheated locally with a flame for a few minutes, it will be found to fluoresce only when one bulb is cooled and distillation started. If now it is subjected to an electrodeless discharge by placing it between the metal plates of a high frequency oscillator ($\lambda = 2·5$ metres), in the course of ten or fifteen minutes the discharge becomes very feeble and the bulb is now found to be in its original condition, showing fluorescence in the absence of distillation. The electrical discharge appears to have driven the water vapour back into the quartz,

Niewodnizanski also reported that the 4358 arc line of mercury appeared on his photograph with excitation by the aluminium spark, but no other mercury lines. This we find due to the fact that his spectrograph was of too low dispersion.

We find practically all of the brighter arc lines, at least in the violet and ultra-violet, and they appear to result from two stage absorption as they vary in intensity with the *square* of the intensity of the exciting light, as shown by the wire-gauze test recently described by one of us in this journal.

Lord Rayleigh has found that the disappearance of the fluorescence by superheating, which was observed by one of us many years ago, holds only for the visible band in the blue-green region. The ultra-violet band remains. The band spectrum in this case was excited electrically.

We find that, with aluminium spark excitation, superheating the vapour at constant density destroys the blue-green band and *enhances* the ultra-violet band enormously (possibly tenfold). The arc lines which appear under this excitation are also greatly enhanced by the superheating. We are now using moving streams of mercury vapour to study the time relations of these processes.

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Ultra-Violet Microscopy.

IN preparation for giving a course of instruction in ultra-violet microscopy, I have had occasion to study some of the incidental problems in this subject. One of the most troublesome was the provision of a satisfactory immersion fluid, which has hitherto consisted of a mixture of glycerine and water adjusted to give homogeneous immersion for the fused quartz system at $\lambda = 0{\cdot}275\mu$. This mixture is strongly hygroscopic, and the absorption of water by the film of liquid between the objective and slide causes a gradual change of focus sometimes noticeable in a few minutes. Moreover, in the process of changing objectives, a necessary part of the present technique developed by Barnard, some of the liquid becomes smeared on the slide, where it can readily absorb water and thus contaminate the liquid on the next objective inserted in position. A 'ropy' layer of liquid appears extremely likely, and this must constitute a serious drawback and a source of uncertainty.

I have lately been able to overcome this difficulty. By means of a recently designed refractometer, I have been able to measure the ultra-violet refractive indices of cane-sugar solutions in thin films, although the liquids are sufficiently absorbent to preclude a satisfactory measurement with a hollow prism for wave-lengths which are *shorter* than the region of $\lambda = 0{\cdot}275\mu$. By interpolation from the results, it was found that a cane-sugar solution having a refractive index for sodium light $n_D = 1{\cdot}4516$ would have the required refractive index (1·4961) for the ultra-violet. Glycerine and water has to be adjusted to $n_D = 1{\cdot}4530$. These figures are approximately correct for 18° C. An Abbe refractometer is convenient in practice.

Control experiments were made by adjusting cane-sugar and glycerine solutions to the same visual refractive index and measuring the refractive index after thorough mixing; this was found to be the same within the probable error of experimental conditions. Although there are indications which would make closer investigations desirable, we may assume a zero change for the present purposes.

Solutions of cane-sugar and glycerine adjusted to the figures given above should possess the same refractive index for the ultra-violet. 10 c.c. of glycerine solution was placed in each of four stoppered tubes to which 1, 1·5, 2·0, 2·5 c.c. of cane-sugar solution respectively were added and thoroughly mixed. The liquids containing least sugar were found to be still hygroscopic, but that with most sugar was found to evaporate very slowly; all such mixtures will, on exposure to the air, absorb or evaporate until equilibrium is reached. Thus on one day the following figures were found:

Proportion of sugar	1	1·5	2·0	2·5
Original n_D of mixture	1·4529	1·4528	1·4528	1·4527
Equilibrium, n_D	1·4497	1·4509	1·4527	1·4540

It is clear that the liquid with its refractive index at 1·4527 is still practically at the strength which gives homogeneous immersion for fused quartz; on another day, another liquid might be nearer; it will be advantageous to have more stops in the series. The small proportion of sugar has not been found to absorb the ultra-violet sufficiently to render its use a drawback in the slightest degree at $\lambda = 0{\cdot}275\mu$.

With such a number of mixtures constantly exposed in shallow flat open dishes, it is possible, then, to select in a few minutes a liquid which will have for the time being a *practically constant* refractive index, and so obtain all the advantages which have already been hinted at. To illustrate the utility of the method, an inspection should be made of the ultra-violet photograph, Fig. 1, which was taken after

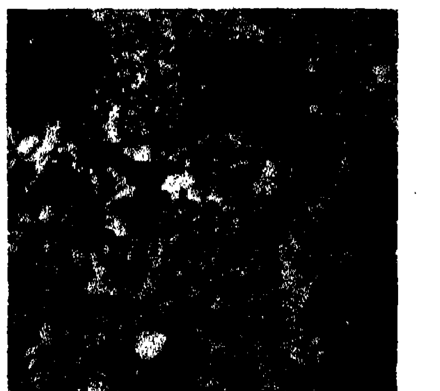

FIG. 1.—Chemically deposited silver film by transmitted light. ×3200. Image given by quartz monochromat using $\lambda 0{\cdot}275\mu$.

the apparatus had been set up and focused with the quartz lens, *and then left for more than 20 hours*; one portion of the field was then *still* in critical focus; central focus was obtained by relative displacement of the objective and stage through $0{\cdot}6\mu$ only.

The optical homogeneity of the liquid contributes materially to the possibility of high resolution. This photograph was taken with an original magnification of 800, and enlarged up to 3200. Every resolvable

detail should thus be clearly visible to unaided vision. This image is better than any we have been able to obtain of the same object using an apochromat (N.A. 1·3) and blue light ($\lambda = 0{\cdot}45\mu$), but there are reasons for thinking that the performance can be still further improved.

The fused quartz objective N.A. 1·20 was made by Messrs. R. J. Beck, Ltd., from material specially selected by thorough interferometric tests in the Technical Optics Laboratory; the design of the objective is due to Mr. R. J. Bracey, of the British Scientific Instrument Research Association. So far as the work has been successful up to the present, it is owing in no small measure to the skill and thoroughness of Mr. B. K. Johnson, who carried out the difficult refractometry necessary in the attainment of this new type of stabilised immersion liquid for the ultra-violet, and has also taken the greatest pains in the difficult initial adjustments of the microscopic apparatus.

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The Pressures developed in Gaseous Explosions.

IN the current issue of the *Journal of the Chemical Society* (Jan. 1928), Dr. G. B. Maxwell and Prof. R. V. Wheeler have published a paper entitled "The Pressures produced on Inflammation of Mixtures of (*a*) Carbon Monoxide and Air, and (*b*) Hydrogen and Air in a Closed Vessel." From their carbon monoxide–air results they deduce the dissociation of carbon dioxide and offer some criticism of Fenning and Tizard's recent work (*Proc. Roy. Soc.*, A, **115**, 318; 1927). One of us has already written a criticism of Fenning and Tizard's paper (see NATURE, July 30, 1927), and we have nothing to add to the views offered in that letter, except to express the opinion that dissociation in a gaseous mixture undergoing combustion is probably very different from that in a gas heated by external means. We note with interest that the Sheffield school now recognises the reality of incomplete combustion at the moment of maximum pressure, at any rate in carbon monoxide–air explosions.

Messrs. Maxwell and Wheeler use their hydrogen–air explosions for the purpose of calculating the specific heat of steam, and they show that in explosions in which there is excess hydrogen present, so that dissociation is presumably negligible, the calculated mean specific heat (15°-t°) does not vary much between 15°-1400° and 15°-2120° C. They infer from this that the specific heat of steam does not increase over the range of 1400° to 2120° C., but it is not probable that this inference will receive much support.

It so happens that we have been engaged on this problem for some considerable time, and while we are disinclined to accept the absolute values as determined by Maxwell and Wheeler, our results suggest that the *apparent* specific heat, as calculated from explosions with excess hydrogen, does not vary greatly over a wide range of maximum temperatures. We believe that we have experimental evidence to show that these peculiar results are due to incomplete combustion of varying extent.

The method which we originally adopted was that of varying the proportion of hydrogen to air, using 'airs' containing varying ratios of nitrogen to oxygen, with the result that we have been able to make investigations over the temperature range 1400° to 2600° C., at an initial pressure of 1 atmosphere. At the lower temperatures dissociation must be negligible, and, on the assumption that combustion is complete at maximum pressure in mixtures containing a heavy excess of hydrogen, we were able to estimate the amount of the incomplete combustion in mixtures which do not contain an excess of hydrogen. Our results are shown in the following table:

MINIMUM VALUES FOR PERCENTAGE INCOMPLETE COMBUSTION AT MAXIMUM PRESSURE.

Hydrogen (per cent.).	Ratio of Nitrogen to Oxygen.				
	0	2	3·7	4·8	5·8
15	6·6	..	..	..	..
16	8·0	7·0	..	..	3·0
18	9·0	8·3	..	..	3·0
20	9·0	9·0	4·5	6·8	3·5
22	..	10·0	6·0	8·0	5·6
24	..	10·8	7·3	8·0	..
26	..	..	7·7	..	..

We are now convinced, however, partly on account of the comparatively small variation in the calculated specific heats over such a wide range of temperature, and partly owing to the results of work by the aid of flame photography now being carried out in conjunction with Messrs. S. G. Richardson and W. Davies, that even with excess hydrogen present, combustion is far from being complete at the moment of maximum pressure. The values for incomplete combustion shown in the table are therefore much too small.

We have not yet published these results, because we wish to combine them with similar experiments at varying initial density. It is thought possible, in view of the fact that the ratio of the maximum pressure developed to the initial pressure for any given mixture strength increases as the initial pressure increases, that the apparent specific heat will, with increasing density, show an asymptotic approach to the true value.

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Feb. 17.

Carbon Dioxide Tension in Tissues in Relation to Cancerous Cells.

IN a paper which appeared in the *British Medical Journal* of Jan. 28 last, I brought together a number of facts from which the deduction was made that a localised increase of the carbon dioxide tension in the tissues, due to a diminished blood supply, may be an important factor in the cancerous change of cells, and may even be the factor common to many known 'causes' of cancer. Exactly how an increase in carbon dioxide tension could alter the cells so that afterwards they continue to behave in an abnormal manner for a vast number of generations, was not suggested. Some recent observations made upon *in vitro* cultures of rat kidney under varying carbon dioxide tensions are suggestive in this connexion. Before dealing with these, and in view of the fact that both X-rays and radium cause cancer, I propose very briefly to refer to some of the effects of these radiations on living cells.

The early workers exposed eggs and noted death

or abnormal development according to the dose. The smaller the dose the less was the deviation from normal development. At the same time, it was noted that mitosis was very abnormal after radiation, the chromatin being especially effected. It was not, however, until recently that attempts were made to see whether there was any effect on inheritance. We now know that inheritance is altered. This information at once suggests an explanation for the cancerous change of cells after exposure to X-rays or radium. It may well be that during abnormal mitosis there is an abnormal distribution of genes or even chromosomes between the daughter cells, so that like produces not like, but unlike, and a normal cell becomes a cancer cell. Now, abnormal cell division not only follows radiation, but has also been observed under other abnormal conditions, and the observations referred to show that they occur when cells are incubated *in vitro* in high concentrations of carbon dioxide. Fig. 1 shows a number of metaphases of fibroblasts extruded from cultures of rat kidney. The numbers in the diagram give the

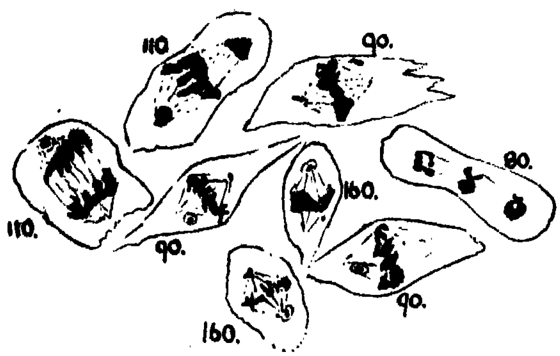

FIG. 1.—Metaphases of fibroblasts extruded from cultures of rat kidney. Cultures were fixed in Bouin's mixture and stained with Weigert's hæmatoxylin.

pressure of carbon dioxide in mm. of mercury. It is seen that fragments of chromatin, chromidia, are not suspended at the equator of the spindle, but are situate in the neighbourhood of the centrosomes. They appear to be outside the spindle, and often surrounded by a small amount of clear cytoplasm or nucleoplasm. These appearances have not been seen in cultures grown in lower concentrations of carbon dioxide. They suggest that as a result there is an unequal division of chromatin between the daughter cells, with the possibility of accompanying hereditary disturbance. Thus a hypothesis with regard to cancer following radiation will apply also to cells subject to other adverse conditions.

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Feb. 21.

Correlation Coefficients in Meteorology.

IN the *Meteorological Magazine* for February, a much criticised statistical theorem of W. H. Dines is restated by F. J. W. Whipple. The original theorem was to the effect that "If there is a cause X and a result Y with a correlation r between them, then in the long run X is responsible for r^2 of the variation of Y." It is suggested that this be altered to "If the correlation coefficient for two variables X and Y is r, and if the appropriate regression equation is used for estimating X from known values of Y, then x', the estimated departure of X from the mean, is related to x, the true departure of X from the mean, by an equation of the type

$$x' = r^2x + \xi,$$

in which ξ is a variable quantity not correlated with x." A rider is added to the effect that the rule involves no assumption as to the distribution of the values of x and y, and no assumption as to the existence of other correlated variables.

That the subject of correlation is full of pitfalls for the unwary, is well illustrated by an example given of the practical use of the theorem in its revised form, added for the benefit of readers unfamiliar with the theory of correlation. In this example, which deals with two places, A and B, between the annual rainfalls of which there is a correlation coefficient of $\frac{1}{2}$, it is calculated that in years when A has an excess of 8 inches, the calculated excess at A obtained from B's rainfall would be $(\frac{1}{2})^2 \times 8$, that is, only 2 inches. But unless the relationship between two variables be linear, the regression equation gives no information about the average value of one variable that will be associated with one particular value of the other, and the example is therefore a misuse of both the original and the revised theorems. It is in any event difficult to see why a special theorem is necessary in order to emphasise the importance of the square of the correlation coefficient, unless it be to show that, having found a correlation of r between X and Y, it is still possible that a correlation, not of $1-r$, but of $1-r^2$, may exist between X and some third variable independent of Y.

To mention another important source of error in the use of the correlation coefficient, meteorological literature abounds in examples of a quite indefensible process whereby the existence of a genuine connexion between two quantities is made to appear far more probable than is actually the case. The process is a misuse of the equation

$$\sigma = \frac{1-r^2}{\sqrt{N}},$$

which gives approximately the 'standard error' of r in terms of the true value of r (not yet known), and of N, the number of pairs of mutually 'independent' observations used in finding r', the apparent correlation coefficient. In order to see whether r' may not be fortuitous, that is, an error of sampling from uncorrelated material, the value 0 should clearly be used for r in the first instance in the above equation, yet the usual practice is to give it the value r': the reality of r' is assumed before this has been established. Let us suppose that r' be found to be 0·7 from 16 pairs of observations, then σ is calculated to be

$$\frac{1-(0{\cdot}7)^2}{\sqrt{16}} = 0{\cdot}13$$

instead of

$$\frac{1-(0)^2}{\sqrt{16}} = 0{\cdot}25.$$

Now 0·7 is not sufficiently large compared with 0·25 to be accepted with very great confidence, and the reality of the connexion would be doubtful. Had the true standard error of sampling been 0·13 on the other hand, the odds in favour of a genuine connexion would have been overwhelmingly great.

E. V. NEWNHAM.

The Buoyancy of Whales.

MANY questions arising in connexion with whales have yet to be answered satisfactorily; why, for example, do whales recently dead float in some cases, and in others sink?

Whales may be attacked with the hand-harpoon, weighing about 10 lb., with the simple gun-harpoon

weighing about 12 lb., or with the Norwegian bomb-harpoon weighing about 150 lb.

Whales struck or harpooned with the hand harpoon or with the simple gun-harpoon rarely die at once but survive, and after descending to a great depth, return to the surface, when they are again attacked with harpoons, being finally despatched with whale-lances; a few, however, of those that survive and descend, fail to return to the surface and are drowned.

Greenland whales, bottlenoses, narwhals, and probably other species as well, irrespective of age, sex, or individual peculiarity, that die at the surface invariably float, while those dying at a depth invariably sink.

Greenland whales dying at the surface, notwithstanding the thickness of their blubber, float no higher than bottlenoses or narwhals; as Scoresby says, they barely float, while those dying under water exert a heavy downward strain on the whale-line, and if it breaks, or if the harpoon draws, the prize is lost.

How are the foregoing facts to be explained? It appears, from a consideration of all the circumstances, that whales usually retain sufficient air in their lungs to enable their bodies to float, but that if a whale dies by drowning and this air escapes, its body sinks, like that of any other mammal. Death by drowning is, however, a fate which only overtakes whales that have descended to a depth and are in some way or another prevented from returning to the surface. Whales that die at the surface do so not from drowning, but from exhaustion or shock, and as the blow-holes are valvular, the air required to give them bouyancy is retained and their bodies float, unless weighted by heavy harpoons and heavy whale-lines.

The instinct of the whale to descend when attacked, and the necessity it is under of returning to the surface to breathe, were fortunate circumstances for the old whalers, for the first exhausted it and the second made it easy to attack the whale a second time. The failure of a large whale struck with a light harpoon to reappear at the surface was an embarrassing circumstance for the old whalers, owing to the time wasted in raising it, and the risk of drawing the harpoon in the process. In 1876, in the Greenland Sea, a large Greenland whale struck with the gun-harpoon, descended to a depth of 900 fathoms and died in a little under an hour. To allow gases to generate and make the whale easier to raise, it was allowed to remain suspended by the line for ten hours; the actual raising of it occupying six hours. On another occasion, when a large hoary-headed old bottlenose was being raised, the harpoon drew when the prize was only 50 fathoms from the surface.

Harpooned whales that descend to a great depth seem to feel the weight of the whale-line when returning to the surface, and if the harpoon is wrongly placed, they feel it more than usual, and may fail to reach the surface and consequently drown; at least this is the explanation given in one case of which I know.

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Nebulium and Hydrogen in New Stars.

IN a recent paper (NATURE, Jan. 28, p. 136) S. R. Pike pointed out that the condition of coexistence of O^{++} and H lines in the spectra of new stars leads to a density of the order 10^{-7} gm./c.c., which is directly opposed to the current ideas that forbidden transitions can occur only at very low densities, as determined, for example, by C. T. Elvey (NATURE, Jan. 7, p. 12) using the 'expanding shell' theory of novæ. Since Mr. Pike's arguments are equally applicable to the spectra of planetaries, it seems of importance to analyse the subject further and to find the probable way out of the difficulty. I think that the real cause of the discrepancy mentioned is involved in the use of Saha's formula, which holds only in thermodynamic equilibrium, and of course cannot be applied to the gaseous shells as produced by the expansion of novæ or those of planetary nebulæ, because in these cases the exciting radiation is extremely diluted; a more general ionisation formula is to be used.

Let us suppose with Mr. Pike that 'coexistence' means that not more than 99·9 per cent. of H is ionised and not less than 0·1 per cent. of O^+. The lowest temperature at which those two substances (H and O^+), having ionisation potentials χ_1 and χ_2 at the same electron pressure, can coexist by the ordinary Saha's formula as used by Mr. Pike, is $T = 840\ (\chi_2 - \chi_1)$. In our case ($\chi_2 = 29·5$; $\chi_1 = 13·5$) and the *minimum* temperature required will be $T = 13,000°$, and the density (for H) only 10^{-8} gm./c.c. in decisive contradiction to all our present ideas on the nebulium spectrum. But let us take a more correct formula for ionisation by diluted black body radiation (temperature T), when the electron temperature is T_0 and the dilution factor is W. For small optical thickness of the gaseous shell we have

$$\frac{X_{i+1}}{X_i} N_e = W e^{-\chi/\kappa T} (2\pi m)^{\frac{3}{2}} (\kappa T_0)^{\frac{1}{2}} \kappa T / h^3$$

where N_e is the number of electrons per c.c. (*Proc. Am. Acad.*, **62**, 5; 1927; Harvard Reprint 38). The dilution factor, W, can be easily estimated for Nova Aquilæ 3, using Hubble and Duncan's data, as previously used by Elvey. Taking the rate of expansion of the shell as 1700 km./sec. during 19 days, we find that for the first appearance of the nebulium spectrum the distance of the shell d from the original star was $2·8 \times 10^9$ km. We can reasonably suppose that the nuclear star has a radius R of the order of one solar radius, that is, of 7×10^5 km.; we obtain, therefore, $W = \left(\frac{R}{d}\right)^2 = 6 \times 10^{-8}$. Now neglecting the unknown difference between T and T_0, we calculate that the resulting density of the shell is 6×10^{-18} gm./c.c. By his method Elvey obtained 2×10^{-17}; taking into account the very rough character of our calculations, we can consider the agreement as very satisfactory and the difficulty raised by Mr. Pike as settled.

It is noteworthy that the calculated density of an expanding gaseous nova envelope (planetary nebula *in statu formandi*) appears to be from 10^2 to 10^3 times higher than that of an already formed planetary, as determined by the theory of a gaseous shell supported by radiation pressure (*Astr. Nach.*, **225**, 90; 1925).

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The Polarisation Factor in X-ray Reflection.

IN comparing the observed intensity of X-ray reflection from crystals with the theoretical formulæ, and in particular in calculating the atomic scattering factor, F, from measurements of the absolute intensity of reflection, it has always been assumed that the incident X-ray beam is unpolarised. This has the effect of introducing a polarisation factor $\frac{1}{2}(1 + \cos^2 2\theta)$, where θ is the glancing angle of reflection, into the expression for the intensity of reflection. Now experiments by Bishop (*Phys. Rev.*, **28**, 625; 1926) show that the characteristic radiation from a molybdenum Coolidge tube may be 15 per cent. polarised,

and Kirkpatrick (*Phys. Rev.*, **29**, 632; 1927) points out that this must have introduced errors into the values of F calculated from experiment. He calculates for the polarisation factor

$$\{\sin^2 \alpha + P \cos^2 \alpha + (P \sin^2 \alpha + \cos^2 \alpha) \cos^2 2\theta\}/(1 + P),$$

where P is a measure of the degree of polarisation of the incident beam, being unity for an unpolarised beam, and α is the angle between the plane of reflection and the plane containing the incident beam and the electron stream in the X-ray tube.

In most experiments α has been zero and, in this case, a degree of polarisation such as that indicated by Bishop would introduce errors of perhaps 5 or 10 per cent. into the values of F determined experimentally for large angles of scattering. This has been pointed out by Havighurst in a recent paper (*Phys. Rev.*, **31**, 16; 1928).

Now Kirkpatrick suggests that it would be advisable in all such experiments to work with $\alpha = 45°$, since in this case the polarisation factor reduces to $\frac{1}{2}(1 + \cos^2 2\theta)$, and is independent of the degree of polarisation of the incident beam.

In view of the detailed comparison of the theory of atomic scattering with experiment which has been based on them, it is perhaps worth while to state that in the determinations of F recently published by the writer and Miss Firth (*Proc. Roy. Soc.* A, **117**, 62; 1927), α was in fact 45°, so that these results would appear to be unaffected by this source of error. It is, however, only fair to state that this value of α was used for reasons of practical convenience and not because of any particular foresight on our part.

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University of Manchester, Feb. 22

Spectrum of Ionised Sodium.

FOLLOWING the extension of the irregular doublet law given by Messrs. Saha and Kichlu [NATURE, Feb. 18, p. 244], I have tried to analyse the spectrum of Na^+, proceeding from the spectrum of neon. I have been able to identify the lines $5L_2(M_1 \rightarrow M_2)$ completely, and the lines $5L_2(M_2 \rightarrow M_3)$ partially. The combination $5L_2M_1$ gives four terms $^3P_{0\,1\,2}$, ^1P analogous to Paschen's s_2, s_3, s_4, s_5 of neon. The differences $^3P_0 - {}^3P_1 - {}^3P_2$ are -765 and -592 and $^3P_1 - {}^1P_1 = 3072$. The combination $5L_2M_2$ gives 10-terms $\begin{pmatrix} ^3D & ^3P & ^3S \\ ^1D & ^1P & ^1S \end{pmatrix}$ analogous to Paschen's p-terms. They have been all identified with the exception of $^1S_0$, and the differences are found to be roughly double the corresponding neon differences (Paschen's P-terms).

There seems to be strong reason for supposing that the identification is quite precise; for Millikan and Bowen (*Phys. Rev.* vol. 23) discovered two lines in the hot-spark spectrum of Na having the wavelengths λ372·3 and λ376·6 with the frequency difference 3075. They are just the fundamental lines $^1S_0 - {}^3P_1$ and $^1S_0 - {}^1P_1$ arising from the transition $5L_1 \rightarrow 5L_2M_1$. 3072 is just the difference found for $(^3P_1 - {}^1P_1)$ in my analysis.

Assuming that the value of $5L_2M_2$-terms $= 4N/3^2$, the value of the ionisation potential of Na^+ comes out to be about 47 volts, with a radiation potential at 32·8 volts. Mohler's values obtained from the electron bombardment methods are respectively 45 volts and 35 ± 1·5 volts. Considering the limitations of this method, the agreement seems to be quite tolerable.

The full analysis will be published shortly.

K. MAJUMDAR.

Department of Physics,
Allahabad University, Jan. 11.

Mnemotropism: Persistence Tendency in Remembering.

MANY hundreds of estimates of given short time intervals incidentally revealed a tendency of successive estimates to approximate each other. For example, in a thousand estimates of ten seconds, varying from 3 to 16·2 seconds, the frequency of differences between successive estimates can be summarised as follows:

0-2 seconds	556 times
-4 ,,	288 ,,
-6 ,,	110 ,,
6 + ,,	45 ,,

There appears to be a tendency to repeat compensatory under- or over-estimates, for example, 10, 6, 10, 7, 10, 7 seconds; or, 11, 8, 6, 12, 8, 6, 12, 8, 8, 7, 11, 7 seconds.

This mnemotropism is comparable to the tendency recently described by Prof. Cathcart and Dr. Dawson (*Brit. Jour. of Psychology*, Jan. 1928) as 'diabatic' or 'persistence.' Working on an ergometer, they found that the rate at which repetitive movements are reproduced is deflected towards the rate at which intervening movements of a similar kind have been made. They also point out that 'persistence' shows itself in piano playing.

The circumstance that estimates of given time intervals appear to run in series (of either low, approximately correct, or high figures), further demonstrates the existence of a momentum or persistence in remembering. It may be added that, in my own crude stop-watch experiments, the interval of ten seconds (that is, 10·0*s*) was estimated correctly in only 2 per cent. of the tests, and in 2·7 per cent. only of one thousand estimates of twenty seconds (20·0*s*).

J. H. KENNETH.

Clynder,
Feb. 17.

The Urinogenital Organs of the Male Frog (*Rana temporaria*).

AN interesting error occurs in the description of the male urinogenital organs of the male frog (*Rana temporaria*) in such standard works as Ecker's "Anatomy of the Frog" (Haslam's translation), Wiedersheim and Parker's "Comparative Anatomy of Vertebrates," and Parker and Parker's "Practical Zoology." Briefly, it is stated that sperms pass through the vasa efferentia to enter a longitudinal duct in the kidney, and thence through transverse ducts in the kidney to the ureter, which acts as a vas deferens.

I have consulted a number of more recent textbooks, *e.g.* those of Borradaile, Bourne, O'Donoghue, Thomson, etc., and find that they state that the vasa efferentia open to the kidney and that the sperms pass through the *kidney* tubules to the ureter; no mention being made either of the longitudinal or transverse ducts of the older writers.

This latter statement coincides with my own observations on a very large number of sections. Not only have I failed to discover any trace of special seminiferous tubules in the kidney, but I have on several occasions examined sections in which sperms were clearly to be seen in very large numbers in the ordinary urinary tubules.

I have, however, failed to find any contradiction of the statement of Ecker and his contemporaries; the two diverse statements being equally available to zoology students.

J. H. LLOYD.

University College,
Cardiff.

Action of Lead-tetra-ethyl in Delaying Detonation in the Internal Combustion Engine.

By Dr. E. Mardles.

THE arrival in Great Britain from the United States of ethyl petrol—the anti-knock fuel containing 6 c.c. of ethyl fluid (lead-tetra-ethyl 54·5 per cent.; ethylene dibromide 36·5 per cent.; and monochlornaphthalene 9 per cent., with a trace of Sudan IV. Red dye) per gallon of petrol, has aroused public interest in the remarkable action of minute quantities of lead-tetra-ethyl and other substances in delaying detonation or 'knocking' in the internal combustion engine. Questions have been raised in the daily press with regard to the benefits to be derived from the use of 'doped' fuel, and as to whether its use is attended with any ill effects on the health or any deleterious action on the mechanism of the engine.

In brief, distinct advantages are to be gained by the use of 'anti-knock' fuels; deleterious action on the engine mechanism by the use of ethyl petrol, if any, is negligible, whilst after investigations in the United States no grave poison hazard appears to have been discovered. The petrol has been sold in America since 1923, and although about 800 million gallons U.S. have been consumed, no illness attributable to its use has been found. In Germany iron-penta-carbonyl in petrol is marketed under the name Motalin as an anti-knock fuel.

Action of Lead-tetra-ethyl.

The main function of the lead-tetra-ethyl is to mitigate the distressing engine trouble of 'knocking' or detonation which arises when a car is accelerating or climbing with open throttle on top gear, especially when the cylinders contain carbon deposits or when an inferior fuel is used. The halogen compounds, namely, ethylene dibromide and monochlornaphthalene, help to remove the lead from the cylinder in the form of lead halogen compounds after the lead-tetra-ethyl has done its work, and they also contribute slightly to the anti-knock action.

It has been found impossible to use an ordinary straight run petrol for high compression engines such as are used for aeronautical or racing purposes without loss of power due to detonation, and it is necessary to employ either mixtures of petrol with benzene, alcohol, etc., for these purposes or to add a small amount of an anti-knocker, such as lead-tetra-ethyl. Ethyl petrol with increased amounts of 'dope' was employed in the winning of the Schneider Trophy (1927) and by Capt. M. Campbell in establishing the world's record of motor-car speed, February 1928.

Engine Experiments with Ethyl Petrol.

For ordinary purposes the following engine experiments illustrate the typical action of 5 c.c. ethyl fluid per gallon of petrol. In a comparatively low performance water-cooled engine which detonated badly at 5 to 1 compression ratio when run on petrol alone, detonation was immediately suppressed when run on the ethyl mixture, and the compression could be raised to 6 : 1 before detonation began. It was calculated from the data obtained that an increase in power of 10·5 per cent. and a decrease in consumption of fuel of 6 per cent. were obtained by employing the higher compression.

In a high performance air-cooled engine at 5 : 1 compression ratio, a slight gain in power was always noticed on changing over from petrol to the ethyl mixture without altering any other condition. Detonation as before was suppressed, and a further gain in power could be got by increasing the magneto advance.

Compression and Efficiency.

The development of the internal combustion engine has been seriously impeded by the tendency of an ordinary straight run petrol to detonate when the compression ratio is raised above 5. It will be seen from Table I., prepared from tests carried out by Ricardo, that considerable progress can be made with the use of higher compression ratios involving an annual saving in the aggregate of many million pounds sterling.

Table I.

Compression Ratio.	Indicated Horse-power.	Indicated Thermal Efficiency.
4	30·3	28·8
5	33·1	32·8
6	35·2	35·9
7	36·8	38·3

Highest Useful Compression Ratio.

H. Ricardo discovered (1918) that though detonation in the internal combustion engine is influenced by a number of important factors, for example, magneto timing and position of plugs, mixture strength, design of piston head, and cylinder shape, etc., the trouble is due to a specific failing of the fuel. Under standard conditions, using a variable compression engine, the E.35 type, he

Table II.

Highest Useful Compression Ratios of Substances (Ricardo).

Substance.	H.U.C.R.
Aromatic free petrol	4·85
Kerosene (heavy fuel)	4·2
Cracked spirit (53 per cent. unsaturated)	5·55
Pentane	5·85
Hexane	5·1
Heptane (normal)	3·75
Carbon disulphide	5·15 (pre-ignition at this point)
Benzene	6·9 (ditto)
Toluene and Xylene	7·0
Cyclohexane (93 per cent. pure)	5·9
Ethyl alcohol (98 per cent.)	7·5
Methyl alcohol	5·2 (pre-ignition at this point)
Butyl alcohol	7·3
Ethyl ether	3·9

determined the point at which during increasing compression the engine gave the first audible signs of detonation. This point he has referred to as the Highest Useful Compression Ratio (H.U.C.R.), that is, the highest compression ratio which it is worth while to employ with a given fuel. If the compression ratio is raised above this limit, excessive detonation leads to pre-ignition and loss of power.

The anti-detonating action of lead-tetra-ethyl is seen at a glance from Table III., which has been compiled from engine data obtained at the Air Ministry Laboratory, Imperial College of Science and Technology, and shows the effect on the H.U.C.R. of a fuel by the additions in varying amounts.

TABLE III.

	Brake Mean Effective Pressure.	H.U.C. Ratio.
Petrol	122 lb./sq. in.	4·9
Petrol + 0·05 per cent. lead-tetra-ethyl	126 ,,	5·3
+ 0·1 ,, ,,	131 ,,	5·7
+ 0·2 ,, ,,	138·5 ,,	6·5
+ 0·3 ,, ,,	142 ,,	7·0
+ 0·4 ,, ,,	144 ,,	7·35

The petroleum refiner, in an endeavour to increase the yield of petrol fraction by including a part of the less volatile distillate which was formerly put into the kerosene fraction, produces a motor fuel which has a greater tendency to 'knock,' but by the use of anti-knockers this disadvantage is removed.

CONDITION OF ENGINE PARTS AND DEPOSITS.

The results of prolonged engine trials with fuel containing not more than 6 c.c./gal. confirm the claims made that ethyl petrol will not injure spark plugs, valves, or stems. After a 33-hour continuous run, an engine which was stripped showed a slight grey oily deposit slightly different from the usual appearance.

Typical analyses of the deposits are as follows:

TABLE IV.

I. Total weight of deposit from piston head and exhaust valve . 2·3 gm./40 sq. cm.
Total weight of lead present in the petrol . . . . . . 28·5 gm.

Deposit analysis.	Per cent.
Oil	4·4
Lead bromide and sulphate	12·2
Iron and aluminium bromides	0·2
Carbon and volatile matter	77·1
Oxides of iron and aluminium	5·4

Lead was found to be present in the oil, but not bromine.

TABLE V.

II. Total weight of lead added . . . . 83·7 gm.

Analysis of deposits.	Total weight, grams.	Lead per cent.	Total weight of lead, grams.
Engine head samples:			
Grey deposit	38·23	54·09	20·7
Black deposit	13·49	21·04	2·8
Exhaust pipe:			
First 2 ft. section	106·14	27·80	29·5
Remainder	12·79	2·26	2·9
Total lead in crank case (oil and deposit)			10·5
Total lead in drop pans under exhaust outlet			1·0
Total lead from all deposits			67·4

The amount of lead in the exhaust gases (undiluted and containing 7 per cent. carbon monoxide) was on an average 150 mgm. per 10 cub. metres.

EXPLANATIONS OF THE PHENOMENON OF DETONATION.

Ricardo from his engine experiments (1918) concluded that detonation differed entirely from pre-ignition, and attributed it to the spontaneous inflammation of residual unburnt charge owing to its compression by the expanding burnt and burning portion. The ignition of the residual charge under high compression and at high temperatures would cause a rapid rise in pressure, causing the cylinder walls to vibrate as though struck by a hammer.

Tizard and Pye extended Ricardo's line of investigation, and studied in particular the behaviour of gaseous mixtures under adiabatic compression. They found that carbon disulphide gave much greater lag periods, subsequent to the arrest of the piston before the rise in pressure due to inflammation occurred, than did ether or heptane, both of which detonate at low compressions, whilst carbon disulphide tends to raise the H.U.C.R. when added to a fuel. They concluded that detonation is a function of the temperature coefficient of the reaction velocity of combustion of a fuel, the lag period being an indication of this value.

Midgley and Boyd (1922), who first discovered the anti-detonating properties of lead-tetra-ethyl and other organo-metallic compounds, aniline, etc., in the engine, considered that detonation is set up in the cylinder when the rate of advance of the flame front reaches the velocity of sound. They attribute such a high rate of flame propagation to a high reaction velocity of combustion. The addition of substances which raise or lower this reaction velocity correspondingly should promote or delay detonation. They showed that isoamyl nitrite promotes detonation to a remarkably high extent, whilst other substances lower it to a greater or less extent, as shown by their results in Table VI.

TABLE VI.

Substance.	Volume in petrol required to effect a given suppression in detonation.
Benzene	25·0
Ethyl iodine	1·6
m. Xylidine	2·0
Tin-tetra-ethyl	1·2
Selenium ethyl	0·4
Tellurium ethyl	0·1
Lead-tetra-ethyl	0·04

Midgley and Boyd employed a $\frac{3}{4}$-kw. Delco-light engine and measured the degree of detonation by means of a rod or pin resting freely on a steel diaphragm set in the cylinder head. When detonation occurred the pin was bounced free from the cylinder, and by means of an electrolytic cell the time whilst in the air was measured from the volume of gas collected. This method is used in the United States, whilst the variable compression engine is employed in Great Britain for measuring the detonation tendency of a fuel.

The view that detonation in the engine is the

same phenomenon of rapid wave propagation observed by Berthelot and Le Chatelier with gaseous explosions in long tubes is now considered to be incorrect, since the engine cylinder is too short to render this probable, and an analysis of the pressure diagrams of Tizard, Pye, and Dixon shows that there is no abrupt transition to the detonation wave during sudden compression. Egerton and Gates found that 'anti-knocks' did not affect the position of detonation in a tube 150 cm. long, even up to initial temperature of 230° C. and pressures of about 100 lb./sq. in.

Nuclear Drop Theory of Callendar.

A theory proposed by Prof. H. L. Callendar (1925) explains in a lucid and simple manner the phenomenon of detonation, and throws light on a large number of isolated facts left unexplained by numerous other theories. In brief, it regards detonation to be due to the simultaneous and violent ignition of a comparatively large volume of unburnt charge containing droplets or nuclei. When petrol is atomised in a current of air, the drops as they evaporate leave a residue or nucleus consisting chiefly of the less volatile constituents, such as the heavier paraffins, which have low self-igniting temperatures and serve as foci of ignition. When benzene and pentane and other fuel vapours are *compressed* they show cloudy condensation. Again, when gaseous mixtures, such as acetylene in air, are heated, a thick fog of ionised particles is produced which sensitises the mixture to ignition. It can be demonstrated that the self-ignition of a gaseous mixture containing liquid droplets is sometimes more than 100° C. below that of the mixture entirely in the vapour state. The inflammation, too, is far more violent in the presence of drops. Thus, a fine spray of amyl nitrite ignited with a violent explosion when projected into a glass tube at 140° C., but the vapour-air mixtures caught fire relatively mildly when a temperature of 480° was reached.

The subject of the formation of ionised particles or nuclei in gaseous media and the chemical changes which occur during the slow combustion in the pre-flame period during adiabatic compression is of considerable significance to the subject of detonation, and is being studied at the Air Ministry Laboratory of the Imperial College of Science and Technology. Quantitative analysis of the products of slow combustion of various fuels shows that aldehydes and acids are formed in profusion, but since these do not promote detonation in the engine, a prior compound was suspected. Further investigations indicated the presence of active oxygen, presumably in the form of organic peroxides, in the condensation products, especially when liquid drops were present and the mixture heated for a few seconds only. It was considered that the aldehydes, carbon monoxide, etc., were the decomposition products of primarily formed peroxides of the fuel, which by concentration in the nuclear drops caused self-ignition of an exceedingly violent character at relatively low temperatures. Organic peroxides are known to be violent explosives. Thus Brodie, who first prepared alkyl peroxides, showed that a few drops detonated like a cannon. Staudinger also found that small quantities of organic peroxides adhering to the walls of a beaker were sufficient to shatter it.

Engine Experiments with Organic Peroxides.

In engine experiments carried out with the use of a synchronised sampling valve, portions of the gas mixture during the compression stroke and before ignition have been withdrawn for analysis. The oxidation products were found to contain aldehydes, acids, etc., and to be similar to those obtained during slow combustion experiments in glass tubes or bulbs in the laboratory. In a 4-stroke engine running at 1200 r.p.m.—that is, with a compression stroke of $\frac{1}{80}$ of a second duration—the presence of active oxygen was demonstrated. With the addition of iron carbonyl or lead-tetra-ethyl to the fuel, the yield of peroxides was appreciably diminished. Experiments were tried with the use of petrol to which small additions of organic peroxides and nitrogen peroxide had been added, and it was found that they all promoted detonation to a marked degree.

Moureu, Dufraisse, and Chaux, working on the autoxidation of hydrocarbons, confirm Callendar's conclusion that peroxidation occurs in the liquid state and is responsible for detonation. Callendar from his experiments (1925) showed that lead particles from the thermal decomposition of lead-tetra-ethyl became concentrated on the surface of nuclear drops, which are in this manner protected against rapid oxidation and early self-ignition, the primary higher oxides formed by the oxygen molecule with the fuel being immediately decomposed by the metal and autoxidation thus delayed.

Experiments with Metallic Vapours.

Egerton and Gates demonstrated that lead vapour from a low tension arc behaved similarly to lead-tetra-ethyl in raising the self-igniting temperature of fuel mixtures and delaying detonation in the internal combustion engine. They investigated the action of anti-knockers and metallic vapours on the self-igniting temperature, determined by the Moore method, of petrol mixtures, and found, for example, that with thallium vapour a rise of 180°, and with lead a rise of 100°, was obtained. Lead-ethyl gave a rise of 90°, iron carbonyl 130°, and selenium diethyl 140°. They concluded that the stable peroxides of the metal react with and destroy the fuel peroxides, for example, aldehyde peroxide, and are then regenerated so that in this way the substances which autocatalyse combustion are destroyed.

Ionisation and Radiant Energy.

Detonation in the engine is accompanied by marked ionisation, and the spectrum of 'knocking' combustion shows an extension in the ultra-violet region. It was considered (Symposium on Gaseous Reactions, Faraday Society, 1926) that these phenomena are the accompaniment rather than the

cause of detonation, though at one time it was considered that 'anti-knocks' acted by absorbing either the radiant energy or the electrons which by advance from the flame front increased the flame propagation and so led to detonation.

Bennett (1927), who studied the influence of substances on the ionisation of various flames and on ionisation during the slow combustion of a number of gas mixtures, found *inter alia* that lead-tetra-ethyl, and iron carbonyl, as well as amyl nitrite, greatly increased the ionisation. It was considered, therefore, that ionisation was not a cause of detonation but merely a temperature effect.

Landlocked Salmon.

FOR many years there has existed in the middle and upper parts of the River Otra, in southern Norway, a fish known locally as the 'Blege,' a name applied throughout the whole of south-western Norway chiefly to the juvenile stages of the sea trout. In fact an important fishery for the 'Blege' took place in old days in the southern parts of the Bygglandsfiord, a fishery mainly restricted to the spawning season late in the autumn and lasting until Christmas.

It is only recently [1] that this fish has been discovered by Mr. Knut Dahl to be a true landlocked salmon (*Salmo salar*). Only exceptionally does this salmon exceed 30 cm. (about 12 in.) in length, and for this reason Mr. Dahl has called it a 'Dwarf-salmon.' In general appearance it resembles an overgrown smolt, through the silvery coat of which the blue parr- or finger-marks are still faintly visible. An examination of such characters as the number of scales in the oblique row running backwards from the adipose fin to the lateral line, the shape and slenderness of the tail, and the short upper jaw, shows that it is indistinguishable from the young of typical migratory salmon, its only difference from the adult salmon being the retention of certain characters peculiar to the juvenile stages and its small size.

The adult fish are somewhat pelagic in their habits and roam about in schools all over the lake, unlike the ordinary trout, which appear to keep more to the shallow water and do not congregate so markedly in shoals. This roaming character is probably correlated with their feeding habits, since their food chiefly consists of the planktonic crustacean, *Bosmina obtusirostris*. Scale examination shows that many exhibit the typical growth periods of the migratory salmon, spending their first years in the river under poor feeding conditions, and then migrating into the lake where food is more abundant. Some, however, are born in the lake itself, and do not show this change in growth rate. A migratory habit is also exhibited by the landlocked salmon of Lake Wenern, which migrate into the river to spawn, returning afterwards to the lake, but unlike the dwarf-salmon they grow to a considerable size. Of the dwarf-salmon born under river conditions, the majority migrate after 2-5 winters. Most of the fish captured were of an age of four to six winters, and older fish were rare. Spawning took place for the first time generally in the fifth or sixth winter.

True salmon are prevented from migrating into these waters by high falls situated at Vigelandsfoss, 15 kilometres from the sea, and from geological evidence Mr. Dahl estimates that the dwarf-salmon must have arisen from fish landlocked about 9000 years ago.

At the present day the impression gained was that these fish were as numerous as the common trout, though the net fishing has diminished owing to the damming of the Bygglandsfiord as a reservoir. Mr. Dahl gives a vivid description of the sport afforded by the dwarf-salmon to the angler, and maintains that in fighting powers they surpass the trout, a supremacy which they hold also as a table delicacy.

F. S. R.

[1] The "Blege" or Dwarf-salmon. A landlocked salmon from Lake Bygglandsfiord in Setesdal. By Knut Dahl. *Skrifter utgitt av Det Norske Videnskaps-Akademi i Oslo.* I. Matem.-Naturv. Klasse 1927. No. 9. Oslo, 1927.

Research and Development in Australia.

THE main objects of the Science and Industry Research Act (1926) of the Commonwealth Government were to reorganise the Institute of Science and Industry, which was founded in 1920, and to provide adequate funds for developing scientific and industrial research in Australia. The first Annual Report of the Council for Scientific and Industrial Research (Melbourne, 1927) contains a review of the activities of this newly constituted body between April 1926 and June 1927; the Science and Industry Research Act, 1920–26, is printed as an appendix to the Report. At the first meeting of the Council, it was decided to devote particular attention to investigations on plant and animal pests and diseases, fuel problems, preservation of foodstuffs, and forest products. In accordance with this decision, arrangements were made to secure information and reports on some of the problems concerned from Prof. T. G. B. Osborn (Adelaide), Prof. H. A. Woodruff (Melbourne), Dr. Franklin Kidd (Low Temperature Research Station, Cambridge), Mr. A. J. Gibson (Indian Forest Service), and other specialists. The various fields thus laid open to inquiry are all of first-rate importance, but a particular interest may perhaps be anticipated for Mr. Gibson's report, which is to deal with forest products problems and with the advisability of establishing a forest products laboratory in Australia.

The Annual Report affords a comprehensive summary of the many investigations in progress, some of which have already been noticed in the Council's journal (see NATURE, Oct. 8, 1927, p. 520). Many of the activities of the Council have an intimate bearing upon the progress of agriculture in Australia. A standing committee on agriculture

has been appointed; a register of agricultural research is being compiled; and the Council is drawing up plans, in collaboration with the British Empire Marketing Board, for the creation and organisation of a tropical agricultural research institute in Queensland.

In co-operation with the Development and Migration Commission and the Anglo-Australasian Tobacco Company, the Council is organising a comprehensive investigation of tobacco-growing in Australia, a sum of £30,000 having been made available for this purpose during the first period of three years. The citricultural research station at Griffith, in the Murrumbidgee irrigation area, is now owned and financed jointly by the Council and the Water Conservation and Irrigation Commission of New South Wales, the Commission contributing £1500 per annum and supplying water free of cost. For work in viticulture the Council has acquired the research station at Merbein, near Mildura; considerable success has attended the researches into manurial and processing problems which are in progress at this institute, the introduction of the 'cold-dip' process for drying sultanas having led to a gain in quality equivalent to some £30,000 during the last season. For reasons connected largely with the quality of the soil, it is proposed to establish a research station at Coomealla, 2 miles from Mildura, for the investigation of irrigation problems.

With regard to plant and animal pests and diseases, a report upon the practicability of controlling and eradicating St. John's wort by the introduction into Australia of suitable insect enemies has been furnished by Dr. R. J. Tillyard, and investigations are being conducted in England with *Chrysomela hyperici* and other species. Dr. B. T. Dickson, formerly professor of plant physiology in McGill University, has been appointed to direct a comprehensive series of researches dealing with the rusts and smuts of cereals, soil-infecting fungi, and plant diseases in general. Prominent among the animal pests under consideration is the cattle-tick; this has caused enormous financial loss in Queensland, and has only been kept out of New South Wales by the maintenance of a buffer area. It is now feared that the buffalo-fly, if permitted to spread southwards from the Northern Territory, may become a worse pest than the cattle-tick. In attempts to effect control by natural enemies, experiments are in progress with *Hydrotœa dentipes*, which may possibly parasitise the larvæ of the buffalo-fly, since in the larval stage it lives on the larvæ of the stable-fly and the house-fly.

News and Views.

HEARTY congratulations are offered to the veteran engineer, Sir Alexander B. W. Kennedy, F.R.S., who celebrates his eighty-first birthday on Mar. 17. Born at Stepney, son of the Rev. John Kennedy, D.D., resident there, he was educated at the City of London School, entering, on the completion of school life, at the Royal School of Mines, South Kensington. His active technical career started with the firm of J. and W. Dudgeon, engineers and shipbuilders, Millwall, afterwards becoming chief draughtsman in Palmer's Engine Works, Jarrow. Elected professor of engineering at University College, London, in 1874, Sir Alexander, for fifteen years ensuing, devoted himself to the establishment of an engineering laboratory in which teaching and practice could proceed with harmonious interaction. Undoubtedly his work in this field had far-reaching results elsewhere. He designed the steel and concrete internal structure of the Alhambra Theatre, when for the first time, we believe, flat concrete slabs were used on a large scale to carry weights. Sir Alexander's services were utilised for many of the early electric undertakings in London and the chief provincial towns, and he was much in request as an official adviser on Government projects. He was president of the Institution of Mechanical Engineers in 1894–1895, and of the Institution of Civil Engineers in 1906–7. In an inaugural address entitled 'Engineering and Modern Life,' Sir Alexander said in modest vein, "I have worked in many branches, from marine to academic, from constructional to electrical. Having spent forty years in so many different wildernesses I cannot reasonably claim to know the ways of any one of them as thoroughly as my more judicious predecessors have shown in their particular regions." So long ago as 1894, at the Oxford meeting of the British Association, Sir Alexander was president of Section G (Mechanical Science).

SIR JAMES EDWARD SMITH, F.R.S., founder of the Linnean Society of London, and its president for forty years, died at Norwich, his birthplace, on Mar. 17, 1828. This centenary, relating to a distinguished botanist and leader of science, merits notice. Besides the foregoing, however, Sir James is remembered through his acquisition in early youth of the scientific collections, library, and manuscripts brought together by Linnæus, the great Swedish naturalist. Smith was the author of numerous botanical treatises; whilst his "English Botany" (1790–1814), issued in thirty-six volumes, with coloured figures by James Sowerby, achieved high success. He published a paper in the *Philosophical Transactions* in 1788, entitled "Observations on the Irritability of Vegetables." "Having heard," he begins, "that the stamina of the Barberry, *Berberis communis*, were endued with a considerable degree of irritability, I made the experiment in Chelsea Garden, May 25, 1786, on a bush then in full flower." It may be mentioned that in the same volume were papers by his eminent contemporaries, John Hunter, Priestley, and Cavallo. The Linnean Society possesses a portrait of Sir James. He was elected into the Royal Society in 1785.

THE story of the purchase and transference of the Linnæus collections to England, to become the personal property of an individual barely twenty-five years old, is of singular import. The more or

less accidental circumstance of breakfasting with Sir Joseph Banks on a certain morning in December 1783 was the mainspring. Smith had just completed his medical studies at Edinburgh, and was deeply interested in botany. He learnt from Sir Joseph that an offer had been made to him by Prof. Acrel, of Upsala, to acquire by purchase the whole of the collections made by Linnæus, with some later additions. The sum named was 1000 guineas. Banks for some reason or other had himself decided against the proposal; but he impressed the matter upon Smith. Correspondence with Prof. Acrel ensued; ultimately, with the provision of funds by Smith's father, the son, Dr. J. E. Smith, undertook to buy. The collections were to be entrusted to a master mariner sailing between Stockholm and London. On Aug. 13, 1784, the safe receipt of the collections in Stockholm was notified, and by the end of October following, the ship, *The Appearance*, Capt. Sweder, had arrived in the Thames with the precious packages.

THE sale of the collections incurred the grave displeasure of the King of Sweden, Gustavus III., who sent a vessel to intercept the voyage, and a courier by land to assist. These efforts, however, were unavailing. Apartments were taken in Paradise Row, Chelsea, for the accommodation of the collections, and soon Banks and Jonas Drylander were assisting in their arrangement. In March 1788, Dr. Smith removed to Great Marlborough Street, of course taking the series with him. After a six years' residence there he moved to Hammersmith, and finally to Norwich. He was knighted in 1814. Annually for forty years the Linnean Society had re-elected its founder as president. However signal the honour, reciprocity was not seen in the bequest of the collections to the Society. On the contrary, the council received an offer from Smith's executor to purchase the collections (as they then were, for some minor sales had occurred) for the sum of £5000. Ultimately 3000 guineas was accepted as the purchase price. But this financial responsibility held the Society to ransom for many years.

DURING the recent visit to Great Britain of Mr. W. Nowell, the director, considerable progress was made with the recruitment of the staff for the Amani Research Institute, or, as it is to be known, the East African Agricultural Research Institute, Tanganyika Territory. When Mr. Nowell was appointed, he had just taken up his duties as Director of the Department of Science and Agriculture, British Guiana, to which post he had been transferred from that of Assistant Director, Department of Agriculture, Trinidad. He lost no time, however, in visiting his new headquarters, and for a considerable period afterwards he toured extensively in East Africa to familiarise himself with local conditions and to become acquainted with the heads and staffs of the agricultural departments. During his visit to England last winter he was busily engaged in framing the general policy of the Institute and making arrangements for the recruitment of staff. Up to date, the following appointments have been made: entomologist, Mr. C. B. Williams, late Director, Plant Protection Service, Egypt; plant pathologist, Dr. H. H. Storey, late mycologist in charge of the Natal Herbarium, Union of South Africa; soil chemist, Mr. G. Milne, late lecturer in agricultural chemistry, University of Leeds; geneticist, Mr. G. F. Clay, late agricultural officer, Uganda; plant physiologist, Mr. F. J. Nutman, late of the Forest Products Research Laboratory; systematic botanist, Mr. P. J. Greenway, late of the Imperial Forestry Institute, University of Oxford. Mr. F. M. Rogers, who for the past few years has been in charge of the station pending its reorganisation, has been appointed superintendent of plantations, and Mr. K. E. Toms, lately of the Department of Agriculture, Zanzibar, assistant superintendent of plantations. Capt. E. M. Nicholl has been appointed manager of the Kivumkoro Coffee Estate which is now attached to the Institute. Mr. R. E. Moreau is appointed secretary and librarian.

THE capital expenditure on the East African Agricultural Research Institute, which must now be regarded as one of the chain of research stations which it is intended to establish throughout the tropical Colonies of Great Britain, is estimated at a total of £22,500. Towards this the Colonial Research Committee has provided £2000, whilst it is expected that the balance will be found from the East African Guaranteed Loan. The recurrent expenditure will be met partly by the East African Governments and partly by the Empire Marketing Board. The following are the annual contributions which are being paid at present: Tanganyika £4000, Kenya £1200, Uganda £1200, Zanzibar £1200, Northern Rhodesia £200, Nyasaland £200. The Empire Marketing Board is expected to make a maintenance grant up to one-third of the running costs of the Institute, but it will not exceed £6000 in any one year, and is subject to reconsideration after a period of three years.

THE Colonial Secretary appointed a committee last June, under the chairmanship of Lord Lovat, to make recommendations for the formation of a Colonial Agricultural Scientific and Research Service for the British Empire, in accordance with the recommendations of the Colonial Office Conference (NATURE, June 4, p. 824). This committee has now issued its report (Cmd. 3049. London: H.M. Stationery Office. 9*d*. net). It is recommended that the proposed Service should include both agricultural and specialist officers. It should be created immediately and recruited from officers of proved attainments in the field or laboratory. The formation of a Colonial Advisory Council of Agriculture and Animal Health, with two committees, dealing with agriculture and animal health respectively, is suggested. Each committee, and also the Council, should be composed of a representative of the Colonial Office, the director of the Imperial Institute, an agriculturist with tropical experience, and other technical and scientific officers, with a lay chairman. The duties of Council and committees would be to attend to the supply of agricultural and scientific officers for Colonial agricultural services, the establishment and direction of central research stations, and the direction of the

main agricultural research policy of the Colonial Empire, the collection and distribution of information in fields not already served, and so on.

IT is particularly interesting to note that Lord Lovat's committee recommends salaries of £2500 and £2000 a year respectively for the chief and the assistant agricultural adviser for the new Service. It is considered that the chief adviser should be a distinguished man of science of proved administrative and organising ability, and it is hoped that the creation of a stable Colonial Agricultural Service, and including in it a grade with a maximum salary of £3000 a year, will attract and retain the ablest men. The cost of the new Service is estimated as £58,000 for the agricultural side, £35,000 for the specialist side, £14,000 for the Advisory Council, and £20,000 for one central research station, to be met by a cess of 1/400 on the revenues of Colonies with agricultural interests and a contribution of about £16,300 from the Empire Marketing Board.

WE have received the first *Annual Report of the Pure Rivers Society*, which was founded last October with the object of aiding landowners and others to bring actions to restrain pollution of rivers and inland waterways, and to give weight to representations for the same purpose. The objects of the Society appear to coincide with those of the Standing Committee on Rivers Pollution, which has done much during the last seven years to check the increasing pollution of the rivers of Great Britain and to bring a serious and growing abuse before the notice of the public. In a leaflet on "River Destruction" by this Society, it is pointed out that sufficient knowledge is available, without further research, to deal satisfactorily with many noxious effluents which are allowed to flow direct into streams. Although cleansing some of our most polluted rivers which pass through industrial cities may be beyond hope, it is abundantly clear that action under existing law would suffice to improve materially the condition of many other rivers without imposing great expense upon the various undertakings required to render their effluents harmless. In most cases the cost of taking such action precludes landowners and riparian authorities from exercising their legal rights, and the Government has been shy of imposing directly upon industries the financial burden of treating noxious effluents before emptying them into the rivers.

THE International Radio Communication Conference which was held last autumn at Washington was attended by 346 representatives from 79 countries. Almost every interest was represented, and the admission of representatives of the press was a departure from precedent which shows the tendency of the age. The general regulations which have been adopted were signed by all countries. The allocation of wave-lengths amongst the various services was one of the most difficult questions that had to be settled. Wave-lengths for ships' services had been previously dealt with at the London Conference in 1912. The further questions considered were in connexion with fixed services, aircraft services, broadcasting services, and commercial and amateur experimental services. Services between fixed stations will have to work on wave-lengths between 30,000 metres and 3000 metres, that is, with waves the frequencies of which lie between 10 and 100 kilocycles. The band between 3000 m. and 1875 m. is for the mobile services, that is, for ships, aircraft, motors, etc. The 2400 m. to 2000 m. wave-band is exclusively for ships' services; that between 2000 m. and 1875 m. is shared between fixed services and broadcasting services. In Europe the range between 1875 m. and 1550 m. is to be used for broadcasting services only, that from 1550 m. to 1340 m. for broadcasting and air services, and that from 1340 m. to 1050 m. for air services only. Waves from 1050 m. to 545 m. are assigned to mobile services, those from 950 m. to 850 m. being for air services only. The S.O.S. wave-length remains as at present, 600 m. Waves from 545 m. to 200 m. are for broadcasting services. For small ships a wave-length of 220 m. can be used. Waves from 200 m. to 5 m. are split up into bands for all services. The band 10·7 m. to 13·1 m. has been left unreserved. It is gratifying to find that a truly representative international conference, after a very thorough and lengthy discussion, has come to a fairly satisfactory solution of a most difficult technical problem.

IN the Faraday lecture given to the Institution of Electrical Engineers on Mar. 1, Dr. S. Z. de Ferranti emphasised the utilitarian value of applied electricity. He pointed out the importance of relieving as much as possible the present routine drudgery of work in the home. The traditional mechanical aptitude of Englishmen has been fostered by the advent of the motor-car, and radio receiving has fostered an interest in electrical matters which will be extremely helpful, as motors and other electrical devices are used more and more widely in the home. The ever-extending use of alternating current supply has brought prominently to the front the many advantages that would accrue provided we could store electric energy delivered by alternating current in a similar way to that provided by the lead storage cell for direct current supply. He pointed out, however, that there is nothing easier than to convert electricity into heat, and that this heat can be stored in water. The most important requirement of the household at the present time is low-grade heat in the form of hot water. Electrical engineers ought to advocate strongly this application of electricity. As to the future, he regarded electricity as the only means of regenerating the agricultural industry in Great Britain, taking into consideration the small acreage available and the need for the most intensive culture. He also visualised the wonderful results that would ensue if some concentrated form of storage after the manner of the lead storage battery, but without the drawbacks of its weight and cost, were invented. It would do away with the internal combustion engine, with the steam locomotive, and even with the steam turbine on board ship. He hoped also that in the future the Faraday lecturer, instead of having to give the lecture five times in different parts of the country to individual audiences, would be able to broadcast it to them all, and at the same time keep in touch with each meeting.

DR. R. S. CLAY delivered his presidential address to the Optical Society on "The Stereoscope" on Mar. 8. He stated that it was Sir Charles Wheatstone who first conceived the idea of presenting a pair of stereoscopic drawings to the right and left eye respectively, so producing the illusion of an object in relief. From a letter written by R. Murray, of Messrs. Murray and Heath, it was proved that Wheatstone had apparatus made for this purpose, using both prisms and mirrors, so early as 1832, though his actual paper, "Contributions to the Physiology of Vision," was not presented to the Royal Society until 1838. In 1840, Wheatstone had induced Fox Talbot (one of the inventors of photography) and Collen (one of its first exponents) to use the new art for taking stereoscopic pictures. Brewster in 1849 devised a more convenient, lenticular instrument, which was introduced and popularised through the agency of Duboscq at the time of the 1851 Exhibition. By the courtesy of the Delegacy of King's College, London, several of Wheatstone's original stereoscopes were exhibited. Among these was a 'moving picture' apparatus, in which a series of stereoscopic pictures of a French soldier presenting arms, mounted on a drum, was rotated by an ingenious intermittent motion. There were also a large number of early stereoscopes loaned from the Science Museum. These included a beautiful example of Swan's 'Cube' from the Court Collection, in which, by the combination of two stereoscopic pictures on the back and side of the 'cube,' an image of a lady appears in stereoscopic relief within the glass. Two original Wheatstone pseudoscopes were shown, by which a rotating glass beaker suspended from a string viewed from one direction appears to be changing its shape as it rotates; while from another direction it appears to be turning over and over about a horizontal axis, when it is really rotating about a vertical one.

MR. A. D. RICHARDSON (*Scot. For. Jour.*, vol. 41, pt. 2) has discussed in an interesting paper the value and quality of the Scots Pine in the north of Great Britain. We are not in full agreement with the writer in his opening statement: "While coniferous timber of such fine quality as that grown at higher latitudes—in Finland and Northern Russia, for example—cannot be produced in this country . . ." The difference in quality of timber may be attributed, we believe, primarily to the fact that our present day Scottish pine is chiefly of plantation and planted origin. The timber from natural seedlings growing in close canopy will always be superior to that from the ordinary type of plantation seen in Great Britain. In making this statement it may be admitted that the slower the growth the finer the quality of timber. That the opinion here expressed is held in expert timber quarters is supported by the following extract from the *Timber News* of Jan. 20: "It is not generally known [the writer presumably refers to trade circles] that the so-called fir or pine wood that is sent to London and other markets in large quantities from Baltic ports is no other than the produce of our native Scotch pine grown under more favourable conditions than are generally to be found in this country. For almost all classes of work this Continental wood is largely in use, such as road paving, building construction, and in the manufacture of small wooden ware of various descriptions. In a few districts of Northern Britain, notably Aberdeenshire, timber of the native pine is produced of quite as good quality as any that is forwarded from Norway, Sweden, or Russia, as was noticed and commented upon by the Canadian wood-fellers during the War." Mr. Richardson's article is chiefly concerned with a remarkable letter, bearing on the Scots pine and its development, which was written by Mr. James Farquharson, of Invercauld, on June 22, 1775, and sent to Dr. Hunter, F.R.S., the editor of the new (York) edition of John Evelyn's "Sylva" published in 1786. Farquharson's remarks with reference to planted and natural pine are worth reading and acting upon if we are ever to reproduce Scots pine to rival the naturally grown forests of Scandinavia and northern Russia.

SHEETS of metal so thin that ordinary type can be read through them are now available as the result of research by Dr. Carl Mueller, of the Charlottenburg Laboratory, Berlin. His method of preparing them is to electroplate the metal on the surface of some soluble substance, such as rocksalt, and then dissolve away the support. A ring of thicker metal can be used to support the films, of which two and a half million would have to be piled to make a stack an inch high. Such films have been made of iron, nickel, gold, silver, and platinum, and it is found that although the nickel is much less transparent to visible light than gold, it readily transmits the shorter ultra-violet rays. The films are very elastic, and will bulge out for as much as a tenth of their diameter without breaking. Another curious thing about them is their high electrical conductivity. As these films are practically all surface, a strip of film containing no more metal than in a round wire one-hundredth of a millimetre in diameter will carry enough current to light several lamps; if the same current were passed through the wire, the latter would be instantly melted. This film may find use in radio and phonograph reproducers, since ordinary diaphragms are so heavy that they dampen some of the overtones and so coarsen the sounds.

THE fourth International Congress of Entomology will be held at Cornell University, Ithaca, N.Y., on Aug. 12-18 of this year, with Dr. L. O. Howard as president. Invitations to send delegates have been forwarded to foreign governments through the State Department at Washington, and a programme is being arranged which provides for every important interest, educational, scientific, and economic. The mornings will be reserved for papers of more general interest, and during the afternoons, sections will deal with taxonomy, distribution and nomenclature, morphology, physiology and genetics, ecology, medical and veterinary entomology, and economic entomology relating to forest, field, and garden, bees, insecticides, and appliances. On an all-day visit to the Geneva Experiment Station, demonstrations of methods of spraying by machinery and dusting by aeroplane will

be given, and immediately after the Congress, excursions are planned to the Niagara Falls, entomological museums of eastern cities, and laboratories of the U.S. Bureau of Entomology. Cornell being the Alma Mater of a very large number of American State entomologists, and Dr. L. O. Howard the organiser of the U.S. Bureau of Entomology, a model for other countries, the attendance of American entomologists will be very large. Various European governments and institutes have already intimated that they will send delegates, and it is sincerely to be hoped that Great Britain likewise will be well represented at the meeting. The great difficulty for Europeans is the question of expenses. In order to obtain certain facilities of travel and to reduce the expenses, it is proposed to arrange for a party to travel together. Particulars of the party can be obtained from Dr. K. Jordan, Zoological Museum, Tring (Herts), the permanent secretary of the International Congresses of Entomology.

ANY technical man who cares to peruse the advertisement pages of almost any technical publication, and then compares such advertisements with those in the general press, must surely be convinced that engineering propaganda is not conducted so effectively as it ought to be. In fact, nearly all technical advertisements look alike, except for the change in illustration and manufacturer's name. In the United States, technical propaganda is conducted with much greater effect, and that explains, perhaps, why Americans are capturing markets that were once British strongholds. Now anything that will advance any branch of science—and 'technical' advertising is a highly specialised science—is welcome. In "The New Propaganda in Industry," a booklet written jointly by a thoroughly trained technical man and an advertising consultant, and published by The Technical Advertising Service, Fitzalan House, Arundel Street, London, W.C.2, entirely novel considerations are brought to bear on this vital problem. Such questions as the nature of the thing to be advertised, how influence is established, the importance of a good policy, and the practical measures for giving effect to the psychological points which are even more important in industrial propaganda than they are in general publicity, are discussed in a way that must appeal to all those who have technical products to market.

THE managers of the Royal Institution have appointed Dr. Alex. Muller to be assistant director of the Davy Faraday Research Laboratory. Dr. Muller is the author of a number of notable papers on the analysis of crystals, particularly the long chain compounds, which have been published in the proceedings of the Royal and other scientific societies.

AT the annual general meeting of the Society of Public Analysts on Mar. 7 the following officers for the year 1928 were elected: *President*, Mr. Edward Hinks; *Vice-Presidents*, Mr. John Evans, Mr. Thomas Macara, Mr. John White; *Hon. Treasurer*, Mr. E. B. Hughes; *Hon. Secretary*, Mr. F. W. F. Arnaud.

THE earthquake which is reported in the daily press to have caused some damage in the south of Italy was recorded at Kew Observatory on Mar. 7, at 10 hr. 59 min. 7 sec. G.M.T., as a well-defined shock. The records show that the epicentre was at a distance of 1250 miles in a south-easterly direction from Kew Observatory, and therefore probably in Sicily. Oscillations persisted for half an hour. A shock was also registered on Mar. 7 at 23 hr. 3 min. 31 sec. G.M.T. The epicentre is estimated to have been 4000 miles from Kew Observatory.

A VERY large earthquake was recorded at Kew Observatory on Mar. 9 at 18 hours 18 mins. 35 secs. The distance of the epicentre is estimated to have been 6200 miles away. Oscillations persisted for more than three hours. A message received at Kew from Bombay states that the distance of the shock from that station was 1880 miles. Combining these estimates, it appears that the earthquake must have originated either in the Indian Ocean or in the north of Sumatra and at about midnight local time.

SOME popular lectures on scientific subjects are being delivered at the Polytechnique, Regent Street, London, in support of the King Edward's Hospital Fund for London. On Mar. 9 Prof. Julian Huxley lectured on the habits and behaviour of ants; and there will be a lecture on beam wireless by Mr. T. L. Eckersley on Mar. 23, and one on liquid air by Mr. A. J. Philpot on Mar. 30—both with experimental illustrations. Tickets (2*s*. 6*d*. and 5*s*.) may be obtained at the doors or at any of Messrs. Keith Prowse and Co.'s offices. Parties of not less than ten from schools are admitted at half-price.

THE following nominations for office in the Chemical Society have been made, and the fellows thus nominated will be declared elected at the next annual general meeting: *President*, Prof. J. F. Thorpe; *Treasurer*, Dr. T. Slater Price; *Secretary*, Prof. T. S. Moore. The retiring president, Prof. H. Brereton Baker, will deliver his presidential address, entitled "Constitution of Liquids: Some New Experiments," at the annual general meeting to be held at Burlington House on Thursday, Mar. 22, at 4 P.M., and the anniversary dinner will be held the same evening at the Hotel Victoria at 7 for 7.30 P.M.

IT is announced by the Natural Resources Intelligence Branch of the Department of the Interior at Ottawa that it has been decided to name the highest peak in British Columbia (13,260 feet) after Dr. G. M. Dawson, the well-known geologist on whose work the chief knowledge of the geology of British Columbia is based. Dr. Dawson was for several years director of the Geological Survey of Canada, and in the course of his work made a detailed examination of more than 6000 square miles of the interior of British Columbia. The exact location of Mount George Dawson given by the Provincial Government Surveys Branch is Lat. 51° 22′ N. and Long. 125° 16′ W., which is about 175 miles north-west of Vancouver and near the head of Knight Inlet.

IN an article in the *Chemiker Zeitung* for Feb. 11, by Prof. Haber, attention is directed to the fact that exactly twenty-five years have elapsed since the late Prof. Birkeland and Dr. S. Eyde solved the difficult problem of producing nitric acid commercially from atmospheric nitrogen. The need for applying a high-tension discharge was of course known, but the many previous attempts to utilise such a discharge on the commercial scale were unsuccessful until Birkeland and Eyde employed the device of electromagnetic distortion of the arc. That this method of solving the problem of nitrogen fixation had in course of time to give place to the more practicable ammonia-processes, was inevitable on thermodynamical grounds. Nevertheless, the achievement of these two pioneers may be regarded as marking the beginning of a new era in industrial chemistry.

MESSRS. Dulau and Co., Ltd., 32 Old Bond Street, W.1, have just issued Catalogue No. 157 of books relating to botany. Of the 1300 works listed, many are choice and rare. The catalogue can be had upon application.

MESSRS. W. and G. Foyle, Ltd., 119 Charing Cross Road, W.C.2, have just issued a short catalogue of second-hand books of science, ranging over the subjects of botany, natural history (including ornithology and zoology), mathematics, and physics. Copies can be had upon application.

WE understand that the works by Sir Flinders Petrie noticed in NATURE of Mar. 3, p. 311, can be obtained from Lady Petrie, University College, Gower Street, London, W.C.1, at the following prices: "Glass Stamps and Weights," 31*s*. 6*d*.; "Ancient Weights and Measures," 52*s*. 6*d*.; or, the two works together, 63*s*.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A laboratory assistant to the biochemist of the Glasgow Royal Infirmary—The Secretary and Cashier, Royal Infirmary, 135 Buchanan Street, Glasgow (Mar. 22). A junior chemist under the Lancashire and Cheshire Coal Research Association—The Director of the Association, College of Technology, Manchester (Mar. 23). A woman assistant lecturer in geography in the department of education of the University of Birmingham—The Secretary, University of Birmingham (April 28). A professor of biology in Canterbury College, Christchurch, New Zealand—The High Commissioner for New Zealand, 415 Strand, W.C.2 (April 30). A demonstrator in organic chemistry and a demonstrator in physics at Bedford College for Women—The Secretary, Bedford College for Women, Regent's Park, N.W.1 (April 30). A full-time teacher of rubber technology at the Northern Polytechnic—The Clerk to the Governors, Northern Polytechnic, Holloway, N.7. A test assistant for photographic work at the Royal Aircraft Establishment—A.269, Chief Superintendent, R.A.E., South Farnborough. A lecturer in geography in the Queen's University of Belfast—The Secretary, Queen's University, Belfast.

Our Astronomical Column.

EXTENT AND DURATION OF THE UNIVERSE.—Dr. J. H. Jeans delivered the Trueman Wood Lecture before the Royal Society of Arts on Mar. 7, its title being "The Wider Aspects of Cosmogony." He naturally dwelt rather fully on the recent researches by Prof. Shapley and Dr. Hubble on the distances of the globular clusters and spiral nebulæ, which have so amazingly widened our conception of the volume of space that is accessible to our largest instruments. He referred to the Einstein view of space re-entering on itself, and concluded that the re-entrant region is not distant more than a thousand times the distance of Hubble's farthest nebulæ, which are at an estimated distance of 140 million light-years. Assuming that the whole of Einstein space is filled with nebulæ as densely as the portion surveyed, he estimated the number of stars in it as 2×10^{24}; he noted that the same number of grains of sand would suffice to cover England with a layer hundreds of yards in depth.

Dr. Jeans introduced some of his own conclusions on the interior of stars. He postulates that the central regions are liquid rather than gaseous, and thinks that this view explains the fact that stars tend to divide themselves into standardised sizes according to the number of rings of electrons left round the nucleur of the atom; the number may be 0, 1, 2, or 3, but cannot be fractional. Stars like Betelgeuse are concluded to have three rings left, while the small dwarf star discovered by Van Maanen has none left. He conjectures that elements exist in the central regions of the stars of higher atomic weight than any known on earth; this would explain the enormous amount of energy that they contain, which is able to keep stars shining for millions of millions of years. A few points in the lecture would not meet with universal assent, but it gave a very graphic picture of the vastness of the universe and its immense duration. Dr. Jeans tries to estimate the past duration in several different ways; they all give periods of the order of five to ten millions of millions of years.

COMETS.—*Popular Astronomy* for February contains a photograph of Encke's comet taken by Prof. van Biesbroeck at Yerkes on Jan. 21; it had a sharp nucleus and a broad tail 5′ long pointing westward; the present is the thirty-seventh observed apparition of Encke's comet; it has not been missed once since 1819. Comets Stearns (mag. 12½), Schaumasse (mag. 15), and Schwassmann-Wachmann (mag. 17) were also observed in January at Yerkes or Bergedorf; there seems to be no doubt now that the last-named comet passed perihelion in 1925; this brings up the number of perihelion passages of comets in 1925 to eleven, which is the greatest number on record; 1898 had ten.

NOVA PICTORIS.—This nova, like many recent ones, has now developed a nebulous ring round it. *Harvard Announcement Card, No. 55*, states that Prof. Hartmann at La Plata describes it as being 1″ in diameter; Mr. Paraskevopoulos, of the Boyden Station, Bloemfontein, notes that the nova is surrounded by a rather narrow well-defined ring of low density and small diameter; it was photographed with a Metcalf triplet, 10 cm. in diameter. Fuller details are promised in a forthcoming *Harvard Bulletin*.

Research Items.

SOCIETY ISLANDS TECHNOLOGY.—Some interesting points in relation to the decay of native arts emerge from a study of handicrafts of the Society Islands, by Willowdean Chatterson Handy, which appears as *Bulletin 42* of the Bernice P. Bishop Museum of Honolulu. The processes studied are plaitwork, including basket making, matting, and braiding, and cord, rope, and net making, the preparation of material as well as the actual methods of making up being examined. The practice of these arts appears now to be identical in all the islands, but at one time there is no doubt that they could have been studied at each of the eight islands as local variants of a parent stock. Old objects are assigned to their place of original manufacture; for example, an old mat is recognised as from Maupati. Certain localities, however, are still recognised as having specialities. The manufacture of *tapa* has disappeared even in households which still carry on the native arts and crafts as part of the daily routine. The art of plaiting, on the other hand, is widely practised owing to the introduction of the making of straw hats by the missionaries in 1820. These, however, are worthy of record, as some of the plaits were formerly used in decorative plaiting on houseposts. On the other hand, the introduction of the sale of oranges in the markets of Papeete has led to the preservation of the nets once used for carrying or hanging bowls or gourds.

SICKNESS IN HUMID AND NON-HUMID WEAVING SHEDS.—The Industrial Fatigue Research Board in Report No. 8, has published some valuable data on artificial humidification in the cotton-weaving industry, by Mr. A. Bradford Hill (London: H.M. Stationery Office). For the successful weaving of certain classes of cloth it is maintained that a high degree of humidity is necessary, and so the natural humidity of the air is increased by injecting additional moisture into the air of the weaving sheds in the form of steam. There has been strong opposition to the practice from the operatives, and several parliamentary inquiries have been held with resulting statutory regulations. It is claimed that the effects of working in these humid sheds is to lower the state of the operative's health. This report aims at determining what is the difference actually in sickness between the workers in humid and non-humid sheds. The weaving sheds chosen were situated in five Lancashire towns, in three of which sheds of both types were to be found; in one only 'dry' sheds, and in one only 'wet' sheds. In all, seventy-four firms took part in the inquiry; the number of separate sheds was 128, and the number of weavers concerned more than 20,000. The sickness history was obtained from the National Health Insurance approved societies. A year's investigation of the sickness incidence revealed no significant difference between the two types of sheds either in the number of days of sickness experienced, in the number of claims made, or in the number of persons suffering from one or more sicknesses. Analysis according to the *nature* of the incapacity suffered in the two environments yielded no evidence of any consistent or distinct differences in the distribution of specific sicknesses between the humid and non-humid sheds.

A CIRRIPEDE PARASITE FROM THE DOGFISH.—The Report for 1926 of the Lancashire Sea-Fisheries Laboratory at the University of Liverpool and the Sea-Fish Hatchery at Piel, contains much that will interest both marine biologists and zoologists. Besides a number of small papers there are two which, both on account of their greater size and their considerable intrinsic interest, command attention. Prof. J. Johnstone and Miss W. E. Frost contribute a valuable paper on the general morphology of *Anelasma squalicola* (Lovén) which considerably advances our hitherto meagre knowledge of this very interesting cirripede parasite which they obtained from the dogfish, *Etmopterus spinax*. The fish were caught on the hake grounds off the south-west of Ireland at depths of about 150-180 fathoms, and some 5 per cent. of them were infected with the parasite which was rooted in the dorsal muscles. The paper contains a detailed account of the morphology of the parasite, well illustrated with clear, though somewhat diagrammatic, figures. Though mouth parts are present, only smaller than in the free-living cirripedes, the tubules of the 'digestive gland' in the one adult specimen examined showed signs of degeneracy, and the authors are inclined to agree with Broch that some part, at any rate, of the food is obtained from the host fish by way of the roots, which were originally exclusively organs of fixation. On the disputed point of the cement glands, they are of the opinion that these are derived from the original germinal material and that the cementing matter, no longer required for its original purpose, is modified to provide a portion of the food yolk in the mature eggs. The other important paper is by R. J. Daniel and is concerned with "The Abdominal Muscular Systems of the Common Shrimp (*Crangon vulgaris*)." The muscles are described and illustrated in minute detail, and their function in causing the backward spring, so important in the life of decapod Crustacea, is clearly demonstrated. It is a paper impossible to summarise here owing to its nature. Congratulations are due to Mr. Daniel for his highly successful treatment of a very difficult piece of work.

NEW INDIAN TREMATODES.—Dr. E. C. Faust reports (*Records Indian Mus.*, vol. 29, pp. 215-218, 1927) on a unique holostome, about fifty specimens of which were collected from the intestinal tract of a holothurian (*Actinopyga mauritiana*) in the Andaman Sea. The most remarkable feature in the structure of this worm, which is designated *Cleistogamia holothuriana* gen. et sp. nov., is the entire absence of cirrus, genital atrium, and uterine opening. At the posterior end of the seminal vesicle, where a genital pore or a cirrus-sac might be expected, the vesicle bends abruptly forward and becomes constricted into a hollow filament which is continuous with the vagina. This apparatus therefore permits the transference of spermatozoa from the seminal vesicle directly into the vaginal sac. "The process here involved is not merely self-fertilisation; it is obligatory self-fertilisation or cleistogamy." The egg bears a long terminal filament, frequently coiled on itself like a watch-spring, which may either serve in rupturing the blind uterine sac, thus allowing dispersal of the enclosed eggs, or it may serve to entangle and fix the egg after discharge. This appears to be the first trematode recorded from a holothurian, and it is further exceptional in that the adult form occurs in an invertebrate. Dr. Faust remarks that the only other mature trematode in an invertebrate is Aspidogaster. S. C. Verma describes (*Op. cit.* pp. 139-156, 1927) a new species of Opisthorchis—only the second species of this genus known from fishes. This species (*O. pedicellata*) was found in the gall-bladder of the siluroid fish *Rita rita*, collected in the rivers Ganges and Jumna, about half the fish being infected. The characters by which *O.*

pedicellata may be differentiated from its nearest relatives are pointed out, and appended is a key to the species of Opisthorchis.

NICTITATING MEMBRANE OF BIRDS AND MAMMALS. —Mr. E. P. Stibbe (*Jour. Anat.*, **62**, 159-176; 1928) has investigated the homologies of the so-called nictitating membrane of birds and mammals, and concludes that the plica of man and mammals differs entirely from the nictitating membrane of birds both structurally and functionally, and that there is reasonable ground for supposing that it is morphologically different also. He proposes to substitute the term *plica intercipiens* for the so-called nictitating membrane of mammals. The author hopes by a study of the ontogeny of the plica in mammals to elucidate its true morphology.

BRANCHING IN THE OIL PALM.—A most remarkable case of branching in this palm (*Elæis guineensis*) is recorded by M. T. Dawe in the recent issue of the *Kew Bulletin of Miscellaneous Information* (No. 1, 1928). The palm in question is at Sierra Leone, is supposed to be more than a hundred years old, and has never been known to bear fruit. It branches very abnormally at a height of six feet or so from the ground, and sends out and up from a kind of fasciated growth eight normal-sized branches which attain a normal height. A further remarkable feature is that two of these branches have also branched. In many cases branching or forking in palms is due to injury or destruction of the growing point. The author finds it difficult to believe that the branching in this case is due to accidental causes, since the repeated branching would seem to indicate a physiological character. He would be interested to learn if any other cases of branching in the oil palm have been met with in any other part of West Africa or elsewhere.

PERIODICAL FLOWERING OF BAMBOO.—In the *Japanese Journal of Botany*, vol. 3, No. 4, Seiichi Kawamura analyses the problem of periodicity in the flowering of the bamboo. The brakes come into flower at intervals of many years, the phenomenon occurring universally and simultaneously in the case of all brakes of the same species, even though situated in different provinces of Japan and in different latitudes. Different species, however, come into flower at different periods. The period of flowering seems to be unrelated to the age and extension of the brake, the thickness of the aerial stems, the fertility and humidity of the soil, exposure to sun, or climate of locality. From incomplete chronological records, the author assumes that the species *Phyllostachys Henonis* flowers at intervals of 120 (occasionally 60) years. Other species of bamboo show a similar order of periodicity. From consideration of the vegetative propagation of the bamboo, carried out by means of subterranean organs, it is suggested that all members of one species originated vegetatively from one ancestor, and thus all individuals of that species would be ontogenetically of the same age. This would explain the simultaneous flowering, which is seemingly independent of external conditions.

GLACIERS OF EDGE ISLAND, SPITSBERGEN.—One of the main objects of the Cambridge expedition which spent August last year on Edge Island was to determine the extent of the ice on that land, for little is known of the island and the interior has not been explored. In a lecture on Feb. 20 to the Royal Geographical Society, Mr. H. G. Watkins pointed out that the ice-covered area is horse-shoe in shape, surrounding the central unglaciated valley which lies in the south-west, at the head of Deevie Bay. On the south-east the ice-cap meets the sea in the well-known King John Glacier, which is an ice cliff more than twenty miles in length. On the south, and probably on the east, glaciers also reach the sea, but on the west and north no glaciers reach the coast. The scarcely known east coast was, however, not explored by the expedition on account of bad weather and lack of time. The ice-cap consists of large rounded domes, each about 1500 ft. in height, on which, in summer, there was the usual absence of snow. All the glaciers which do not reach the sea are retreating except one near the northern limit of the ice-cap; this is temporarily advancing. The bad weather prevented much survey being done by the expedition except on Deevie Bay and in the north-west of the island. It was even impossible to fix the position of Cape Heuglin in the north-east, the exact position of which is doubtful. The work that has been done is linked with the accurate work of the Russian Arc of Meridian expedition of 1899–1901 on the west and north coasts.

INDIAN FOSSIL SUIDÆ.—The fourth, and concluding, memoir of volume 8 of the Geological Survey of India contains Dr. Pilgrim's account of the fossil Suidæ. The wealth of the fauna is shown by the description of more than thirty new species distributed over many genera, seven of which are described for the first time. After an explanatory introduction, the memoir is devoted to a detailed account of the material, which is well illustrated by twenty plates.

ENGLISH EOCENE MOLLUSCA.—The English Eocene Mollusca have long stood in need of revision under the light of modern researches and knowledge. This is now being undertaken by Mr. A. G. Wrigley, whose second paper comprising the Fusinidæ has just appeared (*Proc. Malac. Soc. Lond.*, vol. 17). A careful and critical systematic description of the genera and species is given with beautifully clear line drawings by the author himself of the more important of them. Grabau's hypothesis that the changes in the sculpture of a single gastropod shell as it develops from its protoconch to maturity indicate the history of the stock to which it belongs, comes in for severe castigation, and the author remarks that unfortunately Grabau's 'ancestral' forms are all too frequently preceded by their theoretical descendants.

UPPER CRETACEOUS CEPHALOPODS.—J. B. Reeside, jun. (*U.S. Geol. Surv. Prof. Paper*, 150B; 1927) gives a history of the views which have been held as to whether Scaphites is a natural or a polyphyletic group. Nine generic divisions have been proposed for Scaphites, of which the author accepts four as valid, namely, Scaphites (restricted), Desmoscaphites, Discoscaphites, and Acanthoscaphites, referred to the families Stepheoceratidæ, Desmoceratidæ, and Cosmoceratidæ respectively. A catalogue is given of all the specific names which have been applied to Scaphites, and the work concludes with a table showing the stratigraphical distribution of the species from the Upper Gault to the Mæstrichtian. In another memoir, the same author (*ibid.*, *Prof. Paper*, 150A; 1927) gives an account of the cephalopods from the lower part of the Cody Shale, Oregon; he recognises a zone found in the Niobrara formation of the Great Plains, and considers that some of the species present strongly support the correlation of the Niobrara formation with the European Coniacian (Emscherian). Reeside (*ibid.*, *Prof. Paper*, 151; 1927) also describes and figures the cephalopods of the Eagle Sandstone, in which the principal genera represented are Baculites, Scaphites, Placenticeras, and Peroniceras.

FLUCTUATIONS OF THE LEVEL OF THE CASPIAN SEA.—Prof. A. V. Voznesensky, who studied this problem on the spot very thoroughly, gives in *Priroda* (No. 10, 1927) a brief summary of his observations. The latter are based mainly, so far as ancient fluctuations are concerned, on the historical evidence, particularly with regard to a large building, a karavanserai, in the Baku bay. The building was erected in about 1135 A.D., of course on dry land, on a small hillock. In the interval from 1135 until the beginning of the eighteenth century, the building is not mentioned in any documents; this is understandable, since there exists trustworthy historical evidence that in 1306 Baku was flooded by the sea, which reached a mark about 16 metres above the level of 1135. From the fifteenth and sixteenth centuries there are historical records of the sea receding again, and about 1723 the top parts of the karavanserai appeared from the water. Towards the middle of the eighteenth century the level of the sea rose again almost to the level of the fourteenth century; since then a series of smaller fluctuations has followed, but on the whole the waters have receded, and in 1925 even the foundations of the building became visible. The reason for these fluctuations is partly in the climatic variations (Bruckner's periods), but mainly in the seismic disturbances. The practical importance of the fluctuations is obviously great, since even a small lowering of the level affects navigation and fisheries in the whole of the Caspian Sea, and this makes a detailed study of the problem highly necessary. A survey was carried out on the Apsheron peninsula in 1911–12 by the Seismic Commission of the Russian Academy of Sciences, and it is to be hoped that another will be undertaken shortly which should give valuable data on the problem.

QUARTZ RESONATORS.—The use of quartz resonators as standards for measuring frequency, and also for stabilising the frequency of radio circuits in connexion with radio communication, is rapidly extending. Prof. Cady, of the Wesleyan University, Connecticut, made very valuable researches on the piezo-electric behaviour of small plates of crystalline quartz in 1922. In 1923, Dr. D. W. Dye pointed out that there appeared to be a field of usefulness for quartz vibrators as frequency standards and as frequency stabilisers. Since then, progress has been very rapid. In a paper read to the Institution of Electrical Engineers on Mar. 7, by G. W. N. Cobbold and A. E. Underdown, many practical developments carried out by them at the Army laboratory at Woolwich are described. They show that there is a very simple relationship between the dimensions of the quartz oscillator and the frequency produced. They point out that the frequency is very little affected by the temperature of the quartz. The temperature coefficients found experimentally were less than ten parts in a million per degree Fahrenheit. The other standards used for the determination of radio frequency are an oscillatory electric circuit consisting of an inductance associated with a capacity or an elinvar tuning fork. The latter, when associated with a multi-vibrator, can be made to provide a series of standard points in the band of frequencies used in radio work. The materials used in the construction of the electro-magnetic standard do not retain their permanence in the way that elinvar and quartz do, and their temperature coefficients are higher. The authors consider that for national and international standards of the highest quality the fork is the best. There is, however, a wide field for quartz resonators as secondary standards, especially in short-wave radio practice. In this case the frequencies are enormously high in comparison with the frequency of a tuning fork. The authors describe a crystal multi-vibrator which gives a series of frequencies from 2000 to 15,000 kilocycles per second, that is, from 150 to 20 metres in wavelength, in multiples of 1000 kilocycles per second.

GEOMETRICAL OPTICS.—In his presidential address to the Optical Society in February (*Transactions of the Optical Society*, vol. 28, Pt. 5) Mr. T. Smith dealt with the futility of the present methods of teaching geometrical optics. The well-known diagram of rays incident on one of the principal planes of an optical system and emerging from the other principal plane he characterises as "elegant" but "trivial," and "inconsistent with the known properties of light." As a basis for a more accurate and real geometrical treatment of the subject, he shows that when a ray of light travelling in air falls on the surface of a sphere and is refracted, a straight line drawn through the centre of the sphere to cut both rays cuts them in conjugate points, and that if the triangle formed by the rays and the radius be swung about the centre of the sphere, the ends of the radial line describe concentric arcs which are object and image with constant magnification. From this he shows that the surfaces of constant magnification for either a single refracting surface or for a lens can be easily and accurately drawn. It is to be hoped that these methods will soon find their way into elementary text-books.

SLAG, COKE BREEZE, AND CLINKER AS AGGREGATES.—The Building Research Station of the Department of Scientific and Industrial Research is carrying out work to determine the cause of failures occurring with concrete made from materials such as furnace clinker, and in Special Report No. 10 (London: H.M. Stationery Office) F. M. Lea and F. L. Brady summarise present knowledge on this subject. The composition of acid and basic slags, breezes, clinkers and cementing agents is discussed, and the factors affecting the suitability of these materials for various uses are considered. Slag forms a good concrete provided that it is not very acid or strongly basic, but coke-breeze-concrete is apt to be mechanically weak and is therefore only suitable for inside walls. This is due to the fact that coke-breeze is often contaminated with coal or may have a high sulphur content, in which case weathering causes oxidation of the calcium and iron sulphides to the sulphates with increase of volume. Clinker suffers from the same disadvantages and usually fails on account of the presence of unburnt coal. The methods of utilisation of these materials are discussed, and it is concluded that slag concrete can be made having a strength at least as great as that of gravel concrete. Clinker concrete is not so strong, but is better than that made from breeze. The report includes a bibliography of the more important papers on the subject.

THE SALTING-OUT EFFECT.—The influence of electrolytes on the solubility of *m*-cresol in water has been studied by J. S. Carter and R. K. Hardy, who have described their work in the January issue of the *Journal of the Chemical Society*. The solubility s of a non-electrolyte in a solution of a salt of concentration c is known in many cases to be represented by the equation $s = s_0 e^{-kc}$ where s_0 is the solubility in the pure solvent and k is a constant which is a measure of the salting-out effect. This law has been verified for the effect of sodium and magnesium chlorides and sulphates upon *m*-cresol solutions, but does not hold if the free acids are used. The sulphate ion is much more efficient for salting-out than the chloride ion, and the solubility of *m*-cresol is lowered more by salts than by the corresponding acids.

The Russian Academy of Sciences and its Institutions.

THE Russian Academy of Sciences, representing as it does the highest seat of learning in all its branches in the State, consists of a large number of affiliated institutions, and a survey of them, recently published by the Academy,[1] is of wide interest to all men of science. The interest is not affected by the fact that the survey has been prepared for a specific purpose, namely, for the occasion of the tenth anniversary of the Soviet government, with the view of showing the world the effect that the Revolution has had on Russian science. The volume consists of a series of chapters dealing with each institution separately, and we will follow this arrangement. Each chapter concludes with a bibliography of papers and books dealing with the particular institution, and with a list of scientific and technical staff.

The Library of the Academy was founded by Peter the Great, who brought a number of foreign books home from his travels. At first it functioned as a public library, but with the foundation in 1812 of a special Public Library in St. Petersburg it was transformed into a purely academic library. In 1924 a new building was completed for the library, with a floor space of 12,500 sq. metres. The number of titles of books and manuscripts in the library is more than three millions; the staff numbers 170.

The Steklov Physico-Mathematical Institute developed from the first Russian scientific laboratory, apparatus for which was actually acquired by Peter the Great before the Academy was founded. At first it was called the Physical Laboratory, and amongst its directors have been E. Lentz, B. S. Jacoby, O. D. Chwolson, B. B. Galitzine. The last-named started highly important work on seismology, and it is due to him that the Russian seismological service was developed, but during the civil war and the Revolution it was almost wholly destroyed, and only now are steps being taken to re-establish it. The Physical Laboratory during that time also practically ceased to function. In 1921 the mathematical cabinet was founded under the directorship of V. A. Steklov, and in the same year it was united with the Physical Laboratory to form the present Physico-Mathematical Institute, which was named after V. A. Steklov when the latter died in 1926. At present the institute consists of three departments: mathematical, physical, and seismic; the present director is A. F. Joffé.

The Chemical Institute developed from the chemical laboratory founded in 1748 by Lomonosov, one of the first Russian chemists, and such well-known chemists as Frizsche, Zinin, Butlerov, and others have worked in it. In 1924 the laboratory was transformed into the Chemical Institute with two departments: general and organic chemistry, high pressures and high temperatures. In connexion with the Institute are working some of the institutes of the Commission for the Study of Natural Resources (see below). The department of general chemistry under N. S. Kurnakov is working at present mainly on problems of physico-chemical analysis, pure and as applied to the study of ores and minerals. The second department, under V. N. Ipatiev, is studying the action of high pressures and temperatures on chemical compounds.

The Dokutchaev Soil Institute began its activities in 1881 as an independent public committee under V. V. Dokutchaev and later under K. D. Glinka, who has recently died (*v.* NATURE, Dec. 17, 1927, p. 887). Since 1918 it has been incorporated into the Academy, and at present it consists of a soil museum, department of soil cartography, department of soil surveys, and a department for the study of the dynamics of soil formation.

The Physiological Institute was founded in 1889 as a laboratory, and is at present under the directorship of I. P. Pavlov; its work is mainly on the problems of reflexes, and the physiology of brain generally.

The Yafetic Institute is one of the recently founded (1921) branches of the Academy, and its work consists in research on Yafetic languages of the original population of Europe. The director of the Institute is N. J. Marr.

The Laboratory of Biochemistry and Plant Physiology has been in existence since 1889. Its present director is S. P. Kostychev, and the work is mainly concentrated on biochemistry of fermentation, photosynthesis, fixation of atmospheric nitrogen, and mineral nutrition of plants.

The Special Zoological Laboratory, founded by A. O. Kovalevsky in 1893, was considerably enlarged in 1921 under the directorship of N. V. Nasonov, and is working on different branches of morphology and experimental zoology.

The Geological Museum was originally a part of the *Kunstkamera* founded by Peter the Great. In 1913 funds were obtained for a large new building, but the War prevented its erection, and it was not until 1922 that the Museum obtained new premises for development. At present only some of the galleries are open to the public, but scientific work is being carried out in all directions, under the directorship of F. J. Levinson-Lessing.

The Mineralogical Museum originated in the same way as the Geological Museum. It has now six exhibition galleries and scientific laboratories guided by A. E. Fersman. During the last ten years numerous expeditions have been organised by the Museum for studying mineral resources of outlying parts of Russia.

The Botanical Museum was also founded by Peter the Great. There are no exhibition galleries, the Museum consisting entirely of herbaria, occupying twelve halls. Research work is being conducted mainly in the Caucasus, Siberia, and Northern Russia. The present director is I. P. Borodin.

The Zoological Museum has existed since 1832 as a special institution, and consists of public galleries and scientific departments, under the directorship of A. A. Birula. The scientific staff includes 35 workers. Expeditions for the zoological survey of various parts of Russia are being organised more extensively than in the past, and collections from the Palæarctic region are enormous in size. There are, however, difficulties in publishing the results of scientific work. Exhibition galleries occupy two large halls.

Pushkin House is a museum for preserving all relics connected with the great national poet, for scientific research on Pushkin, and on the history of Russian literature generally. It has a remarkable collection of manuscripts, a library, and public museum. The present director is S. F. Platonov.

The Museum of Anthropology and Ethnography again developed as a part of the *Kunstkamera*. It represents the central place for all research on anthropological and ethnographical problems, and consists of laboratories and public galleries, under the directorship of E. F. Karsky.

The Asiatic Museum is rather a library than a museum, since all ethnographical objects have been

[1] Scientific Institutions of the Academy of Sciences, U.S.S.R. Leningrad, 1927. Pp. 169+17 plates.

transferred to the corresponding museum, and the main aim of the Asiatic Museum is collecting and studying literature, both printed and manuscript, on oriental problems; it has probably the richest collection in the world on oriental studies. The Museum is under the directorship of S. F. Oldenburg.

The Museum of Palæography was founded in 1925 and has as its aim a full representation of systems of writing, from the ancient inscriptions on monuments to the present-day printing technique. The Museum is still in course of organisation.

The Commission for the Study of Natural Resources was founded in 1915 on the initiative of its present president, V. I. Vernadsky, with the view of studying systematically the natural resources of Russia. The main directions of work are defined as: unification and consolidation of local work on the study of natural resources; independent field research; description of separate regions from the point of view of their resources; research in the practical utilisation of natural resources. In accord with its diversity of functions, the Commission has a number of working branches, as follow: Institute of Physico-Chemical Analysis, working on analyses of salt deposits in the Caspian Sea, metallic ores, etc.; Institute for the Study of Platinum and other Noble Metals, studying methods of analysis of platinum ores and the extraction of the metal from them; Section of Non-Metallic Minerals and Gems, which has published a series of monographs on asbestos, sulphur, etc., as well as on gems and valuable stones; Section of Stone Building Materials, which is studying building materials from the point of view of their distribution in Russia, and from the technical aspect as well; the Sapropelite Committee, which is engaged in studying lake deposits and their utilisation; the Gaseous Section, which studies natural gases, mainly from the point of view of the presence in them of helium for aviation purposes; the Section of Energetics is preparing a register of natural power resources, mainly of water, but also of wind and tides; the Geographic section is mainly engaged in research on problems of economic geography; the Bureau of Genetics studied at first problems of heredity in man, but at present it is engaged in work on heredity in wheat, domestic animals, etc.; Section for the Study of Living Substance, under V. I. Vernadsky, is engaged on problems of the influence of organic matter on geochemical processes; the Moscow section of the Commission has also several laboratories—for genetics, applied zoology, etc.

The Commission for the Study of Nationalities occupying Russia is studying the population, preparing maps, studying habits of various national groups, their occupations, etc.

The Commission for Scientific Expeditions is intended to correlate expeditions sent out by various institutions of the Academy. The number of expeditions has increased greatly during recent years, and for the last ten years (1917–1927) their number exceeded two hundred.

The Special Committee for the Study of Allied and Autonomous Republics was founded in 1926 in order to direct and co-ordinate surveys organised by the Academy at the request of republics. The committee is organising expeditions into Kazakstan (Kirghiz steppes), Karakum desert, Armenia, and other parts.

The Commission for the Study of the Yakut Republic was formed at the request of the said republic for a comprehensive survey of its natural resources. The work is calculated to take five years, and preliminary results have already been published.

The Commission for Science and Scientific Workers is preparing registers of all scientific workers in Russia, which it is intended to publish regularly.

The Polar Commission was founded in 1914 for co-ordination of work in polar countries done by different bodies. Its activities have developed only since 1923, and in 1925 an expedition to Novaya Zemlya was organised.

The Historico-archæographical Commission is dealing with the publication of historical documents and manuscripts on nationalities of Russia.

The Dictionary Commission has existed since 1922, and is preparing materials for a dictionary of the Russian language, which is being published.

The publications of the Academy and its institutions are produced in the Academy's printing office. Its publishing activities suffered much during the years of revolution, and at present the pre-War level is still not reached. Publications are distributed by the Academy book-store and the Bureau for International Exchanges. Interruption of exchanges was severely felt by the Academy, but at present exchanges are approaching normal.

The Glacial Retreat from Central and Southern Ireland.[1]

By Prof. J. K. CHARLESWORTH.

THE newer drift of Ireland is bounded on the south by a broad and well-developed kettle-moraine—the 'South Irish End-moraine'—which runs from the vicinity of Wexford round the northern flanks of the Dublin hills and by way of Baltinglass, Bennettsbridge, Cahir, Tipperary, Charleville, and Newcastle West to the mouth of the Shannon, a distance of 310 miles from coast to coast.

Contemporaneous with this stage of the Ivernian ice and the Irish Sea ice were the independent ice-centres in the Kerry and Wicklow Hills, the Comeraghs, Galtees, Knockmealdown, and other mountain clusters of the south. Their extent is likewise indicated by well-marked outer moraines, and corresponds to a snow-line on northern and eastern slopes of about 1000 feet and on other slopes of approximately twice that altitude.

The Irish glacial fauna is restricted, with but few exceptions, to the region outside these moraines.

The ice recession from the Dublin and Wicklow Hills is clearly shown by moraines and marginal drainage-features. These prove a pivoting of the ice on the northern slopes of the hills, immediately south of Dublin, and the sweeping of the ice-fronts to east and west, at successive stages of the retreat, in a series of curves which swing out of each other tangentially and northwards.

The dissolution of the Ivernian ice-sheet caused the emergence of the higher hills, such as the Castlecomer Plateau, the Slieve Bloom, and Keeper Hills, and the formation of large lobes protruded southwards down the intervening valleys. The moraines of the Barrow, Nore, Suir, Shannon, and other lobes are magnificently displayed, making possible the correlation from lobe to lobe and the delineation of the successive positions of the ice margin across the country from coast to coast. The festooning of the moraines in the southern part of the country is governed by the relief, while their sinuous form in the northern region is to be ascribed to the break-up of the ice-sheet into separate lobes, flowing on roughly parallel lines.

[1] Substance of a communication read before the Geological Society on Jan. 25.

The ice-sheet in its recession over southern Ireland remained pivoted on the Dublin hills, and retreated over ever-widening strips of country as the ice-front is followed westwards; a withdrawal of 65 miles in the west is represented south of Dublin by but a few hundred yards.

The ice retreating over the Central Plain was dissected into three perfectly distinct lobes, which centred upon the mountains of Donegal, Leitrim, and Galway respectively. Their stages of recession are indicated by countless moraines, the 'eskers' of Irish glacial literature. True osar occur subordinately, transversely within, and as integral parts of, the kettle-moraines.

University and Educational Intelligence.

CAMBRIDGE.—The Royal Society and the Royal Geographical Society jointly have given to the Polar Research Institute a sum of money of about £200 arising from the sale of the reproduction of *The South Polar Times*, published after the return of Captain Scott's first expedition. Lady Walston has offered to the University a sum of £3000 to endow a studentship in classical archæology, to be called the Walston Studentship, in memory of her husband, Sir Charles Walston. The purpose is to facilitate visits to Greek lands for young graduates of either sex studying archæology and architecture.

Miss S. M. Manton, Girton College, has been appointed University demonstrator in comparative anatomy. Mr. E. P. Weller has been appointed University lecturer in estate management, and Mr. L. F. Newman, St. Catherine's College, University demonstrator in methods of agricultural analysis. Mr. G. F. Hickson, Clare College, has been appointed secretary of the Board of Extra-Mural Studies.

Grants have been made from the Worts Fund to Mr. J. A. Steers, St. Catherine's College, towards his expenses on the British Association expedition to the Great Barrier Reef of Australia and to Mr. H. Gilbert Carter, Trinity College, towards the expenses of a botanical survey of the Island of Madeira. Dr. G. Shearer, Clare College, has been nominated to use the University's table at the zoological station at Naples during the coming vacation.

The throwing open of practically all scholarships, studentships, and prizes to women students has led to the proposal which the Council of the Senate is making to the University, with the consent of the councils of Girton and Newnham Colleges, that the separate Harkness scholarships in geology for men and women shall be united into a single scholarship. The new scholarship will have an endowment of nearly £190 a year.

The *Annual Report* of the Appointments Board shows a marked increase in the number of appointments secured. The steady growth of graduate employment in industry in Great Britain is a marked feature in the year's work.

LONDON.—The following doctorates have been conferred: D.Sc. in Chemistry on Mr. E. A. Fisher (Rothamsted Experimental Station) for a thesis entitled "A Study of Some Moisture Relations and Some Other Physical Properties of Soil, Clay, Wool, Cereal Products, and Some Other Colloidal Materials," and on Mr. D. H. Peacock for a thesis entitled "The Reactivity of Halogen Compounds and Other Papers," together with fifteen subsidiary contributions; D.Sc. (Engineering) on Mr. H. J. Gough, for a thesis entitled "The Manner, Causes, and Characteristics of the Failure of Metals under Static and Repeated Stresses," together with nine subsidiary contributions.

A course of three free public lectures on X-rays will be given at the Imperial College of Science and Technology by Prof. K. M. G. Siegbahn, of Upsala, at 5.30, on Mar. 20, 21, and 22. No tickets will be required.

OXFORD.—The Report of the Curators of the Bodleian Library, presented to Convocation on Mar. 13, contains a matter of special interest to scientific men, namely, the record of the fact that early in the past year the Radcliffe Science Library became a department of the Bodleian. This new development may be regretted on historical and sentimental grounds; but, as the Report points out, the change is certain to lead to increased efficiency, both in the supply of scientific books and periodicals, and in the facilities offered to readers. A strong scientific advisory committee has been appointed to assist the Bodleian Curators in matters pertaining to the Library. The necessary work of reorganisation has been begun, but time and persistent effort will be required for its completion.

UNDER the will of the late Mrs. Emma Grace Marryat, who was interested in Messrs. Caird (Dundee), Ltd., jute manufacturers, of Dundee, a sum of £200,000 is to be set aside for the foundation of travelling scholarships in engineering, electricity, aeronautics, and music, to be known as Sir James Caird Travelling Scholarships, eligible to natives of Scotland only.

THE spring meeting of the Geographical Association is to be held at Oxford on April 13-16. The proceedings will include a public lecture on April 14 by the Right Hon. Sir Halford Mackinder on "The British Empire in Relation to the Geography of the World," a lecture on April 16 by Colonel C. H. D. Ryder on "Surveys from Air Photographs," and a discussion on the same day, opened by Dr. L. Dudley Stamp, on "Practical Steps in Regional Survey Work and Local Studies." The address of the Association is 11 Marine Terrace, Aberystwyth.

THE following appointments have recently been made by the British Research Association for the Woollen and Worsted Industries, Torridon, Headingley, Leeds: Mr. J. A. Fraser Roberts, senior assistant at the Animal Breeding Research Department of the University of Edinburgh, to be head of the Biology Department; Mr. Norman Tunstall, senior physicist at the Department of Physics, University College of Wales, Aberystwith, to be senior physicist of the Physics Department; and Mr. Claude Rimington, research scholar, Bio-Chemical Laboratory of the University of Cambridge, to be bio-chemist to the Association.

THE sixteenth annual dinner of the Finsbury Technical College Old Students' Association was held on Mar. 2, when the chair was occupied by Mr. F. H. Carr, president of the Association. Prof. H. E. Armstrong, in proposing the toast of "The Association," said that Finsbury was the Technical College which Prof. Ayrton and he had started, to carry out the scheme of the City Guilds of London Institute; the curriculum was arranged at the beginning to provide the chemist with some understanding of engineering, and the engineer with some understanding of chemistry. The chemical engineer as produced to-day is neither chemist nor engineer; engineering should be left to the engineer. Finsbury decided at its outset never to touch Science and Art Department or other external examinations, whereas now everywhere examinations are the order of the day. The chairman in reply referred to Prof. Armstrong as the 'father' of Finsbury, who had throughout his life striven for the things which are so important, namely, first principles. Though the College has ceased to exist, its old students should continue to meet and to do what they could to further the principles for which it stood.

Calendar of Customs and Festivals.

March 18.

St. Cyril.—He succeeded Maximus as Patriarch of Jerusalem about 351 B.C. The most noteworthy event of his patriarchate in its effect on the church was the accession of Julian the Apostate to the Imperial throne in 361. At the time of his apostasy some ten years earlier, he had "washed off the laver" of baptism by a self-immersion in bull's blood. His last attack on Christianity was an attempt to rebuild the Temple and revive the Levitican sacrifices, a cause of great rejoicing to the Jews. The undertaking was brought to a stand by "fearful balls of fire breaking out near the foundations, which scorched the workmen." Then followed an earthquake, a whirlwind, fire from Heaven, a luminous cross in the air, and marks of crosses on the garments of the Jews.

St. Tetricus, Bishop of Langres, A.D. 572.—An incident during his ministration serves to illustrate the use of the Bible as a means of divination in the Christian church. Chramn, rebel son of Clothaire, wishing to be informed of the future, three books—the Prophets, the Gospels, and the Epistles—were placed on the altar in the church of St. John, Dijon, while the clergy and Chramn prayed. Each book was then opened. The unfavourable omens indicated by the passages upon which Chramn lighted were fulfilled by his defeat and death.

Sheelah's Day, in Ireland, when the shamrock should be worn as on St. Patrick's Day. Tradition is uncertain who Sheelah was; but popularly she was connected with St. Patrick, either as wife or mother. It is interesting that tradition should associate closely a festival in honour of a female with that of the saint, just as the festival of his mother follows immediately on St. David's Day. In Celtic religion a female deity was usually associated with a male deity, by whom she often came to be, more or less, superseded.

Mid-Lent.—The fourth Sunday in Lent, being the middle period of the fast (Mi-Carême), is still celebrated on the Continent by processions and rejoicings similar to those of Carnival. Some traces of the celebration represented in Mi-Carême also survived in Great Britain. At Bury, Lancs., this Sunday was known as Simnel Sunday, from the fact that people assembled in large numbers in the town and ate simnel cakes, and a general merry-making prevailed, usually with no little disorder, notwithstanding the day. The name of these cakes has been traced to the thirteenth century. It was usual for them to be stamped with a figure of the Virgin or of Christ.

Other names for this day are "Mothering Sunday," "Mulled Ale," and "Braggart Sunday." Mothering Sunday has been explained as the custom of visiting "Mother-Church" on this day and making a presentation on the high altar, or of visiting parents and making them a present of money, a trinket, or "some nice eatable." That these are mutilated survivals of a more significant observance is made clear when they are brought into relation with customs on Mid-Lent Sunday recorded elsewhere. In Seville, children appeared in the streets, fantastically dressed, making an incessant din and crying "Saw down the old woman." At midnight, parties paraded the streets knocking at every door and repeating the same formula. Finally, the figure of an old woman representing Mid-Lent was sawn in two. In Franconia the custom was known as "the Expulsion of Death." An image of straw was suspended on a pole and carried about from village to village, where either it was received with a feast for the bearers, or it was driven away. Sir James Frazer in "The Golden Bough" quotes a number of parallel observances, from which it is clear that the custom, which in England survived only as a merrymaking and feast, originally was a festival representing the death of winter, the figure in the end being burned or thrown into water; and the coming of spring, summer, or life, was represented by a green bough or tree, similar to the green boughs of May Day. This was carried in procession after "Death" had been "carried out."

March 19.

St. Laclean of Clonfert, A.D. 622.—His birth was announced by an angel fifteen years before it took place, while just before the event milk from his mother's breasts healed an old man of blindness. At his baptism no water was at hand; but Mohemath took the fingers of the babe and marked with them a cross on the earth and instantly a fountain burst forth. A grain used as an emetic by the people of the country served as his diet without ill effect. This may be a reference to a form of trial by ordeal from which the saint was exempt in virtue of his sanctity. During a murrain, the red cow which had provided the saint with milk survived to the last; but when the babe was taken to it in his mother's arms, it revived, and its milk being distributed among the other cows, they also revived. The life of this saint, it may be noted, is based almost entirely on oral tradition.

March 20.

St. Cuthbert, A.D. 687.—The great saint of northern England. A border legend relates that when, in accordance with the practice of Celtic saints, he sang his vigils up to his neck in the waves and afterwards on the sands, two otters came out of the water and restored animation to his frozen feet by licking them while he prayed. For long he lived on the desert island of Farne, which no one would visit because it was haunted by demons. The tameness of a species of aquatic birds found on this island only, and known as the 'Birds of St. Cuthbert,' is attributed to the fact that, taking them for his companions, he inspired them with a trust in man which their descendants have inherited. Certain little shells of the genus Entrochus are known as St. Cuthbert's beads, and it is believed that he can be seen seated on a rock by night, using them as his anvil.

St. Wulfram of Lens, A.D. 741.—Missionary to Friesland, where he laboured to suppress the pagan sacrificial rites. The victims were selected for sacrifice by the casting of lots among the children of the nobles. They were then hung on a tree as an offering to Woden, or fastened to a post between the tides and left to drown as an offering to Ran, the sea goddess, that she might not overflow the low-lying-land.

March 21.

St. Benedict, *b.* A.D. 480, *d.* 543.—The initiator of the famous rule of the Benedictine Order, of whom many miracles are related. He was immune from the effects of both fire and poison. When thrown into a hot oven he was still unharmed at the end of twenty-four hours. A poisoned cup broke to pieces when he blessed it.

March 23.

St. Fingar, about A.D. 450, fled to Cornwall to avoid his father's wrath. While travelling, the saint and his party were received at night by a pious woman, who killed her cow for their food. St. Fingar took the skin and put the bones in it, whereupon the cow rose up whole and began to low.

Societies and Academies.

LONDON.

Linnean Society, Feb. 16.—**E. Heron-Allen**: On the further researches of Joseph Jackson Lister, F.R.S., F.L.S., upon the reproductive processes of *Polystomella crispa* (Linn.). At the time when the late J. J. Lister's paper on the production of microspheric young by the conjugation of flagellispores emanating from the megalospheric form of *P. crispa* and other Foraminifera (read in 1894) was in process of publication, he was engaged at Plymouth in further researches, as a result of which he was enabled to establish the production of megalospheric young by viviparity in the microspheric form. He left a succinct account of his work in MS., which was read by Mr. Heron-Allen.—**M. A. C. Hinton**: False killer-whales (*Pseudorca crassidens*) in the Dornoch Firth. The school which entered the Dornoch Firth last October was a large one. Most of the whales were carefully measured, their stomach-contents examined, and parasites, internal and external, collected; practically all the females were dissected for information as to breeding. With the help of local labour the whales were flensed, and the skeletons prepared and dispatched to the Natural History Museum. A full-grown bull and a large cow were sent entire to London, where plaster casts were made from them. Numerous dissections have been made and 143 skeletons collected and cleaned.—**Mrs. L. Hunter**: Alcyonaria of the Abrolhos Islands. There are twenty-four species, eight of which are new and nine of which are represented by new varieties. Representatives of the order Alcyonacea predominate, the majority being species of the Nephthyidæ. The orders Stolonifera and Gorgonacea are represented, but Heliopora, usually abundant on other coral reefs of the Indian Ocean, is absent. The creeping membrane in the specimens of Xenia provides a link between the orders Stolonifera and Alcyonacea. The three species of Eunephthya supply a link between the lobose members of the Alcyoniidæ and the tree-like forms of the Nephthyidæ. The spicules found on *Sarcodictyon tropicale*, the first species of the genus to be recorded in warm waters, are of remarkable interest, since it has incorporated in some way the silicious spicules of the tetractinellid sponge upon which the specimen is creeping.

Royal Statistical Society, Feb. 21.—**T. H. C. Stevenson**: Vital statistics of wealth and poverty. The method employed in the recently published Report of the Registrar-General on Occupational Mortality during 1921–23 is that of inferring social position from occupation. By this means regard can be paid to (average) culture as well as income, and the total occupied population can be included in the inquiry. Respiratory diseases, including phthisis, increase without interruption from a minimum in the highest to a maximum in the lowest social class. The process is reversed for diseases of the digestive system, and for diabetes in later life; mortality from appendicitis increases without interruption from a minimum for the lowest to a maximum for the highest of the five social classes distinguished. Mortality from cancer is lowest in the highest, and highest in the lowest, section of society; but this gradation applies to cancer of certain sites only, mortality from the remainder being much the same for all classes. The graded sites, which are responsible for about half the total deaths (in males, for whom alone the requisite occupational information is available), includes the upper alimentary canal from mouth to stomach inclusive, the skin and the larynx. It would therefore appear that cancer of these sites is largely preventable, though the factors determining its differential incidence will have first to be recognised.

Institute of Metals, Mar. 7 (Annual General Meeting).—**W. Rosenhain** (Presidential Address). It has been found by study of the microstructure of alloys that there is a close correlation between microstructure and all or most of the physical properties. The microstructure is the direct result of the mode of solidification of the alloy; and the most valuable diagram or chart which can be prepared for a series of alloys, therefore, is a chart showing the way in which they solidify and the changes which they undergo, in regard to structure, upon cooling after solidification. As an example of the need of great accuracy and completeness in the study of these diagrams, an account was given of the method of determining the 'solid solubility lines' of various alloy systems. Such determinations have not only furnished the explanation of the age-hardening of duralumin and other aluminium alloys, but form the foundation for a series of new and important alloys of copper and other metals. In some of these, notably the alloys of copper and beryllium recently developed in Germany, the age-hardening effects are very large. An alloy containing only a small percentage of beryllium in copper can have its Brinell hardness raised from 80 to 410 by age-hardening, the tensile strength in the latter condition being of the order of 90 tons per sq. inch. The production of high-strength copper alloys may prove to be of vital importance to the future of the non-ferrous industries.—**S. Beckinsale** and **H. Waterhouse**: the deterioration of lead cable sheathing by cracking and its prevention. The cause and prevention of the intercrystalline failures sometimes found in lead cable sheathing are discussed. The situations in which cable sheathing has failed by cracking indicate that the defect is a fatigue type of failure produced by small alternating stresses. The addition of other metals to lead raises the fatigue limit and so increases its resistance to this type of failure. Amongst the alloys which have been found very effective are certain ternary alloys containing cadmium.—**Ezer Griffiths** and **F. H. Schofield**: The thermal and electrical conductivity of some aluminium alloys and bronzes. Two groups of alloys were investigated: (1) Those rich in aluminium, with nickel, magnesium, iron, zinc, manganese, or silver as second or third constituents; (2) those rich in copper, with tin, zinc, lead, manganese, or aluminium. The aluminium alloys have a thermal conductivity of roughly 70 to 80 per cent. that of pure aluminium, whilst the bronzes range from one-fifth to one-tenth of the value for copper. In contrast with the pure metals, all give considerable increase of thermal conductivity with temperature. A minute amount of phosphorus in a bronze produces a marked lowering of the thermal conductivity. The lowering of the conductivity of copper due to an admixture of 10 per cent. of aluminium is comparable with that due to the same amount of tin. Of the aluminium alloys tested, the 8 per cent. copper and the 4·5 per cent. copper showed the highest conductivity (82 per cent. of that of pure aluminium). The lowest thermal conductivity of the series was given by a 13 per cent. zinc, 3 per cent. copper alloy (conductivity = 64 per cent. aluminium). The ratio of the thermal to the electrical conductivity in the range 80° to 300° C. obeys Lorenz's law with one or two exceptions.—**R. Chadwick**: The constitution of the alloys of magnesium and zinc. The metals form two intermetallic compounds, $MgZn_2$, $MgZn_5$, and all four solid phases; Mg, $MgZn_2$, $MgZn_5$, and Zn, form

solid solutions. In analysing the alloys, the magnesium and zinc are precipitated separately as pyrophosphates from the solution of mixed chlorides.—**Hugh O'Neill**: Historical note on density changes caused by the cold-working of metals. Priority for the observation that its density decreases when a metal is cold-worked is generally attributed to certain continental workers, notably to Spring (1891). It appears that Berzelius (1844) may previously have noticed the effect, but it is certain that Charles O'Neill of Manchester published a careful research upon the subject thirty years before the work of Spring was printed.—**F. S. Grimston**: Season-cracking of small-arms cartridge cases during manufacture. Until recently, burst cases have been attributed to inferior metal, but the defect can be reproduced by certain combinations of the tools used in the drawing operations. Season-cracking in the walls of the case take place during the interval between a drawing operation and the subsequent annealing under certain conditions. The conditions are: (*a*) The existence of differential stresses in the case wall caused by tools of wrong design; (*b*) storage of the unannealed cases in contact with soapsuds contaminated with dilute sulphuric acid used in the cleaning processes.—**F. Hargreaves**: The ball hardness and the cold-working of soft metals and eutectics. For soft metals and eutectics, the relation between diameter of impression and duration of loading is given by the equation $d = ct^s$, where d = diameter of impression, t = duration of loading, and s and c are variable factors. The temperature of testing is of great importance. In all the cases examined the effect of work is to increase factor s, and it is suggested that in the case of pure metals it is a measure of the rate of spontaneous annealing.—**W. L. Kent**: The behaviour of metals and alloys during hot-forging. Small cylindrical specimens of pure metals and some brasses were forged with a standard blow of 50 ft.-lb. at temperatures up to the melting-points, and the mechanism of hot-forging investigated by measurements of the degrees of compression produced and by comparison of the Brinell hardness values so obtained. It is concluded that although the forging test does not measure the malleability of a metal or alloy, it will indicate the relative forgeability at different temperatures, and also the liability for cracking to occur during the operation. When a metal is worked at elevated temperatures, it strain-hardens in much the same way as at normal temperatures, but not to the same extent.—**W. A. Cowan**: Minute shrinkage cavities in some cast alloys of heterogeneous structure. Minute cavities in certain heterogeneous alloys are due to shrinkage, accompanying change in volume between liquid and solid phases, of a relatively low freezing-point component, where it last freezes after the bulk of the alloy has solidified at higher temperature. For example, some tin-base alloys, the main component of which is a solid solution of antimony in tin, which solidifies at 237° C., contain a small amount of the eutectic mixture with lead; this solidifies at 183° C., producing minute shrinkage cavities. Similar alloys without any lead content show no cavities.

(*To be continued.*)

MANCHESTER.

Literary and Philosophical Society, Jan. 10.—**B. B. Bancroft**: On the notational representation of the rib-system in Orthacea. A notation is described and applied to certain species and genera of Orthacea, which are very important fossils in the Palæozoic rocks. It depends upon the type of rib branching, and has been defined principally with reference to the dorsal valve. Certain longer ribs are determined as primaries; branches of primaries are termed secondaries, and branches of secondaries are termed tertiary ribs. The valve is bilaterally symmetrical, so that the ribbing can be described by reference to one half of the valve only. All ribs lying between their parent ribs and the median line are termed internals, and ribs lying on the outer sides of their parents are described as externals. These are represented by appropriate signs. The tertiary ribs derived from the fourth primary in a particular shell would be described thus:

$$4\bar{a}\bar{1},\ 4\bar{a}\bar{2},\ 4\bar{a}\mathring{1},\ 4\mathring{a}\bar{1},\ 4\mathring{a}\mathring{1}.$$

For descriptive purposes a rib and the entire system of branches derived from it is called a sector, which may be of primary, secondary, tertiary, or higher order, and is denoted by a Roman numeral or letter. The method lends itself to statistical and graphical representation.

PARIS.

Academy of Sciences, Feb. 6.—The president announced the death of H. A. Lorentz, foreign associate.—**Gabriel Bertrand** and **L. Silberstein**: The ordinary presence of barium, and probably of strontium, in arable earth. Twenty specimens of earth from France, Italy, Denmark, and Serbia have been proved to contain traces of barium. In certain cases spectroscopic proof of strontium was also obtained.—**E. Bataillon** and **Tchou Su**: Maturation, fertilisation, and polyspermia in the egg of *Bombyx mori*.—**G. Nicoladzé**: Contact between geometrical figures belonging to a continuous system.—**Jacques Chokhate**: The convergence of mechanical quadratures in an infinite interval. Applications to the problem of moments, and to the calculus of probabilities.—**Tibor Radò**: Remarks on subharmonic functions.—**J. A. Lappo-Danilevski**: Algorithmic resolution of the problem of Poincaré for systems of linear differential equations with arbitrary rational coefficients.—**Michel Plancherel**: The rôle of Laplace's transformation in the integration of a class of mixed problems of the hyperbolic type, and the developments in series of a couple of arbitrary functions.—**A. Kovanko**: A generalisation of nearly periodic functions.—**Nikola Obrechkoff**: The summation of certain divergent series.—**Bernard Salomon**: The gyroscopic analogies of electricity: asynchronous gyroscopic apparatus and the application of the theory of the gyroscope to continuous movement or to alternating movement.—**Kiveliovitch**: The problem of three bodies with successive collisions of one body with the other two.—**Julien Pacotte**: The electrical vector-potential with five components.—**A. Andant** and **E. Rousseau**: The photolytic action on pure saccharose of the total or filtered radiations of the mercury arc. Various light filters were employed, removing different parts of the spectrum: the amount of reducing sugar formed was taken as a measure of the photolytic action.—**Svend Aage Schou** and **René Wurmser**: The reducing power of glucose. The spectrographic study of glucose solutions, maintained out of contact with oxygen, affords evidence of the production of a reactive form which may account for the reducing power of these solutions.—**Jean Calvet**: The action of hydrochloric acid upon extra-pure aluminium. The resistance of highly purified aluminium to attack by dilute hydrochloric acid is only temporary, since after immersion for a period of some days the metal is clearly attacked, the hydrogen produced growing regularly for some time, and then becoming constant.—**Ch. Courtot, Fayet**, and **Parant**: Contribution to the study of the indene halohydrins.—**L. Bert**: The synthesis of benzene hydrocarbons by means of mixed organomagnesium

compounds. The decomposition by water of 25 mixed organomagnesium compounds, 21 of which have been prepared for the first time, constitutes a method of preparing benzene hydrocarbons which combines the advantages of the method of Friedel and Crafts and that of Fittig and Tollens.—**Marcel Godchot** and **Mlle. Cauquil**: Molecular transposition in the cycloheptane series. A reaction is described which transforms a seven carbon ring into a six carbon ring.—**Wahl** and **Féricean**: New derivatives of isoindigotin.—**Henri Moureu**: The tautomerism of the α-diketones. The two forms of methylbenzylglyoxal and their reciprocal transformation.—**L. Malaprade**: The oxidation of some polyhydric alcohols by periodic acid. Applications. Glycol, glycerol, erythrite, and mannite reduce periodic acid to iodic acid at the ordinary temperature, and a method of determining these alcohols is given which is based on this reaction.—**Joseph Péneau**: The presence of facies with schist structure in the Devonian of the region of Chalonnes (Maine-et-Loire).—**Pierre Pruvost**: The geological results obtained from the test boring of Ferrières-en-Bray.—**A. Demay**: The lower elements of the Cévenol tectonic complex.—**Etienne Patte**: The persistence of the genus Lingullela in the Tonkin Devonian.—**E. Chemin**: An endozoic Aehrochætium and the development of its spores.—**Liugi de Caro**: The comparative energy yields of various glucides in the development of moulds. In the growth of moulds the ketonic grouping is better utilised than the aldehyde function.—**P. Bourcet** and **G. Dugue**: The digitin of Nativelle. A specimen of digitin prepared by Nativelle has been found to contain two substances, one soluble in chloroform and melting at 278° C., the other insoluble in this solvent, melting point 315° C. The latter is identical with digitonin; the former agrees with the gitogenin of Windaus and Schneckenburger.—**Raymond-Hamet**: The bradycardia produced by uzara and by other digitalis preparations.—**Philippe Fabre**: Direct muscular stimulation by progressive currents.—**G. Lavier**: Paravacuolar formations of the trypanosomes.

Official Publications Received.

BRITISH.

Aeronautical Research Committee: Reports and Memoranda. No. 1110 (M. 51): Note on some Fatigue and Density Tests made of Aluminium Aggregate. By H. J. Gough. Work performed for the Engineering Research Board of the Department of Scientific and Industrial Research. (E.F. 195.) Pp. 8. 4d. net. No. 1116 (Ae. 289): Wind Tunnel and Dropping Tests of Autogyro Models. By L. E. Caygill and A. E. Woodward Nutt. (T. 2360.) Pp. 5+5 plates. 6d. net. (London: H.M. Stationery Office.)

The Pure Rivers Society (covering Inshore Waters). Report of the Executive Committee to be presented at the First Annual General Meeting to be held at the Connaught Rooms, Great Queen Street, London, W.C.2, at 2.30 P.M., on Thursday, March 15th, 1928. Pp. 8. (London.)

Department of Scientific and Industrial Research. Building Science Abstracts. Compiled by the Building Research Station and published in conjunction with the Institute of Builders. Vol. 1 (New Series), No. 1, January. Abstracts No. 1-191. Pp. ii+40. (London: H.M. Stationery Office.) 9d. net; Annual subscription, 10s. net.

The Journal of the Institute of Metals. Vol. 38. Edited by G. Shaw Scott. Pp. xii+813+59 plates. (London.) 31s. 6d. net.

Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau), 1926-27. Pp. iv+142+13 plates. (Calcutta: Government of India Central Publication Branch.) 1.14 rupees; 3s. 3d.

Institute of Marine Engineers. Catalogue of Papers read and discussed from April 1889 to December 1927. (Supplement to February Transactions, 1928, Vol. 40.) Pp. 40. (London.)

Report and Balance Sheet of the National Botanic Gardens of South Africa, Kirstenbosch, Newlands, Cape, (and the Karoo Garden, Whitehill, near Matjesfontein), for the Year ending 31st December 1926. Pp. 27. (Kirstenbosch.)

FOREIGN.

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 30: Statistics of Teachers Colleges and Normal Schools, 1925-1926. Pp. 65. (Washington, D.C.: Government Printing Office.) 10 cents.

United States Department of Agriculture. Technical Bulletin No. 32: Returns from Banded Birds, 1923 to 1926. By Frederick C. Lincoln. Pp. 96+8 plates. (Washington, D.C.: Government Printing Office.) 20 cents.

Carnegie Institution of Washington. Year Book No. 26, July 1, 1926, to June 30, 1927, with Administrative Reports through December 9, 1927. Pp. xix+404. (Washington, D.C.: Government Printing Office.)

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 39: Statistics of State School Systems, 1925-26. Pp. 50. (Washington, D.C.: Government Printing Office.) 10 cents.

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 79. Notes on the Types of *Lepidocyclina mantelli* (Morton) Gümbel, and on Topotypes of *Nummulites floridanus* Conrad. By T. Wayland Vaughan. Pp. 299-303+1 plate. Littoral Barnacles of the Hawaiian Islands and Japan. By Henry A. Pilsbry. Pp. 305-317+3 plates. (Philadelphia, Pa.)

Proceedings of the Imperial Academy. Vol. 3, No. 10, December. Pp. xxv-xxvi+637-709+xii. (Tokyo.)

Scientific Papers of the Institute of Physical and Chemical Research. No. 123: Condensation of Nitriles with Thiamides. vi: Action of Sulphur Acid Chlorides upon Thiamides. By Seiichi Ishikawa. Pp. 237-248. 25 sen. Nos. 124-125: Formation of the Radioactive Manganiferous Deposits from Tanokami, and the Source of Manganese in the Deep-Sea Manganese Nodules, by Satoyasu Iimori; The Green Kaolin from Tanokami; Identity of the Universal Minor Constituents of the Igneous Rock with the Chromospheric Elements of the Sun, by Satoyasu Iimori. Pp. 249-257. 20 sen. No. 126: The Radiograph of a Crystal having the Body-centered Cubic Lattice. By Masaichi Majima and Sakuichi Togino. Pp. 259-261+plates 28-37. 45 sen. No. 127: Stark Effect for the Spectra of Silver, Copper and Gold. By Yoshio Fujioka and Sunao Nakamura. Pp. 263-276+plates 38-40. 35 sen. No. 128: Condensation of Nitriles with Thiamides. vii: Tolunitrile with Thiotoluamide, Naphthonitrile with Thionaphthamide, and others. By Seiichi Ishikawa. Pp. 277-292. 25 sen. No. 129: Condensation of Nitriles with Thioacids. Part 1. By Seiichi Ishikawa. Pp. 293-300. 20 sen. No. 130: The Action of Metallic Salts upon Thiamides and their Derivatives. i: The Action of Mercuric Chloride upon Thiamides and their Derivatives in the Ethereal Solution. By Seiichi Ishikawa. Pp. 301-312. 25 sen. (Tōkyō: Iwanami Shoten.)

Rit Visindafélags Íslendinga. 2: Synopsis of the Fishes of Iceland. By Bjarni Sæmundsson. Pp. 68. (Reykjavik: Prentsmidyan Gutenberg.)

CATALOGUES.

To Metallurgists, Metallurgical Engineers, and all interested in Heat Treatment. Pp. 4. (Birmingham: Birmingham Electric Furnaces, Ltd.)

For Sale. Choice Botanical and Zoological Works: Bibliographies, General Literature: Old Medical and Mechanical Arts. (Catalogue No. 3.) Pp. 16. (London: John H. Knowles, 92 Solon Road, S.W.2.)

"Judex" Analytical Reagents and Laboratory Chemicals. Pp. 26. (London: The General Chemical and Pharmaceutical Co., Ltd.)

Steam Storage: Greater Productive Efficiency in Industrial Plants. An Exposition of Dr. Johannes Ruths' Steam Accumulator System. By Alfred J. T. Taylor. Pp. 56+7 plates. (London: Ruths Steam Accumulators, Ltd.)

Diary of Societies.

SATURDAY, MARCH 17.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Western District) (at St. Bernard's, St. Andrews Road, Exmouth), at 12.—S. Hutton: Short Notes on Exmouth Municipal Undertakings.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Eastern District) (at County Hall, Ipswich), at 2.—E. Tasker: Superelevation.—L. T. Weaser: Bridge Reconstruction.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students' Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—W. B. Brown: Some Notes on Accidents from the Use of Explosives.—J. F. C. Friend: Roof Control on Longwall Faces.—*Paper open for further discussion*:—Miners' Nystagmus, by Dr. R. J. Perring.

PHYSIOLOGICAL SOCIETY (in Department of Physiology, University College) (Annual General Meeting), at 3.—F. W. Lamb and J. V. A. Simpson: Assessment of Schoolboys by Air Force Tests.—F. W. Lamb, E. D. Portman, and G. J. Woolham: Posture Deviations of the Arm and Their Reversal.—A. N. Birkett and F. W. Lamb: Balance of Ocular Muscles in Normal Subjects.—Dr. A. D. Macdonald and E. D. Portman: The Diuretic Principle of Pituitary Extracts.—W. H. Wilson: Responses to Electrical Stimulation of the Tectum Mesencephali in Varanus.—J. H. Gaddum and J. H. Burn: Some Properties of the Separated Active Principles of the Pituitary (Posterior Lobe).—Prof. Swale Vincent and J. H. Thompson: (*a*) The Blood-pressure Reflexes under Varying Conditions; (*b*) Pharmaco-dynamical Action of Chloralose.—J. H. Thompson: The Splanchnic Rise of Blood-Pressure under Various Conditions.—S. Wright: Depressor Reflexes.—I. de Burgh Daly: Conditions Governing the Blood Volume of the Lungs.—G. A. Buckmaster and H. B. Hickman: The Tension of Oxygen in Human Urine.—L. M. Pickford and Prof. E. B. Verney: Kidney Perfusion Methods.—Prof. E. B. Verney and F. R. Winton: The Action of Caffeine on the Isolated Kidney of the Dog.—Prof. E. B. Verney: The Osmotic Pressure of the Plasma Proteins in Water Diuresis in Man.—G. P. Crowden and M. G. Pearson: The Effect of Cold on the Adrenalin Content of the Supra-renal Glands. (Preliminary communication.)—Demonstrations:—F. Campbell Smith: A Simple Method for the Rapid Ultrafiltration of Undiluted Blood Serum.—G. Popa: Demonstration of Pigeons with Wings Deprived of Sympathetic Innervation.—A. C. Downing and Prof. A. V. Hill: Myothermic Apparatus.—L. E. Bayliss and E. A. Mueller: High Speed Rotary Pump.—Prof. D. T. Harris: (*a*) Instantaneous Actinometry of U.-V. Lamps with Photo-electric Cells and Thermionic Valves; (*b*) A D.C. Amplifier for Bio-electric Currents and Potential Differences.—W. R. Amberson: Electric Response of Nerve to Single Shock.—E. W. H. Ellis and C. F. Palmer: Modifications of Physiological Apparatus.—L. E. Bayliss, A. R. Fee, and E. Ogden: An Artificial Lung.—A. R. Fee and M. G. Pearson: A Convenient Method of Kidney Perfusion.—

H. R. Ing and Dr. E. B. Verney: A Method of Comparing the Actions of Two Drugs on the Isolated Mammalian Kidney.—G. P. Crowden and H. A. Harris: Radiograms of the Chest in Forced Inspiration and Expiration against Obstruction.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Transformation of Matter (II.).

MONDAY, MARCH 19.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. E. Bushe: The Precise Action of Faith on Thought Power, and the Mystery of its Influence on our Physical and Spiritual Welfare.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—W. A. Erlebach and others: Discussion on The Registration of Engineers.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool), at 7.

RAILWAY CLUB (25 Tothill Street, S.W.1), at 7.30.—W. A. Willox: A Railway Journey in Spain.

CHEMICAL INDUSTRY CLUB, at 8.—A. J. Underwood: Industry in Soviet Russia.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Mrs. Patrick Ness: From the White Nile to Ruanda.

TUESDAY, MARCH 20.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. I. Bennett: Some Problems of Nephritis (Goulstonian Lectures) (III.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: The Behaviour of Animals (V.).

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.

ROYAL SOCIETY OF MEDICINE, at 5.30.—Special General Meeting.

MINERALOGICAL SOCIETY (at Geological Society of London), at 5.30.—A. F. Hallimond: On the Atomic Volume Relations in Certain Isomorphous Series II.—Prof. A. Holmes and Dr. H. F. Harwood: The Age and Composition of the Whin Sill and the Related Dikes of the North of England.—A. W. Groves: The Identification of Dumortierite in Grains; Dumortierite in Cornish Granite.—Dr. T. V. H. Rao: On Bauxite from Kashmir, India.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the month of February 1928.—G. C. Robson: On the Giant Octopus of New Zealand.—Dr. H. H. Scott: Tuberculosis in Marsupials.—Dr. H. C. James: On the Post-Embryonic Development of the Female Genitalia and of other Structures in the Chalcidoid Insect *Harmolita graminicola* Gir.—Dorothy J. Jackson: The Biology of *Dinocampus* (*Perilitus*) *rutilus* Ness, a Braconid Parasite of *Sitona lineata* Linn.—Dr. Marie V. Lebour: The Larval Stages of the Plymouth Brachyura.

INSTITUTION OF CIVIL ENGINEERS, at 6.

LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.), at 6.30.—Mrs. H. D. Kay: Sand Dunes.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at Technical College, Derby), at 6.45.—G. G. Blake: Applications of Electricity to Medical Practice.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—A. H. Law and J. P. Chittenden: Higher Steam Pressures and their Application to the Steam Turbine.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—F. H. Rosencrants: Practice and Progress in Combustion of Coal as applied to Steam Generation.

INSTITUTE OF METALS (Birmingham Local Section) (jointly with Birmingham Metallurgical Society and Staffordshire Iron and Steel Institute) (at Engineers' Club, Birmingham), at 7.—W. E. Ballard: Non-Ferrous Tubes.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group) (Annual General Meeting), at 7.—W. T. Astbury: Photography and Photometry in X-ray Crystal Analysis.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—Ing. Giovanni Chiesa and D. M. Shannon: The Development of the Fiat Marine Oil Engine.

ROYAL SOCIETY OF MEDICINE (Pathology Section), at 8.30.—Annual General Meeting.

WEDNESDAY, MARCH 21.

SOCIETY OF GLASS TECHNOLOGY (in Coal, Gas, and Fuel Industries Department, University, Leeds), at 2.30.—J. T. Howarth and Prof. W. E. S. Turner: The Study of a Fundamental Reaction in Glass Making.—E. J. C. Bowmaker: A Method of Testing the Probable Durability of Tank Blocks.

ELECTRICAL ASSOCIATION FOR WOMEN (at Westminster Electric Supply Corporation, 112 Victoria Street, S.W.1), at 3.—The History of Electricity Supply in the Westminster District (Lecture).

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. F. B. A. Welch: The Geological Structure of the Central Mendips.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (in Prince Henry's Room, 17 Fleet Street), at 5.30.—J. E. Hodgson: James Sadler: Aeronaut, Engineer, Chemist, and Inventor.

INSTITUTION OF ELECTRICAL ENGINEERS (jointly with Kindred Societies) (in Mappin Hall, Sheffield University), at 7.30.

MERSEYSIDE AQUARIUM SOCIETY (at 1 Falkland Road, Egremont), at 7.30.—A. Wilkinson and J. Gould: Display of Pond-Life, etc., under the Microscope, and Short Lantern Lecture by A. Wilkinson.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—H. W. Newton: The Sun's Cycle of Activity (G. J. Symons Memorial Lecture).

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Prof. D. C. Blair: A Nerve Mechanism in the Capillaries of Muscle.—Dr. J. A. Murray: Contribution to the Study of Diatom Markings.—Dr. G. S. Sansom: A Portable Microscope Table.

ROYAL SOCIETY OF ARTS, at 8.—Lieut.-Comdr. R. T. Gould: The Modern Typewriter and its Portable Future Development.

FOLK-LORE SOCIETY (at University College), at 8.—Exhibits and Short Communications.

INSTITUTE OF CHEMISTRY (London Section).

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (jointly with Institute of Chemistry—London Section).—D. J. Macnaughtan: Common Defects in Nickel Deposits.

INSTITUTION OF MECHANICAL ENGINEERS (Bristol Branch).—E. G. Herbert: Cutting Temperatures: their Effects on Tools and on Materials subjected to Work.

THURSDAY, MARCH 22.

CHEMICAL SOCIETY (Annual General Meeting), at 4.—Prof. H. B. Baker: Constitution of Liquids: Some New Experiments (Presidential Address).

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. J. Collier: Epilepsy (Lumleian Lectures) (I.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Group-Capt. Martin Flack: Physiological Aspects of Flying.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—P. D. Morgan: Electrical Research Association Report on a Critical Study of the Continuous Rating of Low-Pressure Ordinary-Duty Fusible Cut-Outs.

INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) and SOCIETY OF CHEMICAL INDUSTRY (Edinburgh and East of Scotland Section) (at 36 York Place, Edinburgh), at 8.—Dr. W. T. H. Williamson: Recent Advances in the Chemistry of Soils.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—F. Kidd and others: Discussion on The Treatment of Stricture by Excision.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Branch).—Capt. H. G. M. Beames: The Reorganisation of Crewe Locomotive Works.

INSTITUTION OF THE RUBBER INDUSTRY (Manchester Section).—B. D. Porritt: Single Texture Proofing.—Dr. E. P. Rydings: Paper.

FRIDAY, MARCH 23.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—W. D. Flower: The Terminal Velocity of Drops.—Satyandra Ray: Longitudinal Waves Along a Rod.—J. J. Manley: The Damping of Mercury Ripples.—Demonstration by J. E. Calthrop of *Die Kastenmethode*.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of the Present State of Knowledge regarding the Innervation and Movements of the Intestine.

BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College, Regent's Park, N.W.1), at 5.30.—Miss A. M. Bodkin: The Study of Imagination through Poetry.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at 39 Elmbank Crescent, Glasgow), at 7.—Annual Business Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 7.—G. P. Barnard: The Vacuum Tube Family.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section), at 7.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—J. H. Walker and others: Mechanical Handling of Goods.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Informal Meeting) (at Newcastle-upon-Tyne), at 7.15.—H. G. Williams: The Steering of Ships.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—B. J. Axten: High Tension and Low Tension Supply for Wireless Receivers from Electric Mains.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Chemical Society), at 8.—A. A. King: Ultra-Violet Radiation in Industry.

ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Dr. C. O. Stallybrass: Season and Disease.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. E. Cohen: A Physical Chemist in Search of Purity in an Impure World.

SOCIETY OF DYERS AND COLOURISTS (Scottish Section).—A. J. Hall: Some Features of the Swelling and Solution of Cellulose.

SATURDAY, MARCH 24.

ROYAL SANITARY INSTITUTE (at Municipal Buildings, Taunton), at 10.30 A.M.—Discussion on Present Tendencies regarding Disinfection and on House Refuse Collection.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Transformation of Matter (III.).

PUBLIC LECTURES.

SATURDAY, MARCH 17.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. Harcourt: Food and Famines in India.

MONDAY, MARCH 19.

GRESHAM COLLEGE, at 6.—G. P. Bailey: Modern Science and Daily Life: The Conquest of the Air.

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—A. Amos: High Farming *v.* Low Farming.

TUESDAY, MARCH 20.

IMPERIAL COLLEGE OF SCIENCE—ROYAL COLLEGE OF SCIENCE, at 5.30.—Prof. K. M. G. Siegbahn: X-rays. (Succeeding Lectures on Mar. 21 and 22.)

WEDNESDAY, MARCH 21.

BRITISH MEDICAL ASSOCIATION (Tavistock Square, W.C.1), at 8.—Sir George Newman: The Fundamentals of Health (Sir Charles Hastings Memorial Lecture).

THURSDAY, MARCH 22.

BRITISH MEDICAL ASSOCIATION (Tavistock Square, W.C.1), at 5.30.—Dr. E. Graham Little: The Future of Medical Practice.

SATURDAY, MARCH 24.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. E. Marion Delf: Light and Life.

CONFERENCE.

MARCH 26 TO 31.

GERMAN BALNEOLOGICAL CONGRESS (at Baden, near Vienna).

SATURDAY, MARCH 24, 1928.

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New Statutes for the University of London.

THE second draft of the proposed Statutes for the University of London has been published by the Commissioners appointed under the University of London Act, 1926. This Act directed that statutes for the University were to be made by the Commissioners "in general accordance with the recommendations" contained in the Report of the Departmental Committee appointed by the President of the Board of Education (Mr. Trevelyan) in 1924, "subject to any modifications which may appear to them to be expedient"; and the first draft implemented these recommendations, save in one or two particulars, for example, two women's colleges—the Royal Holloway College and Westfield College—were added to the list of colleges accorded direct representation on the Senate, thus ensuring further representation of the special interests of women; and the Principal of the University was made *ex officio* a member of the Senate.

Both before and after the publication of the first draft, voluminous representations were made to the Commissioners. One subject on which representations were made, of special interest to readers of NATURE, is the recognition of research as an important activity of the University. The new draft Statutes provide for the recognition of research institutes as 'Schools of the University' and divide the 'Schools' into three categories—(1) Incorporated Colleges, the title curiously given to the two colleges, University College and King's College, which have ceased to be 'incorporated' in the legal sense; (2) Colleges; (3) Research Institutes. The division of the existing 'Schools' has been carried out by the Commissioners in an amateurish way, for the category 'Colleges' as published includes some professional schools, and the category 'Research Institutes' includes institutions such as the School of Pharmacy and the School of Oriental Studies, the chief work of which is instruction rather than research.

The title of the body charged with the control of the finances of the University has been changed from 'Council'—a name possibly suggesting a body subordinate to a larger body—to 'Court,' a more appropriate title for a body created *ad hoc* with powers both independent and concurrent.

The most important change introduced by the second draft of the Statutes is the complete abrogation of the direct representation of colleges on the Senate. Objection was taken to the principle of

college representation on the ground that a university is traditionally a self-governing guild, not a federation of colleges, and that the members of the supreme governing body in academic matters should not *represent* independent or *quasi*-independent institutions. Huxley gave his views on this question to the Gresham Commissioners in 1892 with his accustomed clearness. "Unify without fettering" expressed his ideal of the relation of university to college. He advised against giving the professoriate a preponderant representation on the Senate and said he would certainly object to any system "by which institutions whether called colleges or by any other names got the whip hand of the University." He would not "cumber" the Senate with representatives of the colleges—referring no doubt especially to lay representatives.

This view has been accepted, on re-consideration, by the present Commissioners. The alternative adopted is the appointment of the heads of the nine named colleges, together with two deans of medical schools to be selected, as official members of the Senate. Even those who objected on principle to college representation recognised that the heads of colleges, by reason of their wide knowledge and experience, were most eligible on personal grounds for membership of the Senate. Apparently it was not possible to avoid giving permanent seats to the heads of the selected colleges—a method which has disadvantages in a democratically constituted governing body—though in the case of the medical schools a system of selection has been adopted.

In addition to the Chairman of Convocation, who is a member *ex officio*, the representation on the Senate of the graduates in Convocation has been increased by one member (from 16 to 17), who is allocated to science; and similarly an additional representative has been accorded to the Faculty of Medicine, composed of teachers (an increase from two to three), the effect being to increase the number of Faculty representatives also from 16 to 17. Past controversies, as well as the relative importance of scientific and medical interests in the University, justify this change. The total membership of the Senate as re-constituted will be 52 (or possibly 53).

The appointment and dismissal of members of the financial and administrative staff of the University is, by a new draft Statute, to rest with the Senate, except as to the Principal, who is to be appointed by the Senate with the concurrence of the Court. This is a new and surprising provision, its effect apparently being to prevent the Court appointing its own officers for the discharge of its onerous duties in relation to finance, including the obtaining of benefactions and public grants for the University.

Another surprising innovation is the proposed acceptance, as internal students, of students who have not matriculated in the University, including students preparing for degrees of other universities (for example, medical students preparing for degrees at Oxford and Cambridge) and students preparing for the diplomas within the purview of the Academic Council. The definition of internal students is contained in the schedule to the Act of 1898, and the Departmental Committee recommended no change in this important matter. It is a wide departure from established practice to register internal students without any prescribed educational standard, though it must be remembered that Huxley was opposed to all matriculation tests, and there will be great advantages in enabling all regular students of colleges to register as internal students. The registration of external students, a much-needed reform, is authorised by a new draft Statute, but not directed.

On the difficult question of an 'appointed area' for the University, the Commissioners have not found enlightenment, retaining the illogical and unscientific London County Council area for the admission of new 'Schools,' except as regards institutions "wholly or mainly devoted to the pursuit of some branch of University study which cannot, in the opinion of the Senate, be adequately pursued within that area," for which no area is prescribed. The present thirty-mile radius for institutions at which teachers can be 'recognised' disappears, the recognition of teachers under the new conditions being without restriction of area. Is it to be inferred from these new arrangements that places like Wimbledon, Watford, Chingford, Chislehurst—admirably situated for day and residential colleges for London students—are outside the sphere of influence of the University of London and are at liberty to create new universities? Even at this late hour, it may be hoped that the Commissioners will find inspiration for a better definition of the 'London area' in respect of higher education.

The Commissioners announce April 30 as the last day for receiving further representations, and it is to be presumed that renewed controversy is not expected. In view of the important new issues raised by the amendments to the first draft of the Statutes, the time allowed for further discussion appears to be unduly restricted.

Economic Ornithology.

The Practical Value of Birds. By Prof. Junius Henderson. Pp. xii + 342. (New York: The Macmillan Co., 1927.) 10*s.* 6*d.* net.

ALTHOUGH we in Great Britain are only just beginning to realise the importance of avian economics, other countries have long been cognisant of the important part played by wild birds, and none more so than the United States of America. Since 1885, when investigations were commenced under the ægis of the Government, there has been a long series of distinguished investigators whose work has been published in upwards of two hundred memoirs. Valuable as these works are to all engaged on similar researches in this particular branch of science, they are scarcely the literature desired or to be understood by a large body of the general public who are anxious to learn something of the economic status of the wild bird fauna. It is therefore most fitting that the results of these invaluable suggestions should be summarised, and a résumé provided for those generally interested, for such cannot fail to bring home to a wide circle of readers the extent and national value of this long and brilliant series of investigations.

Prof. Henderson's work is divided into two parts, the first dealing all too briefly with the principles involved and the more important groups of facts. The seventeen chapters are contained in about one hundred pages, and, while full of interest, scarcely do justice to the voluminous literature on the subject. The second part consists of a systematic discussion of "the more significant data" relating to American economic ornithology. The author has not only included a very full bibliography, but also, unlike many present-day authors, has credited every author quoted with an actual reference.

The work that has emanated from the Bureau of Biological Survey is so thorough and reaches such a high standard that we wish the author had confined himself to an epitome of this alone. We question whether the results obtained by Aughey fifty years ago have more than historical value. As all investigators know, odd notes on the food of one or two specimens of a bird observed at a particular season and district are really of very little value, and in the present case they only tend to detract from the valuable results obtained by workers of long experience. Any further advancement in the subject of the economic status of any species of wild bird will only be made as the result of a systematic examination of the stomach contents of a large series of specimens obtained during each month of the year and from various districts. This is clearly indicated by the work of Barrows, Beal, Fisher, Judd, Kalmbach, McAtee, Oberholser, Wetmore, and others, who have laid a sure and lasting foundation for economic ornithologists.

Useful as are the details given under the various species as to the volumetric percentages of the different food items, in our opinion they are insufficient for the general reader and others for whom this book is intended. As McAtee has so pertinently remarked, such figures are merely "convenient handles to facts" and require interpreting. Significant as they are to one versed in the study of animal economics, they convey very little information to others. The reader is left to decide for himself whether a species is beneficial, injurious, or neutral in its relationship to mankind. It is to be regretted that the author has not summarised the economic status of either individual species or the family as a whole. This is such a prominent feature in the works of Beal and other writers that we are rather surprised at the omission, for it is obvious that the general reader wishes to learn the conclusions arrived at after the prosecution and completion of a long, highly technical, and extremely difficult investigation.

As American workers have since 1885 employed the volumetric system of expressing the volume of food contained in a bird's stomach, we should have expected a more precise method of stating the quantities of food required by birds; unfortunately such is here absent. If a bird requires the cubic capacity of its stomach filling four or five times a day, it is surely important to know what that cubic capacity means in grains and ounces, when such information is obtainable, in order that the volumetric analyses of individual stomachs or the total averages of such may be rightly understood. We are fully aware that, unfortunately, such figures do not exist for all species, desirable as they are, but Beal gives these for many species, and other writers have estimated the weight of the total bulk of food required in a year.

One fact which is brought out by these researches is that of upwards of five hundred species of birds, the stomach contents of which have been examined, very few indeed are proved to be wholly injurious. Species that are injurious in one part of the country during a season are just as beneficial, or even more so, in another district during a later season, all of which only tends to show how very exhaustive an inquiry should be before any species is condemned.

If we seem to have dwelt upon the shortcomings

of this work, it is not because we do not appreciate its good points, which are many and obvious. Should a further edition be called for, we trust the above criticism will be considered helpful. Although confined almost entirely to American birds and the work of American workers, the general principles enunciated hold good for practically all countries, and all interested in the economics of wild birds will find a wealth of material for careful consideration. Prof. Henderson's book is a valuable addition to the literature on economic ornithology, and he is to be congratulated on meeting an obvious need.

Walter E. Collinge.

Science and Faith.

Adventure: the Faith of Science and the Science of Faith. By the Rev. Canon Burnett H. Streeter, Catherine M. Chilcott, John MacMurray, and Dr. Alexander S. Russell. Pp. ix + 247. (London: Macmillan and Co., Ltd., 1927.) 7*s.* 6*d.* net.

The book, Canon Streeter tells us, arose out of a series of informal conferences at which the relations between science and religion were discussed, mainly by the "scientists and philosophers of the post-War generation in Oxford." The essays have, therefore, somewhat of a common viewpoint, and it is a novel and stimulating one. The title is intriguing. We do not as a rule associate the idea of adventure with religion, or very often with science, and books about their relation are apt to be dull and platitudinous. The present volume does escape that reproach, and does treat the question from a new viewpoint.

Dr. A. S. Russell, who writes the first paper, on "The Dynamic of Science," has little difficulty in showing that the spirit of adventure is active in science at the present day, particularly in the physical sciences.

"At the present day," he says, "the student of natural science does not allow himself to be deterred from a theory merely because it appears incredible or incompatible with all that has gone before. To such theories indeed he is attracted. The spirit of adventure is strong in him. During the second half of last century the development of science was away from adventure and towards a form of intellectual pharisaism. All the great principles appeared to have been discovered and correctly formulated, and the scientist was inclined to believe that all that needed to be done, especially in physics, was to improve the petty details. This point of view changed rapidly when it was realised that the details were not petty, but capable of leading to astounding conclusions" (p. 18).

It is the facts themselves that have shaken the old conceptions—the facts discovered by bold and patient experiment. Nature is much more remarkable than our theories or imaginings admit. Dr. Russell writes mainly from the point of view of the physicist, and we miss in the book any equivalent treatment of biology. Or is the spirit of adventure, of revolution, less manifest in this domain?

What of adventure in religion? Mr. MacMurray considers this in a really remarkable essay entitled "Beyond Knowledge," in which he deals in a penetrating way with the relation of 'faith' to 'knowledge.' He rejects the common view that faith is a kind of knowledge—that it is belief opposed to reason, or based upon intuition, or on mystical experience. He considers it to be an attitude of will, a way of acting in the face of uncertainty or ignorance. This is, he maintains, what faith means in the New Testament, and he discovers the same attitude at the root of scientific endeavour.

"Modern science," he writes, "rests upon an attitude of will which meets the impotence of mere thought by a continuous reconstruction through criticism and experiment. This attitude of will, we have argued, is the presupposition of all living knowledge, and we have suggested its identity with faith" (p. 37).

It is action—the experimental and courageous grappling with practical difficulties—that is "beyond knowledge." Purely rational and "careful" thought does not take us very far; there must be constant testing by experiment, constant adventuring into the yet unknown complexities of Nature. Science and religion are both based upon this attitude of faith, and "Such a life of faith lies beyond knowledge, because it is the transcendent spirit of knowledge, the courageous life of creative adventure" (p. 45).

It is perhaps rather unfair to Mr. MacMurray to attempt to present his point of view in a few sentences. The whole essay, which is closely reasoned and rich in suggestion, must be read. There is much in it open to criticism, but it does present a vital and stimulating point of view,—all the more stimulating if one does not fully agree with it.

The remaining essays in the book take us rather beyond the scope of subjects appropriate for discussion in Nature. There are three theological essays by Canon Streeter, Mr. MacMurray, and Miss Chilcott, and a long article on "Moral Adventure" by Canon Streeter, in which the problems of sex morality are dealt with in a broad and sane, but not very adventurous, way.

E. S. R.

Pascal as a Man.

Portrait of Pascal. By Mary Duclaux (A. Mary F. Robinson). Pp. 232. (London: T. Fisher Unwin, Ltd. (Ernest Benn, Ltd.), 1927.) 10*s*. 6*d*. net.

THIS new short life of Pascal—for we must call it that in spite of Mme. Duclaux—will take its place suitably beside the little books on Newton and Descartes which have been recently noticed in our columns. In some ways the Pascal book ranks above the others, because Pascal was so much more interesting as a man than either Newton or Descartes. He died younger, less than forty years of age, and he had all the fascination for his contemporaries of a dreamy delicate man, full of great thoughts and divided in his allegiance between his passion for physical experiments and mechanical inventions and religious solicitude for the welfare of his soul. It was the latter interest that finally prevailed, and—with all reverence be it said—it was not the higher interest, for the religion of Port Royal, which carried off first his sister Jacqueline and then himself from the parental moorings, was not of the highest or most inspiring order. It was morbid and introspective, and put the salvation of the individual sinner above all other thoughts, human or divine. That Pascal was equally open to the other side of religion and morals—the social and humane—is evident from the tenderness of his private life and many strains in his writings; but for eight years before he died the pietistic strain was uppermost. The root cause was physical. He had suffered from childhood from a paralytic nervous weakness, and this was aggravated by a carriage accident in 1654, from which he never really recovered.

It is the struggle and the contrast between the two sides of Pascal's nature which gives the penetrating charm to all his writings, and especially to the "Pensées." Something like Shelley in personal appearance, he was like him too in the conflict between the positive and the dreamy tendencies in his thinking, but whereas Shelley sets free his imagination in picturing and glorifying the powers and future of man, Pascal is oppressed by the thought of the infinite pettiness of the individual, face to face with the immensities of space and time. The seventeenth article of the "Pensées" gives the best expression to this feeling. It ends with the quietist doctrine, that being unable to comprehend the whole or pass beyond that middle point between nothing and the infinite, true wisdom is to be found in repose, each in the place where Nature has placed him.

As the man of science it is difficult to estimate Pascal's contribution with certainty, owing to the share taken by others in his most famous work. The first idea of the pressure of the air, which was suggested by Torricelli's tube, came no doubt from Galileo. Pascal plunged into the discussion with all the ardour of his scientific, inquisitive nature. It was he probably who first thought of the decisive experiment on the Puy-de-Dôme, though Descartes claimed the credit in a conversation with Pascal. Such questions are often insoluble, when some new question is being eagerly canvassed by a group of men in close contact with one another. We may be quite sure of one or two points in this much-discussed story. One is that Pascal, being the retiring and self-centred person, was likely to have thought much more about it than others who made more noise in the world, and that he was the indefatigable experimenter on any subject in which his interests were engaged. He made fifty models of the calculating machine which was to help his father in reckoning the taxes payable by the individuals in his district. Above all, it is certain that, had his life been prolonged and had he been free from the religious obsessions which secluded him for years, and took up most of his writing time, he would have done far more for the advance of physical science.

At twelve, Pascal had been found by his father making out for himself the thirty-second proposition of Euclid on the equality of the angles of a triangle to two right angles. At sixteen he had written a complete treatise on conic sections. Nothing but good health and concentration were needed to make him the greatest geometer of modern times, the 'New Archimedes,' as Father Mersenne called him. As it was, he remains a brilliant and tragic figure, the broken column in the history of science. Mme. Duclaux catches this aspect of him admirably in her book, but she should have found a prominent place for the inspiring thought which he develops at some length in the preface to the "Traité du vide": "Toute la suite des hommes, pendant le cours de tant de siècles, doit être considérée comme un seule homme qui subsiste toujours et qui apprend continuellement." This he points out is the distinguishing characteristic of human intelligence. The 'fragile science' of bees and ants does not grow greater with the generations. But man is born for infinity. It was the thought which, had he followed it throughout, would have given the grand consistent purpose to his life.

F. S. MARVIN.

Discharge-tube Physics.

Handbuch der Experimentalphysik. Herausgegeben von W. Wien und F. Harms. Band 14: *Kathodenstrahlen*, von P. Lenard und A. Becker; *Kanalstrahlen*, von Wilhelm Wien. Pp. xiv + 788. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1927.) 72 gold marks.

IN contemplating this massive volume of nearly eight hundred pages, one's thoughts irresistibly fly back to Sir J. J. Thomson's pioneer little book containing his Princeton lectures on "The Discharge of Electricity through Gases," which, published in 1898, was followed five years later by his monumental "Conduction of Electricity through Gases." This latter work not only collected and discussed in masterly fashion the relevant knowledge to date, but also by its suggestiveness served as an inspiration for the next generation of workers. There must be very many who have regretted that no recent revised edition has been forthcoming, though one realises how formidable the task would be to preserve the original degree of completeness in all the ramifications which the subject has since assumed.

Some of the developments are fraught with importance to the general community; others have contributed vitally to the more abstract aspects of scientific work. A few of these developments, which have resulted from or been influenced by investigations on gaseous ionisation, come to mind at once — thermionics and the hot-cathode valve, X-rays, cathode rays, positive rays, radio-activity, photo-electricity, electric lighting. The list might be greatly extended. In each of the subjects an enormous literature has come into being. Take, for example, the present volume on *Kathodenstrahlen* and *Kanalstrahlen*, terms, we may recall, which were introduced by Goldstein, the former in 1876, the latter in 1886. Prof. Lenard and Dr. Becker's treatment of cathode rays alone extends to above four hundred large and closely printed pages, while Prof. Wilhelm Wien's discussion of positive rays is no less impressive. These contributions bear testimony, were it needed, to the epochal stimulus to physics which followed Sir J. J. Thomson's isolation of the electron thirty years ago, and recall Maxwell's far-seeing prediction in the early 'seventies of the great potentialities of the discharge tube contrived by Hauksbee more than two centuries ago.

As would be anticipated from the standing of its authors, the book under review is characteristically complete, authoritative, and exact, and, so far as we have been able to test it, fair in its recognition of work carried out in other countries. There are more than 100 tables and nearly 500 figures. The volume is indeed a mine of information and remarkably up-to-date despite its size. In so comprehensive a work we find it difficult within the compass of a short review to single out any particular aspect for comment, but the treatments of their own investigations by Prof. Lenard and Prof. Wien respectively have a conspicuous interest and freshness of outlook. The latter's generous recognition of the work of Sir J. J. Thomson and Aston on positive rays calls for particular notice.

We confess we see little or no advantage in the plan of combining what are two independent treatises in one volume. Even now they are separately indexed, and the paragraphs, figures, and tables in the two sections are separately numbered. If each section had been issued independently, we venture to think it would have been in the interests of both the public and publisher. As it is, the volume, in view of its costliness, will mainly find a home on the shelves of institutional libraries. The publishers deserve commendation for the excellence of the printing, binding, and general 'get-up.' G. W. C. K.

Our Bookshelf.

(1) *Das elektromagnetische Feld: ein Lehrbuch.* Von Prof. Emil Cohn. Zweite völlig neubearbeitete Auflage. Pp. vi + 366. (Berlin: Julius Springer, 1927.) 24 gold marks.

(2) *Quelques idées sur l'électrodynamique: théories nouvelles sur l'oscillateur de Planck et le mouvement autonome exposées devant la Société française de Physique.* Par R. Ferrier. Pp. 48. (Paris: Albert Blanchard, 1927.) 5 francs.

(1) THIS book is a second edition of the author's work of the same title published in 1900. It is much smaller in size than the first edition, but the arrangement of the subject matter is more carefully balanced, and the thread of the general argument is not now broken by frequent incursions into the realm of the practical realities of the subject. The whole treatment—as in the first edition—is based on the Hertzian view of an electric field which recognises matter only indirectly by its influence on the electric and magnetic properties of the ether. This view would never have persisted in face of the much greater simplicity of the modern electrical theory of matter, were it not that certain of the general critical results deduced in it seem to be supported by certain results in the more modern development, which are nevertheless, in spite of their persistence, erroneous. We refer in particular to the expressions for the energies and tractions in the field. Never-

theless, this book can still be recommended to those who wish to become acquainted with every side of a subject which has perhaps not yet reached its ultimate form.

(2) An ingenious illustration pointing the last remark of the previous notice is provided by R. Ferrier's little pamphlet. By a slight and apparently insignificant mathematical modification of the fundamental equations of Maxwell's theory—supported, however, by very cogent physical argument—certain extraordinary possibilities are opened out, which the author very ingeniously connects up with the question of the structure of the ether and the origin of the discontinuities of the quantum theory. New types of radiation fields—associated with such an old friend as the Hertz-Planck oscillator—are exhibited and their physical significance indicated. The ideas are of course merely tentative and very highly speculative, but they serve to illustrate the alternative possibilities of a theory, one half of the theoretical development of which is probably still nothing but pure conjecture.

G. H. L.

Collected Physical Papers. By Sir Jagadis Chunder Bose. (*Bose Institute Transactions*, 1927.) Pp. xii + 404. (London: Longmans, Green and Co., Ltd., 1927.) 10*s*. net.

Sir Jagadis Bose has brought together in this volume a number of papers, mainly on physical subjects, written between 1895 and 1925. They include some of his papers on the applications of physical methods to the study of living matter. Of recent years he has devoted himself mainly to this branch of the subject. His early researches were on the optical properties of electric waves. They were made soon after Hertz's experiments, and his success was largely due to the method he perfected of generating electric waves, the wavelengths of which were within a few octaves of the waves forming visible light. Sir Jagadis obtained important results in this field on such subjects as coherence, polarisation, double refraction, and rotation of the plane of polarisation.

When working with receivers for electric waves, the author found that the sensitiveness of metallic detectors disappeared when they were subjected to continuous stimulation. When, however, they were allowed to rest for a sufficient period, they regained their normal sensitiveness. The records he obtained of the successive responses of metallic detectors were very similar to those he obtained when experimenting on the fatigue of an animal muscle. Thinking that prolonged rest would make a metallic detector more sensitive, he laid it aside for several days. On again testing it, he was surprised to find that it had become inert. A strong electric shock, however, made it sensitive again. He concludes that this experiment indicates two opposite treatments for fatigue from overwork and for inertness due to long passivity. No break was found in the continuity of the phenomena.

Sir Jagadis Bose considers that there is no line of demarcation between the physical phenomena and the physiological phenomena. It is impossible to say whether a phenomenon is one shown by dead matter or a vital phenomenon peculiar to the living. The book contains brief accounts of many interesting and suggestive experiments.

Operational Methods in Mathematical Physics. By Dr. Harold Jeffreys. (Cambridge Tracts in Mathematics and Mathematical Physics, No. 23.) Pp. vii + 101. (Cambridge: At the University Press, 1927.) 6*s*. 6*d*. net.

The operational methods of Heaviside for the solution of differential equations have the advantage of proceeding direct to the result in terms of given boundary conditions. Bromwich's interpretation of the operators by means of contour integrals have led to a generality and convenience of application which will ensure a warm welcome from mathematical physicists of Dr. Jeffreys' lucid and interesting exposition. Moreover, this is the only available connected account of Heaviside's methods, and is illustrated by a variety of applications. The value of the book is enhanced by the inclusion of a chapter on dispersion, with a description of the method of 'steepest descents.'

Éléments de géométrie infinitésimale. Par Prof. Gaston Julia. Pp. vi + 242. (Paris: Gauthier-Villars et Cie, 1927.) 45 francs.

This is an interesting course on differential geometry of three dimensions, which occupies an intermediate place between Darboux's "Théorie des surfaces" and such accounts of the subject as are to be found in most treatises on analysis, Goursat, for example. The emphasis is rather on the analytical than on the geometrical side, and a good deal of attention is given to the theory of contact and envelopes. The theory of congruences of lines is developed in some detail and, in particular, there is a discussion of singular lines as affording an application of singular integrals of differential equations.

The Romance of Chemistry. By Prof. William Foster. Pp. xvi + 468 + 31 plates. (London: George Allen and Unwin, Ltd., 1927.) 12*s*. net.

Prof. Foster's book is clearly written and gives an interesting account of many parts of chemistry and of its border-line subjects which should appeal to the general reader. Many of the examples chosen will, no doubt, be more familiar to American than to European readers, but the book can be recommended as a very good popular account of some of the generally interesting parts of modern chemistry.

Vorlesungen über Differential- und Integralrechnung. Von Prof. R. Courant. Band 1: *Funktionen einer Veränderlichen.* Pp. xiv + 410. (Berlin: Julius Springer, 1927.) 18·60 gold marks.

This is simply an ordinary text-book of calculus, without any freakish ideas and without undue elaboration of any special point leading to lack of balance. The volume does not, however, contain anything of importance not accessible in current English mathematical literature.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Activation of Cholesterol at Liquid Oxygen Temperature.[1]

AT the temperature of liquid oxygen (- 183°), most bimolecular chemical reactions are largely inhibited. The rates of these reactions, in general, decrease rapidly with decreasing temperature. At very low temperatures the rates become too small to be measured, and for practical purposes it may be said that reaction ceases. This is especially true of oxidations, since, for example, neither sodium nor phosphorus immersed in liquid oxygen undergoes any apparent oxidation. However, the rates at which photo-molecular changes take place decrease more slowly with temperature. With this in mind, the irradiation of activatable cholesterol was carried out in liquid oxygen with the object of obtaining evidence as to the nature of the change involved. It was found that cholesterol of ordinary purity even at liquid oxygen temperature becomes antirieketic upon exposure to ultra-violet light.

The cholesterol used in these experiments melted clear at 149°. An investigation of its absorption spectrum by Dr. W. A. MacNair demonstrated that it contained 1·2 parts per thousand of ergosterol. Preliminary biological tests proved it to be highly activatable, although not antirieketic prior to irradiation. Our biological technique (line test) is described elsewhere.[2]

Irradiation was performed as follows: A cylindrical brass tube 42·5 cm. long and 4·5 cm. in diameter, closed at the lower end, was immersed in liquid oxygen contained in a silvered Dewar flask. The depth of immersion varied between 25 cm. and 15 cm. on account of evaporation of the oxygen. To prevent the condensation of water vapour in the tube and the settling of frost on the sample to be irradiated, the open, upper end of the tube was covered with a quartz plate thermally insulated from the metal by a ring made from asbestos board. A thin disc 4·2 cm. in diameter bearing 200 mgm. of pulverised cholesterol was lowered to rest on the bottom of the tube, and allowed to cool to liquid oxygen temperature. A quartz mercury vapour arc was adjusted a few centimetres above the tube and operated at 120 volts with about 30 ohms resistance in series. After irradiation for 105 minutes, the cholesterol was allowed to warm to room temperature, then dissolved in ether and evaporated on to McCollum's Diet 3143. Before and after irradiation the cholesterol was carefully protected from ultra-violet light. A similar experiment was made with the same apparatus, but at room temperature. On account of transportation, etc., a week elapsed between the preparation and administration of the modified diets.

The cholesterol irradiated at room temperature induced advanced healing of rickets when administered at 1/10 per cent., or even at 1/100 per cent. in the diet. The cholesterol irradiated at liquid oxygen temperature induced advanced healing at 1/10 per cent., but failed at 1/100 per cent. Thus it is evident that cholesterol is readily activated at liquid oxygen temperature, although the product obtained under the conditions of this experiment was not so potent as the product of irradiation at room temperature.

We regard these data as a strong confirmation of the evidence which has been accumulated recently by Rosenheim and Webster,[3] Windaus and Hess,[4] and Bills and McDonald,[5] that the activation of cholesterol (or ergosterol) consists not in an oxidation, but in an isomerisation—a rearrangement at the double bond or an *Elektronenverlagerung*.

In the activation of sterols by ultra-violet rays, it is important to consider the temperature coefficients of both the vitamin formation and accompanying destruction. For the formation the coefficient is evidently low. We find, however, that the spontaneous deterioration of (unactivated) ergosterol has a high temperature coefficient. If activated ergosterol also exhibits a high coefficient in its decomposition, then the way is clear for the preparation of a vitamin D of greater potency than has hitherto been attained.

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[1] Publication approved by the Director of the Bureau of Standards of the U.S. Department of Commerce.

[2] Bills, C. E., Honeywell, E. M., and MacNair, W. A., *Jour. Biol. Chem.*, **76**, 251; 1928.

[3] Rosenheim, O., and Webster, T. A., *Biochem. Jour.*, **20**, 537; 1926.

[4] Windaus, A., and Hess, A., *Nachr. Ges. Wiss. Göttingen, math.-physik. Klasse*, 175; 1927.

[5] Bills, C. E., and McDonald, F. G., *Jour. Biol. Chem.*, **72**, 13; 1927.

Cholesterol and Vitamin D.

BILLS, Honeywell and MacNair have recently demonstrated (*Jour. Biol. Chem.*, **76**, 251; 1928) that both ergosterol and ordinary purified cholesterol, in addition to the previously observed well-defined absorption bands at 293·5, 281·5, and 270 $\mu\mu$ (Morton, Heilbron and Kamm, *Biochem. Jour.*, **21**, 78; 1927), exhibit a faint but distinct band at 260 $\mu\mu$. They have also discovered that cholesterol purified by a thrice repeated conversion into the dibromide and recovery from same by treatment in boiling alcohol with zinc dust (so-called cholesterol E) can, contrary to the contentions of Windaus and Hess (*Nach. Ges. Wiss. Göttingen, math.-physik. Klasse*, 175; 1927) and Rosenheim and Webster (*Biochem. Jour.*, **21**, 389; 1927), still be activated by ultra-violet rays. According to the American workers, this activatability is associated with faint absorption bands at 315 and 304 $\mu\mu$ as well as the three characteristic ergosterol bands.

We are able to confirm the existence of a faint band at 260 $\mu\mu$ in ergosterol, but this is only detected with certainty when a continuous light source is used. As regards the newly observed bands, however, we desire to direct attention to the bands found by us in cholesterilene, which is characterised by selective absorption with maxima at 294, 304, and 321 $\mu\mu$ (*Jour. Chem. Soc.*, p. 47; 1928). The first of these coincides with the 293·5 $\mu\mu$ band of ergosterol, whilst the others are in close agreement with the two found by Bills, Honeywell and MacNair in their specially purified cholesterol. Bearing in mind the known instability of cholesterol dibromide (Lifschütz, *Zeit. physiol. Chem.*, **106**, 271; 1919), and also the complex nature of its decomposition, we suggest that the two bands observed in cholesterol E may well be due to traces of cholesterilene formed during the purification process. The amount of this hydrocarbon which would be necessary to show the selective absorption

under the conditions employed by Bills, Honeywell and MacNair is of the order of 0·01 per cent.

The above suggestion in no way invalidates these authors' results regarding the slight activatability of their purified cholesterol, but simply dissociates the phenomenon from the absorption bands at 315 and 304 $\mu\mu$, for cholesterilene is not rendered active by irradiation.

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The Nebulium Spectrum in New Stars.

IN NATURE of Jan. 28, p. 136, Mr. S. R. Pike makes an objection to the density which I have found, by the 'expanding shell' theory for novæ, to be necessary for the production of the nebulium spectrum. Mr. Pike applies the formulæ of the theory of thermal ionisation and finds that it is inconsistent to have the spectra of hydrogen and nebulium present at the determined density and both existing under the same temperature. For coexistence of these substances, defined as 0·1 per cent. H atoms and 0·1 per cent. O^{++} atoms, he finds that a density of about 10^{-7} gm./c.c. is necessary, as against the density of about 10^{-17} gm./c.c. given by me.

I believe that the entire discrepancy is due to the inapplicability of the theory of thermal ionisation. This theory as developed assumes a condition of thermal equilibrium, and it does not seem possible that equilibrium would have been reached in a few days after the outburst of a nova. Also, one might expect that photoelectric ionisation would be an important factor, especially in considering gases of very low density near a hot star. Furthermore, Mr. Pike's arguments might be extended to the nebulæ as well as the nova shell, in which case one would expect densities of the same order of magnitude, about 10^{-7} gm./c.c. Such a density would be comparable with the mean density of the giant stars, and would indicate that the masses of the nebulæ are enormously greater than has been generally accepted.

It seems to me that a method for studying the coexistence of spectra in novæ would be similar to that followed by Milne (*Mon. Not. Roy. Ast. Soc.*, **84**, 354; 1924) in his study of the life of a Ca^{+} atom, and combining with it some additional suggestions given by Eddington (*Mon. Not. Roy. Ast. Soc.*, **88**, 134; Dec. 1927), where he shows that the dilution of the exciting radiation may account for the 'forbidden lines' of an atom being as strong as its ordinary lines. The problem is very difficult, as one knows nothing of the extreme ultra-violet radiation of novæ.

I should like to take this opportunity to correct a statement in my communication in NATURE of Jan. 7, p. 12. Referring to the coefficients of $\rho_0 r_0^2$ in the densities of the nova shells, it was stated that the constancy indicates that the novæ originate from stars of similar physical conditions. That statement can apply only to the radius of the star and the density of its atmosphere.

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Science Teaching in Schools.

IN NATURE of Feb. 25 appears a stimulating article by H. E. A. on "The Range of the Scientific Faculty," with most of which all interested in the pursuit of science will agree. In directing attention to the absence of scientific appreciation on the part of the literary man, a view so ably propounded by Sir Richard Gregory in his presidential address to the Science Masters' Association in January last, the author is performing a public service. Unfortunately, it is doubtful if NATURE, despite its literary charm, will find its way into the temples of those deficient in 'factor X.'

What, however, are we to say of H. E. A.'s indictment of the schools in the latter part of his article? He writes . . . "The teaching of science is a failure, because it is parrot work . . .; because it is so far beyond the common intelligence and the teacher's." Again, . . . "No attempt is made in the schools to teach the simplest elements of scientific method. . . ."

Surely H. E. A. cannot mean these statements to be taken seriously. If he does, we are entitled to ask where he has been hiding during the last twenty years. Has he fallen asleep like Rip van Winkle and just wakened up thinking things are still as when he commenced his slumbers?—and meanwhile the precious leaven of Armstrong's heuristic method has been at work with far-reaching effects on science teaching in the schools. Still more important, has he ever tried to teach in a modern school, and has he visited several of these much maligned institutions and seen the science masters at their work?

The brilliant young researchers at the National Physical Laboratory and kindred places, and those making good in the field of industry and in the fight against disease, drawn as they are from all types of secondary schools, are in themselves a tribute to the work of the science masters, who have been responsible for introducing them to the method of science.

The chief canon of scientific method is to make generalisations only when supported by overwhelming evidence.

Is it not as necessary for H. E. A. to be scientific in the full sense of the word when passing judgment on a section of the community as in expressing opinions regarding the effect of 'hydrone' in chemical combination?

E. NIGHTINGALE.

St. Albans, Mar. 3.

SEVERAL recent leading articles in NATURE have criticised the scope and character of science teaching in schools, and with much justification. In a leader in the issue of Feb. 25, two statements are made by H. E. A., namely: that

(1) "the schools say they are in the hands of the universities, whilst these retaliate that they are subject to the schools."

(2) "The Science Masters' Association has neglected great opportunities in the past half-dozen years of discussing the problems, when at Oxford and Cambridge, with the authorities."

Both these statements are true, and something should be done at the next meeting of the S.M.A. at Cambridge. A haphazard discussion is, however, useless. Definite proposals must be made, and if possible a select committee appointed to discuss them. NATURE, being almost the only authoritative journal read by dons and schoolmasters alike, could urge this most effectively.

Science masters may suggest, but they cannot act alone. The pace in the schools is set partly by the School and Higher Certificate Examinations, but principally by the entrance scholarship papers. No school can afford to ignore these without penalising its potential scholars. The same *impasse* has been reached as in disarmament conferences; all desire to reduce the standard, but each is afraid to begin.

How furious the pace is in the schools is not realisey by everyone, least of all perhaps by the university examiners. The School Certificate is a very elementary

examination; and it is right that it should be. A specialist course at most schools starts after the School Certificate has been obtained, or an equivalent standard reached, and lasts on an average for two years before the scholarship examination is taken. In this short space of time it is apparently thought desirable that an amount of knowledge should be imparted, which, if really digested, would certainly assure the candidate a first-class degree in natural science without any further preparation whatsoever. Looking through a few chemistry papers set recently at one group of Cambridge colleges, I find questions on the alloys of mercury and potassium, ionic transport numbers, the manufacture of lithopone, and the synthesis of dimethylacetic acid. Remember that at least two other subjects have to be taught as well, that practical work is involved, and that the school time-table will certainly include some study of literature and modern languages.

I submit that to set questions of this kind, and to talk in the same breath of the necessity of acquiring a sound grasp of scientific method (which would of course involve a considerable amount of historical work), imply either insincerity or a painful lack of imagination. Many science masters, it is true, do their best to impart method and principle, but they have to do so always with one eye on the clock. Certain examiners, again, are endeavouring to set questions which seek to probe the 'chemical sense' of examinees; but little advance can be made in this direction until some sort of agreement and uniformity are obtained. At present a really promising boy may be taught—on paper—the reactions of ethyl acetoacetate; he may remember (with luck) how to calculate a transport number; he may even, if he has worked very hard, be able to analyse successfully a mixture of sodium stannate, nickel chromate, and cobalt phosphate. But he will almost certainly be unable to bore a cork or to investigate a simple inorganic reaction unless he knows the answer beforehand; and he could not possibly explain the essential points of difference between the atomic theories of Dalton and Demokritos. Conversely, if he can do these things, he will be woefully ignorant of lithopone and the mercury-potassium alloys.

It is to be hoped that NATURE will not cease from castigating schools and universities until some return to sanity is effected; and that that return will come speedily, before our more progressive pedagogues start teaching quantum mechanics and stellar chemistry in anticipation of the scholarship papers of 1935.

A. K. GOARD.

Marlborough College,
Mar. 5.

No one could be better qualified than H. E. A. to write upon the value of a mind which combines scientific and literary gifts, for we all read his essays and discourses with interest and pleasure. I regret, therefore, that he should have dragged into his essay "The Range of the Scientific Faculty," which appeared in NATURE of Feb. 25, his well-known views upon the science teaching in universities and schools. He says, "The teaching of science in our schools is a failure, because it is parrot work, not scientific; because it is confined to special subjects—chiefly chemistry and physics—geology, botany, and biology being all but neglected."

I have formed the impression that H. E. A. objects strongly to deductions which are not derived from scientific observation and reached by scientific method. He says, "No attempt is made in the schools to teach the simplest elements of scientific method." Could H. E. A. give us the observations and facts on which his statements about the methods used and the subjects taught in schools are based? Would it be fair to ask him how many schools he has personally visited and inspected during the last five years? And is his opinion that the schools "are controlled by people who only know the old knowledge and are without understanding of scientific method" based on personal acquaintance with the heads of schools, or at least on first-hand knowledge of their methods? I am interested to know whether in making these statements he has conformed to his own canons of scientific method.

I cannot claim to have first-hand acquaintance with the work of more than a few schools, and I agree that our work in science could be improved by co-operation with the universities. But, lest a wrong impression of the work of schools should be left by H. E. A.'s remarks, I do think it fair to say that, to the work of some schools, H. E. A.'s statements do not apply, at least so far as the subjects taught and the aims sought are concerned. My own impression—which I cannot claim to be more than impression—is that H. E. A.'s generalisation upon the science work of schools and their heads at the present day fails to do them justice.

F. S. YOUNG.

The College, Bishop's Stortford,
Herts, Feb. 25.

MY cordial thanks are due to the writers of the above letters for their welcome support. The evidence I have of the general accuracy of my indictment is so overwhelming that I must ask that it be taken seriously. If anyone will tell me of schoolwork in progress anywhere to teach the elements of true scientific method, *as applied to ordinary life and to ourselves*, I shall endeavour to see it and be more than glad if I can report that there are exceptions that 'prove my rule,' showing that such teaching can be and is given. Probably I differ from most in my definition of 'scientific method' and shall not easily be satisfied. Reference is made to the heuristic method. Surely this was ruled out years ago, at least by Mr. Wells, as 'food unfit for the Gods,' because of the time needed to digest it. He has never found this, I judge.

I do not blame teachers in schools but the callous system which produces them and the immoral system under which they are forced to work. Nearly everywhere they are the tools of the class deficient in factor X. I particularly blame those who have taken the life and morality out of education and both professionalised and commercialised it from top to bottom. As factor X now governs the world, the class which has it not must be relegated to offices which it can hold with efficiency; we cannot with safety remain much longer under the governance of ignorance. The late President Woodrow Wilson seems to have been an outstanding example of the class. From his "Biography" it is clear that he all but went out of his way to avoid reading anything which would have informed him of the modern advance of knowledge. We need not wonder that we were led into such quandary at Versailles.

My desire was not to direct attention to the absence of scientific appreciation from the literary man. Considering his inborn limitations, he is a good enough, companionable fellow in his way, far more so generally than he who is bitten with the scientific afflatus. My essential contention is, that he is an ear out of which the purse embracing 'science' contemplated by Sir Richard Gregory cannot be made. In the epilogue to Vol. 2 of Sir Sydney Lee's Biography of our late King Edward, we are told—"Literature

and science he could not appreciate. . . . *Son métier était Roi.*" So it is with most of us—each of us has his inborn *métier* and must cultivate his own special garden with its peculiar soil. Sowing words, the literary can only reap words.

The chief point I desire to make is, that the body scientific has its fate in its own hands and must be trained to do its own literary work. Frenchmen show us that this is possible. Our Royal Society *Proceedings*, at the present moment, are standing proof that the oncoming generation, especially that raised at the ancient universities, has not yet 'learned the trick' of sane and satisfactory expression. It indulges in fatuous futilities of language which cannot be rationally construed. The practice would be of small consequence were it not that the use of an ill-conceived jargon by scientific workers is producing an ever-widening breach, not only between us and our literary brethren and the public but also within our own ranks. Unfortunately, those who thoughtlessly so misdemean are thereby aiming at inclusion within the Society—once within its ranks they will but spread the disease. On the other hand, a secretary of the Society can entrance an audience with a polished rhapsody upon 'Candle-ends,' whilst his rival at Cambridge outvies him in declaiming the merits of their Snarkian variant, 'Toasted cheese'; he is even acclaimed of *The Times Literary Supplement*, because of the perfection of the language in which he depicts the vagaries of the fully stripped proton (sex undetermined) in presence of a crowded following of loose electrons. Sir J. J. Thomson, in like manner, can thrill the young things at Girton with an account of the new shingled electron and its waved front.

Such is the power of words—owing to this high-brow advocacy, Candle-ends, Toasted-cheese and Electrons, shared and unshared, shingled and unshingled, are now made the standard diet of the schools. Meanwhile, the boy leaves unable to bore a cork and with no proper regard for energy, for water, for air, for coal, for food, let alone his own body. *Moral*: in attempting in schools to teach what we are pleased to call science, we must also give training in the art of simple direct expression; only in this way can proof be given that what is learnt *is* learnt. Does any teacher anywhere do this? They all say 'there isn't time.' At least, we might seek to rank with the notable profession of bath-chair propellers, who are notorious, we have been told recently, for their literary tastes.

It is imperative that the schools and the universities now discuss the problem of examinations together. A beginning should be made at the next meeting of the Science Masters' Association at Cambridge. As a past-president, if the Association will so charge me, I am willing to undertake to present a considered report upon the situation, to include constructive proposals, if possible. Such a report might serve as the basis of a general discussion. A beginning must be made somewhere and by someone, if we are ever to secure an efficient scientific service in the schools. The decision should be made forthwith, as the task of preparation will be a long and difficult one.

H. E. A.

The Nature and Function of Golgi Bodies.

IN the *Proceedings of the Royal Society*, B, vol. 97, 1924, is a paper by Prof. Subba Rau, Dr. Rogers Brambell, and myself, entitled "Observations on the Golgi Bodies in the Living Cell." In this paper (unnoticed by Prof. Walker) we have given photomicrographs of the Golgi apparatus in living and stained cells. More than this we cannot do, except to ask those zoologists and physiologists who may be interested in this problem to read this paper and to examine the material we have used ourselves.

With regard to Dr. Ludford's letter in NATURE of Feb. 4, p. 169, I might point out that Golgi bodies are visible not only in molluscs, but also in annelids. In the ovary of the common earthworm both mitochondria and Golgi bodies can be followed throughout oogenesis, in freshly dissected ovaries, untreated by stain or fixative (Gatenby and Vishwa Nath, *Quart. Jour. Micr. Sci.*, vol. 70, Part III. Sept. 1926).

Prof. Walker in his latest letter (NATURE, Feb. 25, p. 279), as well as in his former ones to NATURE, takes the view that because certain emulsions treated by modern cytological techniques reveal objects resembling Golgi bodies, therefore the latter are artefacts. This is a curious position to take up, especially in view of the fact that in his last letter Prof. Walker shows that he has not examined Helix ovotestis cells. As a matter of common knowledge to all cytologists who have taken the trouble to examine such cells, the *nebenkern* batonettes (Golgi bodies) and mitochondria alone show well in fresh cells, the archoplasm being too transparent to be seen easily. This fact is proven by the paper of Rau, Brambell, and myself, by means of photomicrographs of dead and living cells, and can be confirmed by any student of microscopy who cares to examine snail spermatocytes, fresh, stained in Janus Green or Dahlia, or treated by any of the modern techniques for the cytoplasmic inclusions.

Now Prof. Walker's original position was that *both categories of cytoplasmic inclusions are artefacts.* In his printed paper he merely claims that the Golgi bodies alone are artefacts. But how does he explain the fact that with the technique upon which every modern text-book account of spermatogenesis is based, *both mitochondria and Golgi bodies appear constantly side by side*? The technique I refer to is chrome-osmium iron hæmatoxylin, with which almost all the work of Bowen in America, Schütz in Russia and Switzerland, and Hirschler in Poland, was done, and which the British cytologists have used constantly. This technique is merely the old Flemming and iron hæmatoxylin with the acetic acid left out or much reduced (Meves' fluid). How does Prof. Walker explain this fact? How could the Golgi bodies be artefacts if the mitochondria are not also?

How does Prof. Walker explain away the following fact? If one takes a fresh preparation of snail cells, and runs chrome-osmium fluid under the cover-slip, one can see the Golgi bodies and mitochondria being fixed *in situ* and in the light of day. The subsequent staining in iron hæmatoxylin merely blackens the same bodies one saw *intra vitam*. Will Prof. Walker explain where the catch comes in? Has he tried this experiment himself?

How does Prof. Walker explain the following fact? Take any tissue, from invertebrate or vertebrate, fix and stain by a Golgi apparatus method, and if the method has been used properly, a Golgi apparatus always appears in the same place in the same kind of cells. It is *not* a matter of a precipitate here or a precipitate there, haphazard. How then does Prof. Walker explain the constancy of position of these Golgi bodies in given cells?

Will Prof. Walker explain the following fact? Golgi bodies have been described by workers in every civilised country, *from all orders of animals.* The work of Bowen on plants brings the latter into line with animals. Will Prof. Walker say that all this work is incorrect? Prof. Walker has criticised modern cytological technique. Will Prof. Walker explain at what step the artefacts are produced, and

indicate a technique which he considers better? Is it corrosive acetic or Bouin's fluid, or is it Carnoy?

Was the Moore and Walker paper on mammalian spermatogenesis ("Liverpool Cancer Report," 1906) done with a better technique than we have to-day? I think not! The cells described and drawn by those workers are merely wrecked skeletons of their former selves! The proteid structures are twisted and distorted, and there is scarcely any lipoid left in the cells.

Now it would be regrettable if anyone, zoologist or non-zoologist, were to entertain the idea that Prof. Walker has any support from cytologists. His views, so far as modern cytology goes, are unique. They will remain unique as time goes on, for modern cytological technique is logical and takes into account our biochemical knowledge of the solubilities of lipoids and other subtle cell bodies. We can explain every step in what we do. We get results which agree with the intra-vital appearance of the cell, and it is unlikely that further gross improvements in cytological technique will be made. J. Brontë Gatenby.

Trinity College, Dublin, Feb. 28.

Certain of Prof. Walker's assumptions (Nature, Feb. 25, p. 279) are opposed to direct observation. Thus his idea that the archoplasmic vesicles and Golgi bodies are one and the same thing is quite untenable in the light of recent work (see J. Hirschler, *C.R. Soc. Biol.*, **98**, No. 2, 145-6; 1928).

Prof. Walker has ignored one significant feature, that in many cells, for example, gland cells, the Golgi apparatus occupies a definite position between the nucleus and the lumen. When the gland is stimulated to activity the Golgi apparatus enlarges, while still retaining its relative position with regard to the nucleus. That is to say, we have within the cytoplasm a specific area capable of precise experimental modification. On the basis of Prof. Walker's own views, one would have to assume that the lipins of the cell are collected in this specialised area. It is this part of the cytoplasm that is called the Golgi apparatus. R. J. Ludford.

Laboratory of the Imperial Cancer Research Fund, Queen Square, London.

James Gregory, John Collins, and some early Scientific Instruments.

Dr. R. T. Gunther has described (*Archæologia*, vol. 76, p. 273) scientific instruments belonging to the University of St. Andrews which were exhibited in the Lewis Evans Collection at the Oxford meeting of the British Association. The St. Andrews instruments include the two-foot astrolabe by Humphrey Cole, dated 1575, "the finest extant Elizabethan scientific instrument"; an armillary sphere, also by Cole, 1582; an old Dutch or Flemish circumferentor; and a sea-astrolabe, or mariner's astrolabe, with one quadrant divided diagonally, inscribed "Elias Allen Fecit 1616."

Ever since Dr. Gunther directed attention to the value of these instruments, I have been puzzled to account for the way in which they came into the possession of the University. Facts have recently emerged which go far to establish the theory that they were purchased by James Gregory, the inventor of the Gregorian telescope, in 1673. A Commission from the University authorities "to Mr. James Gregorie, Professor of Mathematics," dated June 10, 1673, empowers him to select and buy "such instruments and utensils as he with advice of other skilful persons shall judge most necessary and usefull for the above-mentioned design" [providing ane observatory]. An interesting sidelight on this episode is afforded by an extract from the Burgh Records of Aberdeen for Oct. 15, 1673, from which it appears that "seeing the said professor was ane town's man heir . . . the councell . . . appoynts ane collectione to be at the Kirk dores . . . the nixt or subsequent Lord's day for the forsaid effect [for the Observatorie at Saint Andrews]."

In a letter to Collins, dated Feb. 15, 1669, Gregory had asked for a divided quadrant and a brazen sector, and in letters written in 1672 and 1673 he speaks of visiting Collins in connexion with the purchase of mathematical instruments. In a letter from Newton to Collins, Sept. 17, 1673, the former writes: "I understand that Mr. Gregory is at London, and intends to make Cambridge in his way into Scotland" (Rigaud, "Corr. of Scientific Men," vol. 2). On April 30, 1674, Gregory writes to Rev. Colin Campbell: "It wer tedious to write down particularlie all the instruments I have brought home, yea a larger letter would not contein all ther names and sizes, for I have of all sort: our largest quadrant is of oak, covered with brasse, 4 foot in radius and actually divided in minutes, of which we can judge $\frac{1}{4}$ or $\frac{1}{5}$: we have two semi-sextans, all of brasse, 6 foot in radius, diagonally divided, in which we can judge $\frac{1}{6}$ or $\frac{1}{7}$ of a minut: our largest telescope is 24 foot long; which magnifys one dimension of the object 100 times" ("Archæologia Scotica," vol. 3, p. 275, 1831). Gregory says: "the instruments ar keeped in the bibliotheck," but of those mentioned there is now no trace, although Gregory's clock is still in the University Library and through the building passes a meridian line which he constructed.

The observatory at St. Andrews never materialised, and in 1674 Gregory received a call to the College of Edinburgh, which he accepted. He died suddenly before he had been a year in his new home.

The suggestion that the Cole astrolabe was purchased by Gregory during his visit to Collins is supported by the fact that the instrument of 1575 is accompanied by a tablet inscribed "John Marke fecit lat. 56° 25′." Dr. Gunther remarks that John Marke flourished about 1668 at the sign of the Golden Ball, near Somerset House, where he sold Collins's quadrants of paper gummed on plates of copper and varnished (*Phil. Trans.*, 1668). The latitude of St. Andrews is actually 56° 20′, but it is doubtful whether Gregory had instruments for an accurate determination before his visit to London. Even after his return he writes, "the latitude here is 56° 22′."

I take this opportunity of correcting a mistake in my article in Nature of Feb. 18, p. 238, to which my attention has been directed by a correspondent. Relying upon A. G. Stewart's "Academic Gregories" (p. 28), Collins was referred to as a secretary to the Royal Society. He was elected a fellow of the Society on Oct. 24, 1667, but was never secretary.

H. S. Allen.

The University, St. Andrews.

Prof. Stanley Allen has put forward a very satisfactory working hypothesis to account for the presence of these early English instruments at St. Andrews. The additional plate supplied by John Marke proves that the Cole astrolabe was in the hands of this eminent maker in London about the time when Prof. Gregory was collecting scientific instruments there. May I add that the finest picture of Cole's great astrolabe was published in colour in the *Illustrated London News* for Aug. 14, 1926.

R. T. Gunther.

The Old Ashmolean, Oxford.

Light and Sight.

IN a recent number of NATURE (Jan. 21, p. 95), Sir John Parsons, referring to the duplicity theory of vision, says without qualification that the "rods are responsible for scotopic, the cones chiefly for photopic vision," though he later refers to 'difficulties' in this formulation.

Current theories of colour vision may be divided into two groups: Young-Helmholtz (three-colour processes, all positive) and Hering (two-colour processes, with positive and negative conditions, and white). The first logically leads to a postulate of three photopic light-sensitive pigments, and a fourth for scotopic vision.[1] Following this scheme, it is logical to assign the four pigments each to a separate series of organs, and to assign scotopic vision to the rods, which alone have been recognised as possessing the scotopic pigment. The photopic pigments should be present in such minute amounts as to be undetectable with our present crude methods.

The Hering theory, with its negative as well as positive colour-processes and its double maximum for the red process, leads as naturally to some physical (refraction, interference or diffraction) separation of the colours, and a single, indifferent photopic pigment is sufficient (the same which any theory seems to demand for the peripheral retina). In this case there is no obvious reason why the two pigments, photopic and scotopic, should coincide in distribution with the presence or absence of the special structures leading to colour separation, and Sir John Parsons's statement is no longer obvious.

In fact, the existence of an acute colour sense in the middle range of adaptation[2] (that of ordinary lamp-light), where the rapidity of adaptation shows that the scotopic pigment is functioning, seems incapable of explanation unless this independence is assumed. Under the Helmholtz theory, the colour-processes, being dependent quantitatively on the minute surviving amount of photopic pigment, should be completely overshadowed by the ten or a hundred times greater activity of the 'rods.'

I have recently worked out in some detail a hypothetical separation of the colour-sorting and photosensitive processes on this basis of independence, with a physical basis (interference) for one and a chemical (photosensitive pigment) for the other (*American Journal of Psychology*, **40**, 1-25; 1928).

As to the foveal 'cones,' it should be noted that they are really organs of intermediate character, at least in the monkey and man, and could just as well be interpreted as modified *rods*.

WM. T. M. FORBES.

Cornell University, Ithaca, N.Y., U.S.A.

[1] It is necessary to assume for the peripheral retina either a fifth pigment or an equal mixture of the three colour pigments in the individual rods.

[2] I propose to call this middle range of adaptation 'mesopic.' Most experimental work is done within it, but may be reported either as 'photopic' or 'scotopic,' causing much confusion of interpretation.

The 'Dative' Chemical Bond.

WAVE mechanics notwithstanding, the electronic conception of valence in chemistry is serving a useful purpose. It is true that we know little in regard to what we symbolise by a shared pair of electrons, but even less was ever known of the inner meaning of the single bond of organic chemistry, although nobody would deny that the conception of such a bond has been a useful one.

In recent years, a clear distinction has been drawn between two types of co-valence involving a pair of electrons shared by the atoms *A* and *B*. In the first type, 'normal' co-valence, each of the two atoms contributes one of the two electrons. In the second type, one of the two atoms, say *A*, contributes both electrons. Since *B* gains a share in the pair, it gains in negative charge; while *A* loses in negative or gains in positive charge. Because of this separation of charges, the molecule is rendered polar.

Various names have been suggested for the second type of co-valence here described. So long as the conception remains a useful one, by all means let us have a good name for it. One of the earliest names, suggested in 1921 by Perkins in the *Philippine Journal of Science*, was a 'borrowing direct union.' Lowry proposed the names 'mixed' or 'ionised' double bonds, because the union partook of the nature of electro-valence as well as of co-valence. These names have been adversely criticised by Porter, Rankine, and others. Sugden in 1925 proposed the term 'semipolar double bond,' which is perhaps unduly polysyllabic. Realising that none of these names is entirely satisfactory, Sidgwick called this type of bond the 'co-ordinate' link or bond. But this is apt to lead to confusion, in such a typical case, for example, as the following. In considering the compound $[Co\,Cl(NH_3)_5]Cl_2$, chemists now universally follow Werner's usage and speak of the chlorine and the five ammonia molecules within the square bracket as being co-ordinated with the central cobalt atom. But of these six co-ordinated entities, only five are attached by 'co-ordinate' links.

Adopting a useful terminology, Sidgwick has called the atom *A* above a 'donor' and the atom *B* an 'acceptor' atom. To this it cannot be objected that the names savour overmuch of electro-valence, where one electron is given and taken, for the second type of co-valence has indeed a close analogy to electro-valence, and this may rightly be indicated in the nomenclature. In consonance with this idea, I wish to suggest that the second type of co-valence bond described above be called a 'dative' bond or link. 'Dative' is a short word, and unspoiled by previous usage in chemistry.

ALAN W. C. MENZIES.

Princeton University, Feb. 4.

Luminescence of Mercurous Chloride of Standard Purity.

ON studying the photochemical changes of a pure and dry mercurous chloride, prepared in a dark room, a greenish-white luminescence was observed when this was stirred by a dry glass rod. This phenomenon was noticed in glass, porcelain, and metallic crucibles for about five seconds, and it was not possible to produce it with the same rod again unless the rod was cleaned of its deposit of mercurous chloride powder. The luminescence was produced also for about the same length of time if the rod itself with its thin mercurous chloride cover was slightly rubbed with a dry cloth. The foregoing illumination of the sample has no effect on the duration and quality of the excited light.

The experiments so far made show that the dryness of the sample treated plays an important rôle in the intensity and the duration of the phenomenon described. On the other hand, one could not increase the duration of scintillation, although all traces of water and other impurities were most carefully excluded both in preparation of the chloride used and during the operation with it.

So far as could be proved, the phenomenon observed is not caused by electric charge produced by rubbing, nor is it a case of phosphorescence or crystalo-luminescence, since it is affected neither by a previous illumination nor by a perfect pulverising.

The details will be published elsewhere after the experiments have been completed.

J. KŘEPELKA.

The Institute of Inorganic Chemistry,
Charles University, Prague, Feb. 22.

The New Science Museum.

THE Science Museum, which is the national museum of science and industry in Great Britain, dates from 1856, when the various collections which had been acquired by the Royal Commission of the Exhibition of 1851 for the purpose of illustrating the application of science and art to industry were brought together and arranged for exhibition at South Kensington. The exhibition so formed was housed in temporary buildings and was known as the South Kensington Museum, which title it retained for more than half a century. In 1909, that part of the collections pertaining to art was transferred to the newly constructed Victoria and Albert Museum, and the science collections which remained were brought under a separate administration. The Science Museum from that time ceased to be a purely departmental institution and became a national one; its new aspect was emphasised by a Departmental Committee, which reported in 1911 and 1912 on its scope and aims, recommending the erection of new buildings to provide a very considerable addition to the area of the exhibition galleries. The erection of the first block of the new buildings was begun in 1912, but, owing to the War, its completion was indefinitely postponed and the development of the collections was retarded. This portion, the Eastern Block, has, however, now been completed and was opened by His Majesty the King on Mar. 20.

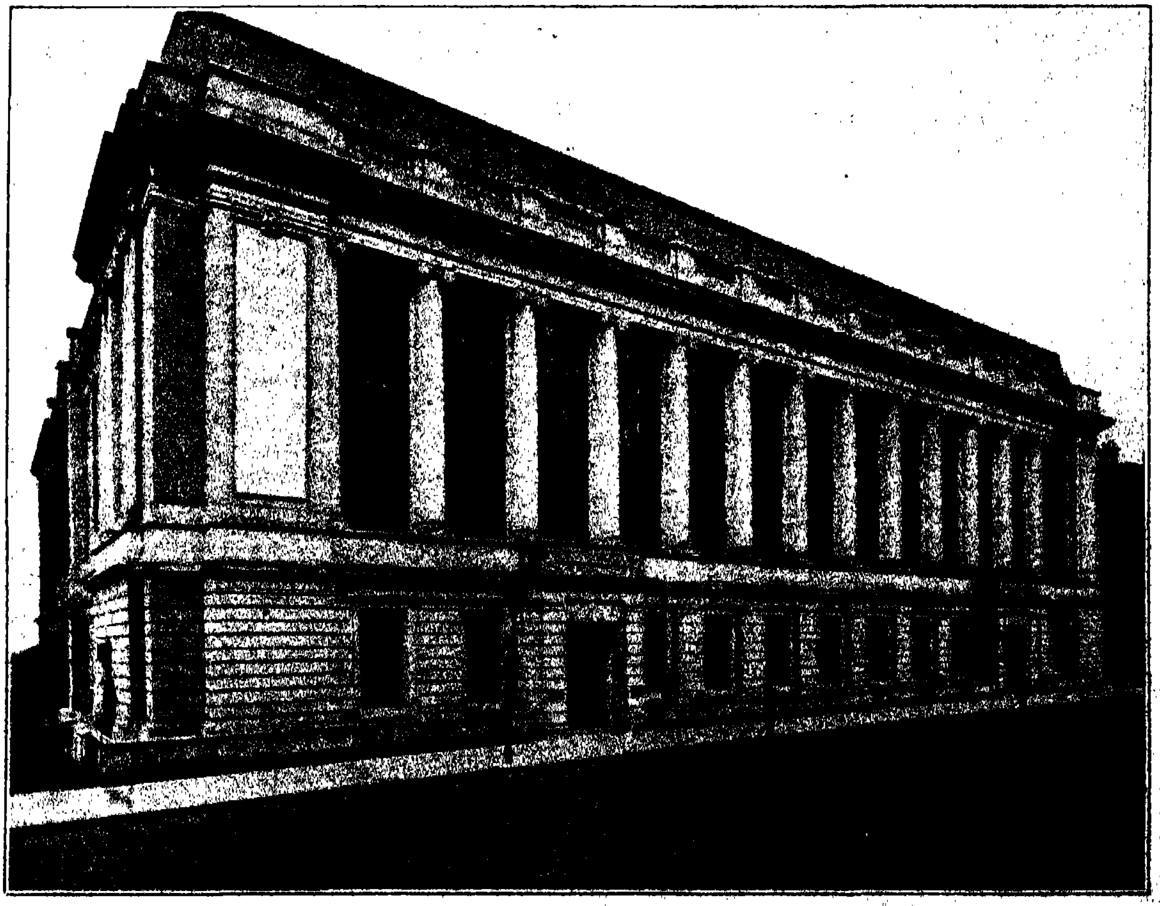

FIG. 1.—New buildings of the Science Museum, South Kensington. East block, from Exhibition Road.

The main object of the Museum is to illustrate science and the application of science to industry, and for this purpose the collections are grouped broadly under four divisions: (1) Industrial engineering; (2) stationary engines and land transport; (3) water transport and air transport; (4) science and scientific apparatus. This classification (and that of the many groups within these divisions) is not strictly logical, but is determined largely by the conditions of space and by the history of past development, and will be subject to revision when that is possible. In the various groups or sections development takes place in accordance with a system introduced by the present Director, Sir Henry Lyons, which provides approved schemes of development to include a historical series of critically selected objects which will illustrate the most important stages in the past development, and also a series illustrating current practice. Without some such clear plan, museum collections tend to become ill-balanced, some parts being over-represented and

others comparatively neglected. The historical series changes but slowly, and should contain all objects of enduring importance ; in the representation of current practice the objects are of necessity changed frequently, being replaced by newer or more efficient examples as these are produced. In this way it is possible to maintain the collections representative in character without their becoming unmanageable in size.

The objects forming the collections are obtained by gifts, loans, purchases, or by construction in the Museum workshops. During recent years the number of acquisitions annually has been from about 1200 to 1500, and of these 90 per cent. are gifts and loans. The funds allotted for the purchase of objects are only £800 per annum, so that the number of exhibits thus acquired is small. A descriptive label, which gives both a general and a technical description of the exhibit, is placed with every object, and illustrated catalogues of the various sections are published. Models, apparatus, and machinery are shown in motion whenever this is practicable ; in many cases exhibits are sectioned in order that the internal construction may be seen. The collections of the Science Museum are very rich in examples of original historical apparatus ; they contain full-sized machinery and apparatus whenever possible, and accurately executed scale models when space must be restricted.

The new building has galleries providing an exhibition area of approximately 143,000 square feet —a little more than one-third of the area recommended as ultimately necessary—a main entrance hall, demonstration rooms, offices, workshops, and stores. The exterior is in Renaissance style, while the interior is simple and devoid of ornamentation, giving a suitable setting for the exhibition of machinery and scientific apparatus. Particular attention has been paid in the design to the special needs of the Science Museum ; the average ratio of glass to floor area is about 1 : 4, excluding glass roofs, and the floors are provided with an elaborate system of ducts which accommodates the lighting, gas, and compressed air mains, and enables the power necessary for operating models, etc., to be available readily.

The main entrance in Exhibition Road opens direct into a reception hall from which access is given immediately into a top-lit lighting hall 120 feet long and 40 feet wide, roofed at third-floor level and bounded on all sides by other exhibition galleries. This hall is devoted normally to stationary engines, and contains, among many historical exhibits, three of the original engines designed by James Watt. The important inventions of Richard Trevithick in the development of the high-pressure engine are well represented, but the collection covers the whole period from the primitive application of animal power, wind and water wheels, to the modern steam turbine and internal combustion engine.

A roof-lit gallery adjacent is devoted to railway engineering generally, and contains a very representative series of models illustrating many types of locomotive engines as well as the original *Puffing Billy*, *The Rocket*, and other historical engines. At the west end of this gallery is a reproduction of James Watt's attic workshop, in which at Heathfield, Birmingham, he did experimental work on sculpture-copying machinery during the latter years of his life. The contents are placed exactly as they were left by him at the time of his death in 1819.

Another gallery on the ground floor accommodates the aeronautical collection, which includes, among several historical machines, the original Wright aeroplane of 1903—the first man-carrying aeroplane to make a free flight under power—and the Vickers-Vimy trans-Atlantic aeroplane of 1919. A series of more than one hundred models illustrates the development of lighter-than-air and heavier-than-air craft up to the present day, and the progress made in aero-engine design is adequately shown.

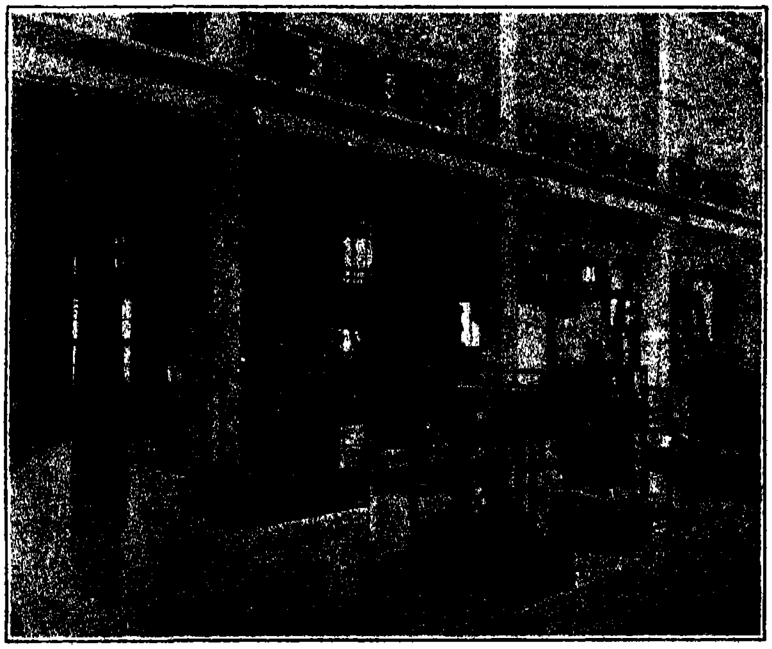

FIG. 2.—Stationary engines and prime movers.

The collections illustrating electrical engineering, electrical communication, hand tools and machine tools, mining and metallurgy, textile machinery, and a part of ship construction are shown in the first-floor galleries. In electrical engineering there is a valuable collection of early dynamos and electrical machinery, with examples of modern practice. A modern automatic telephone exchange system is arranged for demonstration and may be operated by the public. A receiver for radio telephony is

arranged also for operation in order to demonstrate modern distortionless reproduction. In the hand and machine tool collection the development of some of the more common tools is shown from the earliest civilisations down to the present day. Textile machinery is represented by some very valuable original machines made by Arkwright, replicas of Hargreaves' spinning jenny and Crompton's mule, with models and actual machines showing the various stages in spinning and weaving.

The Eastern Gallery on the first floor contains a historical series of models tracing the development of the sailing ship from the Viking long-ships to the great three-deck sailing ships of the Crimea War on the naval side, and to the Australian wool-clippers on the mercantile side. Many of the models are contemporary, such as that of H.M.S. *Prince* (1670), and have been made in the actual yards when the ships were built. Another series of models shown here illustrates, in considerable detail, the development of the armoured battleship from H.M.S. *Warrior* of 1861 up to the super-Dreadnought, H.M.S. *Monarch* of 1912, while sectioned models show advances made in internal construction.

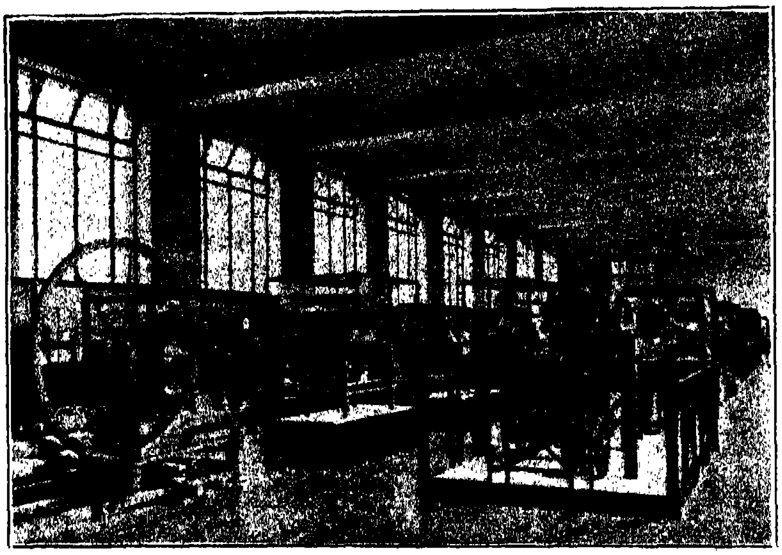

FIG. 3.—Textile machinery.

The corresponding gallery on the second floor contains a series which illustrates the development of the merchant steamship from its infancy to the present day. A particularly fine series of Cunard models shows the growth and improvements of Atlantic liners, while cargo vessels, tank steamers, and their special systems of construction are well represented. The Eastern Gallery on the third floor is devoted to a collection of small craft from all parts of the world, and it gives special facilities for the study of the results produced both by race and environment. The various types of fishing vessels peculiar to the different portions of the British coasts, and now fast disappearing, are illustrated by some models, most of which are at least forty years old. Junks and sampans from China and from Japan, Arabian dhows and dahabias from the Nile, are well represented, while a collection of yacht models traces the development from the Dutch yachts of Stuart times and the pilot cutters of the early nineteenth century to the highly specialised racing yachts of to-day.

Other collections to be found on returning to the second floor are those illustrating meteorology, geophysics, electrical instruments, mathematical instruments, time measurements, pumping machinery, and building construction. In meteorology the development of the various meteorological instruments is shown in a historical series, and the method of computing and producing the daily weather reports of the Meteorological Office is illustrated. The group illustrating geophysics, including atmospheric electricity, terrestrial magnetism, seismology and gravity, is represented by instruments ranging from Choko's seismoscope of A.D. 132 to the modern Milne-Shaw seismograph and the latest models of the Eötvös torsion balance.

The section relating to time measurement includes examples of water-clocks, sundials, clocks, watches, and chronometers, ranging in period from the time-measuring devices of ancient Egypt to modern systems of electric clocks. Of special interest are the representations of a water clock from Karnak of about 1400 B.C. and an Egyptian shadow clock of the tenth to eighth centuries B.C., also the fourteenth century turret clock from Dover Castle. The second of John Harrison's four chronometers, the performance of the last of which obtained the award offered by the British Government for a method of determining longitude, is also shown here.

The third-floor galleries contain the collections illustrating chemistry and industrial chemistry, geography, geodesy and surveying, optical instruments and astronomy. A large gallery adjoining the reception hall, with an entrance direct to Exhibition Road, has been allotted for special temporary exhibitions such as those illustrating the results of current scientific research which have been contributed in the past by the various research associations and have proved of considerable interest. At present this gallery contains the King George III. collection of scientific instruments which was formed during the latter half of the eighteenth century and located in the King's Private Observatory at Richmond until 1841. This collection forms an interesting and valuable record of the state of instrument design and development at that period, and includes instruments intended for serious scientific research in astronomy, electricity, and mechanics, as well as apparatus devised purely for instructional purposes.

Obituary.

Sir Aubrey Strahan, K.B.E., F.R.S.

On Mar. 4 Sir Aubrey Strahan died at the age of seventy-five at his house, Fairfield, Goring, Berks, which had been his residence since his retirement from the directorship of the Geological Survey of Great Britain and the Museum of Practical Geology in July 1920. He had been in fairly good health up to within a few days of his death, and took an active interest in local public affairs, and was a member of the Court of the University of Reading.

Sir Aubrey Strahan was the son of Mr. William Strahan of Blackmore Hall, Sidmouth, and was born on April 20, 1852. He was educated at Eton, where he went in 1865 to the Rev. Herbert Snow's house. In 1870 he entered St. John's College, Cambridge, and took his honours degree in natural science in 1874. His experience at Cambridge moulded the course of his future life, for he was associated with a group of students under Sedgwick, McKenny Hughes, and Bonney, destined to attain great distinction as geologists. Among his friends of those years may be mentioned Teall, Marr, Sollas, and Clough. In 1875 he joined the Geological Survey of Great Britain as an assistant geologist, and in that service he continued for the rest of his active life, ascending through every grade until he became director in 1914. His early work was done in the coalfields of North Wales and in the Isle of Wight, and his interests were principally in Secondary and Carboniferous rocks: all his work was done with painstaking thoroughness and has well stood the test of time.

Strahan was a geologist of sound judgment, little disposed to speculation or hypothesis. His great merits as an authority on coalfield geology received recognition in 1903, when he was appointed a member of the Royal Commission on Coal Supplies. He was one of the most valuable members of that Commission, which produced a report of the greatest permanent value, such as no other country than Great Britain possesses. Since 1897 Strahan had been in charge of the revision of the maps of the South Wales coalfield, which were old and unsatisfactory. This work occupied his attention for nearly twenty years and resulted in the production of a complete series of memoirs, one-inch and six-inch maps of that coalfield, which are recognised as being of a very high standard. With Dr. William Pollard he also produced a memoir on the coals of South Wales, discussing the causes of anthracitisation, which has attracted much attention.

In January 1914, on the retirement of Sir Jethro Teall, Strahan was appointed director of the Geological Survey. Very soon thereafter the country became involved in the War, and the whole of his energies were absorbed in the task of supplying geological information for civil and military purposes. He prepared and issued maps of the Belgian war zone, and undertook a great variety of tasks, both personally and through his staff, in connexion with active operations on all the fronts. In addition to this, the demands for home sources of minerals for industry became very urgent. The staff was greatly depleted by the departure of geologists on active service, but Strahan organised a bureau of information which gradually increased its activities until it took in every part of the field of British economic geology and extended also to many of the Dominions and allied countries. The result of this work afterwards appeared in a series of special reports on the mineral resources of Great Britain, which now comprises thirty volumes and contains accurate descriptions of practically every useful source of economic minerals in Great Britain.

During and after the War, Strahan served on many departmental committees and was much consulted in reference to problems of reconstruction and the development of research in connexion with industry. He aided in the reorganisation of the Geological Survey which resulted from its transference to the Department of Scientific and Industrial Research in 1919, and placed the institution on a much more satisfactory basis.

The maps and memoirs which Strahan prepared in collaboration with his colleagues are far too numerous to mention individually. Among the more important may be cited the memoirs on Chester, Rhyl, Flint, Isle of Purbeck and Weymouth, and the series on the South Wales Coalfield. He was very specially interested in the problem of buried or concealed coalfields in the south-east of England. Several important papers from his pen have appeared in the *Quarterly Journal of the Geological Society of London*.

Among the honours conferred on Strahan were the fellowship of the Royal Society (1903), president of the geological section of the British Association (1904), vice-president of the International Geological Congress (1913), president of the Geological Society of London (1913-14), and the Wollaston medal (1919). He took the degree of Sc.D. at Cambridge in 1907 and was created K.B.E. in 1919.

The distinguishing characteristics of Strahan's personality were his thoroughness and his trustworthiness. His opinions on all questions of geology were given with caution and were very highly valued. The conclusions he arrived at were always founded on very elaborate investigation. Although he did not shun speculation, he was averse to brilliant and elusive hypotheses. He had great charm of manner, and his friendship was much prized. In addition to this he had a shrewd judgment of men and excellent business capacity; these qualities made him a Civil Servant of outstanding distinction, and coupled with an intense love of geological work and a wide knowledge of British geology, they raised him to the highest position in the Geological Survey.

J. S. F.

News and Views.

Dr. Jeans's recent lecture before the Royal Society of Arts, which forms our Supplement this week, affords one more example of its author's remarkable power of presenting the results of the most recondite astronomical research in intelligible and exceedingly interesting language. No one has contributed more conspicuously to the impressive story which it unfolds than Dr. Jeans himself, and the secret of his success, both in investigation and exposition, can be traced in no small measure to the fact that he never loses sight of the universe while examining the stars. He has learnt, as every astronomer and physicist must ultimately do, to think cosmically. It is an awe-inspiring tale he tells, and one which tends to escape critical appreciation by the reason, by virtue of its overpowering effect on the imagination, unless one is careful to repeat to oneself over and over again the warning that " our three-days-old infant cannot be very confident of any interpretation it puts on a universe which it only discovered a minute or two ago." This necessary corrective to our enthusiasm might well receive greater emphasis without risk of chasing the impassioned expression from the countenance of the most poetical of the sciences. There is a danger that the charm and artistic completeness of Dr. Jeans's exposition should cause readers to invest his remarks with a finality which his own intellectual control would not allow him to claim for them. It must be borne in mind that the 'immortal moment' to which he refers is not necessarily the moment of glimpsing immortal truth. A child has two immortal moments—one when he first beholds the sea, and another when he reads "Treasure Island." It is perhaps an open question which is the more worthy of comparison with the present outlook in cosmogony.

Sir Oliver Lodge, on the occasion of Dr. Jeans's lecture, directed attention to the most striking deficiency of our present views, in asking what becomes of the radiation which the stars are continually pouring into space. In the last few ticks of the clock we have learnt where the radiation may come from, but no one has yet been able to hazard even a plausible guess as to where it goes, or is destined to go, in a possibly finite space. Our ignorance on this point may well make us doubtful whether we have yet begun to understand the universe. Can we really say we have begun to understand geography if we have learnt where a river may rise, but remain unaware of the existence of the sea? Dr. Jeans's figures lead to the conclusion that the mass-equivalent of the radiation already discharged must far exceed the total mass of matter now existing as stars and nebulæ. We therefore know nothing of the greater part of the substance of the physical universe. If we have cause for congratulation, it is that we can now realise more clearly than before how inadequately our present conceptions represent reality. That is a great advance—perhaps an essential part of every advance the human mind is capable of making—and the considerations which Dr. Jeans has brought before us contribute substantially to intellectual progress when judged by this standard.

In January 1927 the Australian Development and Migration Commission submitted to the British Government a scheme for a geophysical survey of certain parts of Australia. This scheme was referred by Mr. Amery to the Empire Marketing Board, which invited the Committee of Civil Research to set up a sub-committee to investigate the proposal. Appointed in April last, the sub-committee presented a report which was approved by the Committee of Civil Research in July; the Empire Marketing Board then arranged with the Australian Government to finance the scheme jointly, by equal contributions up to £16,000 each, spread over two years. Already by November last the leader of the survey party had been chosen, namely, Mr. A. Broughton Edge. The report of the sub-committee has recently been issued, under date November 1927, though for press purposes it was ' released ' only in February 1928. The report is a valuable and important document, and in the short space of 15 pages indicates where and to what extent geophysical methods of surveying have been employed for economic purposes, what are the principal methods that have been successfully used, with their range of usefulness, and what recent advances in method have been made.

Geophysical surveying methods depend on properties which can be detected without direct access; the chief of these are gravity, electrical conductivity, intensity of magnetisation, and elasticity. They may be used directly to ascertain the presence of bodies of ore which themselves produce measurable effects at the surface, or indirectly in cases where such effects, though not caused by the bodies sought for, are produced by other underground substances usually associated with those bodies. The indirect method has an important application to the location of oil deposits, which appear to be associated with salt-domes, the location of which can be determined directly by geophysical means. The development of such methods has occurred mainly since the War, stimulated by the increasing possibility of working deep deposits, and by the cost and difficulty of borings and shafts for the direct location of deposits. The report indicates in outline how far it is of value to use different methods in conjunction with one another. The specific recommendation is in favour of an experimental survey of a restricted area, say 20 miles square, in Australia; the choice of the area, among the large number which the committee considers are likely to be suitable prima facie, being left for decision by the leaders of the party in consultation with the leading Federal and State geologists, regard being had to the desirability of developing new regions for expansion of population. Detailed recommendations are made as to the personnel, cost, duration,

(Continued on p. 471.)

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The Wider Aspects of Cosmogony.[1]

By J. H. JEANS, Sec. R.S.

INTEREST in scientific cosmogony is a recent, and still a very tender growth. Anthropologists and geologists tell us that man has existed on earth for something like 300,000 years; we must go this far back to meet our ape-like ancestry. Between them and us some 10,000 generations of men have walked the earth, most of whom have probably given some thought, in varying degrees, to the significance of their existence and the plan of the universe.

Of these 10,000 generations of men, the first 9990 unhesitatingly regarded the earth as the centre, and terrestrial life as the central fact, of the universe. As was suited to its majesty and dignity as the abode of man, the earth stood still while the celestial sphere spun round it, covering in the earth much as a telescope-dome covers in the telescope; and this dome was spangled with stars, which had been thoughtfully added so as not to leave the central earth unillumined at night. Ten generations at most have been able to consider the problem of their existence in anything like its proper astronomical perspective.

THE POSITION OF MAN IN THE UNIVERSE.

The total age of the earth far exceeds the 300,000 years or so of man's existence. The evidence of geology, and of radio-activity in rocks in particular, shows that it must be something like 2000 million years, which is several thousand times the age of the human race. Old Mother Earth must regard man as a very recent apparition indeed; he has just appeared to burrow into her, burn her forests, put her waterfalls into pipes, and generally mar the beauty of her features. If he has done so much in the first few moments of his existence, she may well wonder what is in store for her in the long future ages in which he is destined to labour on her surface. For in all probability the life in front of the human race must enormously exceed the short life behind it. A million million years hence, so far as we can foresee, the sun will probably still be much as now, and the earth will be revolving round it much as now. The year will be a little longer, and the climate quite a lot colder, while the rich accumulated stores of coal, oil, and forest will have long been burnt up; but there is no reason why our descendants should not still people the earth. Perhaps it may be unable to support so large a population as now, and perhaps fewer will desire to live on it. On the other hand, mankind, being three million times as old as now, may—if the conjecture does not distress our pessimists too much—be three million times as wise.

Looked at on the astronomical time-scale, humanity is at the very beginning of its existence—a new-born babe, with all the unexplored potentialities of babyhood; and until the last few moments its interest has been centred, absolutely and exclusively, on its cradle and feeding-bottle. It has just become conscious of the vast world existing outside itself and its cradle; it is learning to focus its eyes on distant objects, and its awakening brain is beginning to wonder, in a vague, dreamy way, what they are and what purpose they serve. Its interest in this external world is not much developed yet, so that the main part of its faculties is still engrossed with the cradle and feeding-bottle, but a little corner of its brain is beginning to wonder.

Taking a very gloomy view of the future of the human race, let us suppose that it can only expect to survive for two thousand million years longer, a period about equal to the past age of the earth. Then, regarded as a being destined to live for threescore years and ten, humanity, although it has been born in a house seventy years old, is itself only three days old. But only in the last few minutes has it become conscious that the whole world does not centre round its cradle and its trappings, and only in the last few ticks of the clock has any adequate conception of the size of the external world dawned upon it. For our clock does not tick seconds, but years; its minutes are the lives of men. A minute and a half ago the distance of a star was first measured and provided a measuring-rod for the universe. Ten seconds ago Shapley showed how the peculiar stars known as Cepheid variables

[1] The Trueman Wood Lecture delivered before the Royal Society of Arts on Wednesday, Mar. 7.

provide a longer measuring-rod, and taught us to think in distances so great that light takes hundreds of thousands of years to traverse them. With the very last tick of the clock, Hubble, using the same measuring-rod, has found that the most remote objects visible in the biggest telescope on earth are so distant that light, travelling 186,000 miles a second, takes about 140 million years to come from them to us.

Not only is our vision of the universe continually expanding, but also it is expanding at an ever-increasing rate. Is this expansion destined to go on for ever? So far as we can at present see, no; for a general guiding principle, that of generalised relativity, fixes a limit, which we are fast approaching. According to this theory, space cannot extend for ever; it has no limit, but is nevertheless finite like the surface of the earth. Without exploring and surveying the whole of the earth's surface, we can make a fair estimate of its total area by measuring its radius, which we can do by measuring its curvature at any one point. In the same way the total volume of space is fixed by a quantity, the curvature of space, which can be determined by measuring the density of distribution of matter in space. Space which contained no matter would go on for ever, but the parts of space we can survey with our telescopes contain enough matter to show that we already see an appreciable fraction of the whole of space. It is as though our baby, watching ships coming from over the horizon, concluded that the earth's surface was curved, and formed a general rough conception of its size by imagining the observed curvature continuing until the earth's surface rounded back on itself.

Exact figures are impossible, but Hubble has calculated that space is not likely to extend to more than about a thousand times as far as the farthest nebula visible in the biggest telescope. Nothing prevents our going on and on in space beyond this distance, but, if we do, we merely come back to ourselves. The possessor of a sufficiently sensitive wireless apparatus may emit signals and pick them up a seventh of a second later after they have travelled round the world. In the same way a not inconceivable increase in the size of our telescopes would take us round the whole of space, and we should see the stars surrounding our sun by light which had travelled round the universe, not of course as they now are, but as they were 100,000 million years ago.

Such considerations make it improbable that the expansion of the universe can continue at its present rate for much longer. Having grasped that the world is round, the infant speedily forms a fair idea of its size. Our particular infant, mankind, has made the great discovery of the existence of the outer world, has formed some conception of its size, and adjusted his ideas, not by a process of slow revelation, but by a brain-flash of the last few seconds. In his mature years and his staid old age he is no doubt destined to make many sensational discoveries, but he can never again live through the immortal moment at which he first grasped the immensity of the outer world. We only live through a few ticks of his clock, and fate might have ordained that they should be anywhere in the three days that the child has already lived, or in the seventy long, and possibly tedious, years yet to come. The wonderful thing is that she has selected for us what is, perhaps, in some ways the most sensational moment of all in the life of our race.

The child sets its newly awakened mind to work to adjust and co-ordinate a new array of facts. If the world was not made to surround its cradle, what purpose can it serve? If the lights of the great ships in the harbour were not designed to light its nursery at night, what can they possibly be for? And, most interesting problem of all, if the world is such a big affair, can there be other cradles and other babies?

These remarks will have served their purpose if they suggest that what I am rashly trying to set forth here should not be judged as a finished science or the solution of a problem; it is rather the first confused gropings of the infant mind trying to understand the world outside its cradle. And if the impression produced by its first inexperienced glance at the outer world had to be described in a single word, it would probably select the word 'immensity.'

The Immensity of Space.

The immensity of space is measured by the figures already mentioned. Light and wireless signals travel at the same rate because, of course, they are essentially the same thing; and this thing takes a seventh of a second to travel round the world, and probably something like 100,000 million years to travel round the universe. The ratio of these times (2×10^{19}) measures the dimensions of the universe in terms of the familiar dimensions of the world; incidentally, it also measures the expansion of our spatial ideas since Copernicus. The disparity of size is too great to be easily visualised. Suppose the size of our earth represented by a single atom. Then the range of vision of the biggest telescope is about represented by the whole earth, and the size of the whole universe, according to the theory

of relativity, is represented by a stack of a thousand million earths.

Scarcely less bewildering than the immense extent of space is the immense amount and variety of matter it contains. The sun, which is a million times as big as the earth and 300,000 times as massive, proves to be something less than a grain of sand on the seashore. It forms one of a family whose number must certainly be counted in thousands of millions; Seares has estimated it at thirty thousand millions. This is not the only family of stars in space. Each of the great spiral and other extra-galactic nebulæ, such as are shown in Figs. 1, 2, and 3, is either a family of stars, or consists of stars in the making, or of matter which is destined ultimately to form stars. We can estimate the masses of these great nebulæ by gravitational means, and each is found to contain enough matter to make a thousand million suns. This of itself will give some conception of the vast size of these nebulæ, but to tell the whole story, it must be added that their colossal masses are so tenuous that each millionth part of an ounce is, on the average, as big as the Matterhorn. Think of a body which is bigger than the Matterhorn by as much as a thousand million suns is heavier than a millionth part of an ounce, and we have the size of any one of these great nebulæ. Any one of the three photographs here reproduced would have to be enlarged so as to cover the whole of Asia before a body of the size of the earth became visible in it at all, even under the most powerful of microscopes.

Hubble estimates that about two million such nebulæ are visible in the great 100-inch telescope at Mount Wilson, and that the whole universe has about a thousand million times the volume of that part of space visible in this telescope. Let us now multiply 1000 million by 2 million, and the product by 1000 million. The answer (2×10^{24}) gives some indication of the probable number of stars in the universe; the same number of grains of sand spread over England would make a layer hundreds of yards in depth. Let us reflect that our earth is one millionth part of one such grain of sand, and our mundane affairs, our troubles and our achievements, begin to appear in their correct proportion to the universe as a whole.

While the stars may fairly be compared to grains of sand in number, they differ too much *inter se* for the comparison to be carried further. There is an enormous variety of big and little stars, of bright and faint stars, of red and blue stars, and of hot, hotter, and still hotter stars. The faintest of known stars (Wolf 359) emits only a fifty thousandth part of the light of the sun, while the brightest (S. Doradus) emits 300,000 times as much light as the sun. The smallest known star (Van Maanen's star) is about the size of the earth; a million such stars could be packed inside the sun and leave room to spare. The largest known star (Betelgeuse) is so large that 25 million suns could be packed inside it. Their ranges are greater than those between a searchlight and a glowworm, or between balloons and bird-shot.

Yet the stars are essentially similar structures. A normal atom consists of a central nucleus round which a number of electrons revolve like planets round the sun—a miniature solar system, in fact, in which the vacant space far exceeds that occupied by matter. With great heat the electrons begin to break loose and fly off at a tangent. The central temperatures of the stars can be calculated with fair precision, and prove to be so high that most of the electrons must have already broken loose from their atoms. Of recent years, a great deal of labour has been devoted to testing the hypothesis that practically all the electrons have so broken loose, the stripped atoms and electrons flying about in a general hurly-burly like the molecules of a gas. But the hypothesis has proved disappointing, and a much more probable hypothesis is, I think, that the atoms are not stripped quite bare, but that in most stars they retain a few rings of electrons which give the atoms so much size that they jostle one another about like the molecules of a liquid. This hypothesis explains beautifully the otherwise puzzling fact that stars of large mass fall into distinct groups, of what may almost be described as 'standardised' sizes. On the 'liquid star' hypothesis, these different sizes correspond to the different sizes possible for the stellar atoms which

Fig. 1.—Regular shaped nebula (N.G.C. 4594) with ring of dark matter surrounding equator.

may have 0, 1, 2, or 3 rings of electrons left, but cannot have fractional numbers. The largest stars of all, such as Betelgeuse, have three rings left, while minute stars, such as Van Maanen's star, consist of atoms most of which are stripped quite bare, so that there is almost no limit to the closeness with which they can be packed together. An average handful of the matter of which this star is composed would contain about ten tons.

Thus the observed sizes of the stars proclaim the secret of the structure of the atom. The sizes of the stars are discontinuous because the sizes of atoms broken down to different stages are discontinuous. These discontinuities can be traced in turn to the discontinuities which form the central feature of the new quantum dynamics. Thus the distinguishing characteristic of the laws which govern the most minute processes in Nature is transmitted directly into the large scale phenomena of astronomy and governs the distribution of the huge masses of the stars. The infinitely great is never very far from the infinitely small in science, but it would be hard to find a more sensational illustration of the unity of science than that I have just given.

On this hypothesis, not only do the observed sizes of the stars disclose the general structure of the atom, which is old knowledge, but they also reveal the detailed structure of the particular atoms of which the stars are composed, and this is new knowledge. To be precise, the observed sizes of the stars disclose the atomic weights of the stellar atoms; they indicate that the stellar atoms are probably rather heavier than the heaviest atom, uranium, known on earth. The atoms which reveal their presence in stellar spectra are, of course, atoms of the ordinary terrestrial elements—hydrogen, iron, calcium, and the like. These, being the lightest atoms in the star, must naturally float up to its surface, and, as the earth was originally formed out of the surface of the sun, the earth is necessarily composed of them. But it now appears likely that down in the depths of the stars are other unknown and heavier atoms. We may almost say that it must be so, for no terrestrial atoms, not even radium or uranium, can produce anything like the amount of energy which these stellar atoms are observed to produce.

The Immensity of Time.

The immensity of space is paralleled by that of time. We can estimate the ages of stars from the impression that time has made upon them, just as we estimate the age of a tree from the number of subdivisions of its stem, or of rings in its cross section. There are three principal methods of doing this. The orbits of binary stars, which are circular at birth, are gradually knocked out of shape by the forces from passing stars. As we can calculate the rate at which this process occurs, the shape of stars' orbits can be made to reveal their ages. The moving clusters provide a second method. Groups of bright stars such as the Great Bear, the Pleiades, Orion's Belt, are often found to consist of exceptionally massive stars which move in regular orderly formation through a jumble of slighter stars, like a flight of swans through a confused crowd of rooks and starlings. Swans, however, are conscious beings, and continually adjust their flight so as to preserve their formation. The swan-like stars cannot do this, so that their orderly formation must in time be broken by the gravitational pull of other stars. When this happens, the lighter stars are naturally knocked out of formation first, while the most massive stars retain their formation longest. This agrees with what is observed, and as we can calculate the time necessary to knock out the lighter stars, we can at once deduce the ages of those which are left in. A third method of investigation rests upon a rather abstruse dynamical theorem, which shows that after a sufficient time the energies of motion of the different types of stars must tend to equality, the little stars making up for the smallness of their mass by the rapidity of their motion. Seares has shown that the stars near the sun have nearly attained to this ideal state, and as we can calculate the time needed to establish it, we can again deduce the ages of the stars.

It is gratifying and significant that all three lines of investigation lead to the same result: the stars are found to be some millions of millions of years old, perhaps from five to ten millions of millions. We cannot state their age with much precision, but it is the general order of magnitude, not the exact figure, that is important.

Stellar Radiation.

Year after year, century after century, for millions of millions of years, the sun radiates enough energy from each square inch of its surface to keep a 50 h.p. engine continually in action; still hotter stars may radiate as much as 30,000 h.p. per square inch. If this energy were produced by the combustion of coal, the stars would all be completely burnt out in a few hundreds or thousands of years. Where, then, shall we find a source of energy to last millions of millions of years?

More than twenty years ago I directed attention to the enormous store of energy made available by the annihilation of matter, by positive and negative electrons falling into and annihilating one another, thus setting free the whole of their intrinsic energy as radiation. On this scheme neither energy nor matter had a permanent existence, but only a sort of sum of the two; each was, theoretically at least, convertible into the other. Whether energy is ever transformed into matter we do not know; probably not. But the falling together of electrons and protons forms the obvious mechanism for the transformation of matter into energy, and it now seems practically certain that this is the actual source of the radiation of the stars. A beam of radiation exerts pressure on any surface it falls upon, just as a jet of water does or a blast of air. The reason is that radiation carries mass about with it, and electromagnetic theory tells us the amount of this mass. For example, we can calculate that a searchlight which is radiating 50 horse-power of energy is discharging mass into space with the radiation at the rate of a gramme and a quarter a century; with sufficiently delicate adjustments it might even be possible to observe the recoil of the searchlight. Indeed, the pressure of radiation has actually been measured, although not in this particular way. New mass is of course being continually fed into the searchlight by the electric current.

Each square inch of the sun's surface is in effect a searchlight discharging radiation into space at the rate of 50 horse-power, and so is discharging mass at the rate of a gramme and a quarter a century, and the sun's surface is so large that the sun as a whole is discharging mass into space at the rate of 250 million tons a minute. Now the sun has no source of replenishment. It must have weighed 360,000 million tons more yesterday than to-day, and by to-morrow will weigh 360,000 million tons less. These are not mere speculative statements; they rest on observation, and on generally accepted principles which are directly confirmed by observation.

Allowing for the fact that a more massive star emits more radiation than a less massive one, we can calculate that five or ten million million years ago the sun must have been several times as massive as it is to-day, so that it has already lost most of the mass it had at birth. Of each ton it had at birth only a few hundredweights at most remain to-day. The loss of mass which accompanies radiation is, then, no mere academic hair-splitting. It is a real astronomical phenomenon, and young stars must be many times as massive as old stars.

There is a certain amount of direct evidence of this change of mass. The radiation of the stars imposes an endlessly recurring capital levy upon their masses, which, as observation shows, is graduated and increases very steeply indeed for the richest stars. The levy makes all the stars poorer, but it also tends to equalise what wealth remains; the older the stars get, the more nearly equal their impoverished masses become. This is a large part of the reason why the stars are nearly equal in mass. The process is most clearly marked in the binary systems, which have been formed by a single star breaking into two. The two component stars of such a system are necessarily of the same age, and it is a matter of observation that the small stars of old systems are nearer to equality of mass than the massive stars of young systems.

Thus observation and theory agree in indicating that the universe is melting away into radiation. Our position is that of polar bears on an iceberg that has broken loose from the icepack surrounding the pole, and is inexorably melting away as the iceberg drifts to warmer latitudes and ultimate extinction.

Five million million years ago the sun had stored up within itself the energy which was destined to provide its light and heat until to-day, and the mass of this energy was many times the present mass of the sun. No means is known by which so much mass could be stored except in the form of electrons and protons. Thus we must suppose that the radiation of the sun through these millions of millions of years has been produced by the annihilation of electrons and protons which existed in it originally, but no longer exist now. These electrons and protons are pure bottled energy; the continuous breakage of these bottles in the sun sets free the radiation which warms and lights our earth, and enough unbroken bottles remain to provide light and heat for millions of millions of years to come.

The amount of energy made available in this way is amazing. The annihilation of a pound of coal a week would produce as much energy as the combustion of the five million tons a week which are mined in the British Isles; an ounce of coal a month would provide locomotive power for all the British railways, while a single drop of oil would take the *Mauretania* across the Atlantic. When we speak of the efficiency of a steam engine as 5 per cent. or so, we regard complete use of the thermal energy of combustion as 100 per cent. efficiency. If we measure the work done against the total intrinsic energy of the fuel, as made

available by its complete annihilation, the efficiency is more like 0·00000001 per cent. On this scale the efficiency of the sun and stars is exactly 100·00 per cent.

Modern physical theory shows that the annihilation of an electron must produce a single flash of radiation of wave-length far shorter than any we can produce on earth. As this radiation threads its way through a star, its wave-length is continually increased, or, to use the technical term, the radiation is continually softened. In time it becomes γ-radiation, then hard X-radiation, then soft X-radiation, and finally it emerges from the surface of the star as ordinary light and heat. Consider, however, an electron which is annihilated not inside a star but outside in free space, or in one of the almost transparent nebulæ. The short wave-length radiation now undergoes no softening, but travels on until it meets something capable of checking it. Thus all astronomical bodies, including the surface of the earth, ought to be under continual bombardment by radiation of shorter wave-length, and consequently of greater penetrating powers, than any we can produce on earth.

Many years ago such radiation was detected in the earth's atmosphere by McLennan, Rutherford, and other observers; it has recently been studied in detail by Millikan and others. There is no reason to doubt that it originates just where it ought to, namely, in the great nebulæ, and its amount is about what it ought to be, if it is evidence of the whole universe melting away into radiation. The wave-length of the radiation might be expected to reveal the physical process by which it is generated, but the evidence is a bit puzzling. The hardest terrestrial radiation penetrates inches of lead and corresponds to a voltage of hundreds of thousands of volts. The cosmic radiation penetrates about five yards of lead, and the hardest rays are now found to correspond to about 60 million volts. Millikan was at one time inclined to attribute the rays to the combination of four atoms of hydrogen to form an atom of helium, but rays so produced would only be of the hardness corresponding to 30 million volts. There are many ways known to physics of softening radiation, but none of hardening it. Thus we must look for some source more energetic than the synthesis of hydrogen into helium, and I can see no possible stopping-place short of the annihilation of matter. Again, we are not dealing with a minute phenomenon of mere academic interest. In a sense this radiation is the most fundamental physical phenomenon of the whole universe, most regions of space containing more of it than of visible light or heat. Our bodies are traversed by it night and day. Short of going down into a mine or in a submarine we cannot escape it, and it is so intense that it breaks up several million atoms in each of our bodies every second. It may be essential to life or it may be killing us.

The Lives of the Stars.

The stars are almost certainly born in nebulæ of the type of the great extra-galactic nebulæ, such as are shown in Figs. 1, 2, and 3. These nebulæ show a great variety of shapes, but a single thread connects them all; they are the shapes of huge masses of gas endowed with different amounts of rotation. So definitely is this the case that when Hubble recently tried to classify the shapes of these nebulæ, deliberately and avowedly shutting his eyes to all theoretical considerations, he found that purely observational considerations compelled him to classify them in precisely the sequence I had predicted on theoretical grounds some ten years earlier.

A huge mass of gas which was entirely devoid of rotation would of course assume a strictly spherical shape; rotation would flatten this shape out, just as the earth is flattened by its rotation, until ultimately most of the matter was spread out in a thin disc. We see the process beginning in Fig. 1, and it is well advanced in Fig. 2. Fig. 3 shows a nebula which is probably physically similar to that shown in Fig. 2, but viewed from another angle. Now mathematical theory shows that the thin disc-like structure could not remain a mere featureless mass of gas. Just as the cooling of a cloud of steam causes it to condense into drops of water, so the cooling of a cloud of gas causes it to condense into detached masses. We see the phenomenon in progress in nebular photographs; it is a necessary theoretical consequence of the laws of gases and the law of gravitation.

Now the same theory which predicts that the phenomenon must happen, predicts the scale on which it will happen. We can calculate how much matter will go to the formation of each 'drop,' and the calculated masses of the drops come out to be just about the same as the masses of the stars. Indeed these drops are stars, and the process just described is that of the birth of stars. Unmistakable stars have been observed in the outer regions of many of the spiral nebulæ. It is naturally not possible to identify every observed spot of light with a star, but some of them show precisely the same peculiar fluctuations of light as characterise a certain

class of variable star, the Cepheid variables already mentioned, and these put the identity of these particular spots of light beyond all reasonable doubt.

In these nebulæ, then, we are watching the birth of stars, the transformation of an inchoate mass of

FIG. 2.—Spiral nebula (N.G.C. 891) seen edge on.

gas into an 'island universe' of stars. Indeed Hubble found it necessary to end up his classification of nebulæ with clouds of stars. At one end of his continuous sequence is a nebula, shaped like a mass of rotating gas, in which not a single star is visible: at the other end a star-cloud in which nothing but stars are visible. Our galactic system of stars is probably the final product of just such a transformation, the Milky Way still recording the position of the equatorial plane of the original nebula.

Stars born in this way may meet with a variety of accidents and these result in different observed astronomical formations. A star may rotate too fast for safety, just as a flywheel may; when this happens it breaks into two, and the two stars so formed revolve endlessly about one another as a binary system. Two stars may run into one another, although this is very rare. A more common occurrence is for two stars to escape running into one another by a narrow shave. When this happens, huge tides are raised on the two stars involved, and these may take the form of long streamers of gas, which ultimately condense into 'drops' just as did the gas in the outlying regions of the spiral nebulæ. It seems reasonably certain that the planets were formed in this way.

The birth of the solar system, then, resulted from the close approach of two stars; if a second star had not happened to come close to our sun, there would have been no solar system. It may be thought that with a life of millions of millions of years behind it, one star or another would have been certain to come near enough at some time to tear planets out of the body of our sun. Calculation shows the reverse; even after their long lives of millions of millions of years, only about one star in 100,000 can be surrounded by planets born in this way. A quite unusual accident is necessary to produce planets, and our sun with its family of attendant planets is rather of the nature of an astronomical freak.

In the thousand million stars surrounding our sun there are, at a moderate computation, not more than ten thousand planetary systems, because there has not been time for more than this number to be born. They are of course still coming into existence; calculation suggests a birth-rate of about

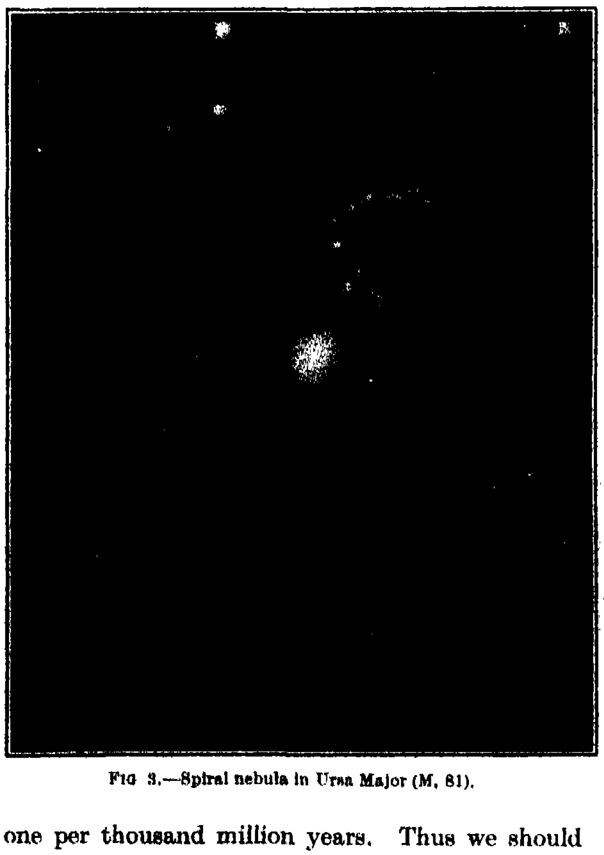

FIG 3.—Spiral nebula in Ursa Major (M. 81).

one per thousand million years. Thus we should have to visit thousands of millions of stars before finding a planetary system of as recent creation as our own, and we should have to visit millions of millions of stars before finding a planet on which civilisation, and interest in the outer universe, were

as recent a growth as are our own. We are standing at the first flush of the dawn of civilisation, and are terribly inexperienced beings.

It may be suggested that the creation of planetary systems is also only beginning, and that in time every star will be surrounded, like our sun, by a family of planets. But no; the stars will have dissolved into radiation or disappeared into darkness before there is time for this to happen. So far as we can judge, our part of the universe has lived the more eventful part of its life already; what we are witnessing is less the rising of the curtain before the play than the burning out of candle-ends on an empty stage on which the drama is already over. There is not time for many more planets to be born.

Life and the Universe.

The planets are the only places we know where life can exist. The stars are too hot; even their atoms are broken up by the intense heat. Nebulæ are in every way unsuitable; even if cool solid bodies exist in them, they would probably be so drenched with highly penetrating radiation as to render life impossible. Life demands a special type of matter, such as does not produce intense light and heat by transforming itself into radiation. We find it only in the surfaces of the stars, which are too hot for life, and in the planets which have been pulled out of these surfaces.

On any scheme of cosmogony, life must be limited to an exceedingly small corner of the universe. To our baby's wonderings whether other cradles and other babies exist, the answer appears to be that there can at best be very few cradles, and there is no conceivable means of knowing whether they are tenanted by babies or not. We look out and see a universe consisting primarily of matter which is transforming itself into radiation, and producing so much heat, light, and highly penetrating radiation as to make life impossible. In rare instances, special accidents may produce bodies such as our earth, formed of a special cool ash which no longer produces radiation, and here life may be possible. But it does not at present look as though Nature had designed the universe primarily for life; the normal star and the normal nebula have nothing to do with life except making it impossible. Life is the end of a chain of by-products; it seems to be the accident, and torrential deluges of life-destroying radiation the essential.

There is a temptation to base wide-reaching inferences on the fact that the universe as a whole is apparently antagonistic to life. Other quite different inferences might be based on the fact of our earth being singularly well-adapted to life. We shall, I think, do well to avoid both. Each oak in a forest produces many thousands of acorns, of which only one succeeds in germinating and becoming an oak. The successful acorn, contemplating myriads of acorns lying crushed, rotten, or dead on the ground, might argue that the forest must be inimical to the growth of oaks, or might reason that nothing but the intervention of a special providence could account for its own success in the face of so many failures. We must beware of both types of hasty inference.

In any case, our three-days-old infant cannot be very confident of any interpretation it puts on a universe which it only discovered a minute or two ago. We have said it has seventy years of life before it, but in truth its expectation of life would seem to be nearer to 70,000 years. It may be puzzled, distressed, and often irritated at the apparent meaninglessness and incomprehensibility of the world to which it has suddenly wakened up. But it is still very young; it might travel half the world over before finding another baby as young and inexperienced as itself. It has before it time enough and to spare in which it may understand everything. Sooner or later the pieces of the puzzle must begin to fit together, although it may reasonably be doubted whether the whole picture can ever be comprehensible to one small, and apparently quite insignificant, part of the picture. And ever the old question obtrudes itself as to whether the infant has any means of knowing that it is not dreaming all the time. The picture it sees may be merely a creation of its own mind, in which nothing really exists except itself; the universe which we study with such care may be a dream, and we brain-cells in the mind of the dreamer.

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and procedure of the survey. News of the actual work and results of this very interesting development in the application of research to Imperial problems will be awaited with keen interest.

THE freedom of the City of Stoke-on-Trent was conferred, on Mar. 14, on Sir Oliver Lodge, who was born at Stoke in 1851. Lady Lodge, who accompanied her husband, has local associations too, and Sir Richard Lodge, formerly professor of history at the University of Edinburgh, accompanied his brother. The visitors were heartily welcomed throughout their brief stay, and at Stoke Town Hall were received by the Mayor, Alderman T. C. Wild. Among others, the city electrical engineer, Mr. C. H. Yeaman, was introduced to Sir Oliver, under whom he studied at Liverpool. Sir Oliver and Lady Lodge were greeted enthusiastically by the aldermen, councillors, and citizens assembled in the Council Chamber. The Mayor, in moving the resolution to admit Sir Oliver as an honorary freeman, referred to his attainments and his important contributions to the striking progress made in modern times, concluding by offering, on behalf of the Council and the inhabitants of his native city, "a very hearty and sincere welcome home." The Deputy-Mayor seconded, and the motion was carried with great applause, the Mayor then handing to Sir Oliver the freeman's scroll. Sir Oliver Lodge, responding, recalled that thirty years ago, when he received the Rumford Medal of the Royal Society, he regarded it as the highest honour of his life. Now he doubted it, for few people receive the freedom of their native city, especially after more than fifty years' absence. Continuing in reminiscent mood, Sir Oliver mentioned, *inter alia*, that he left school at fourteen years of age, then for seven years was his father's book-keeper, devoted all spare time to such pursuits as mathematics, physics, and experiments, attended local science classes, and eventually got to University College, London, for further study.

THE Bodleian Library, Oxford, contains at present about 1,500,000 volumes, besides more than 40,000 manuscripts. To this collection between 20,000 and 25,000 volumes are added each year. At the present rate of growth the existing accommodation will not last more than another eight or nine years. To meet the need which will soon become pressing, various measures have been suggested, the most important of which are the following: (*a*) To build an extension of the Bodleian Library on the north side of Broad Street, and to acquire sufficient land in the neighbourhood of Oxford to provide accommodation for little-wanted books and periodicals. It is estimated that this plan would give the necessary space for at least 100 years. (*b*) To build an entirely new library in a central place, keeping Duke Humfrey's fifteenth century Library with the Arts and Selden ends as a library of early printed books, and the Radcliffe Camera as a reading-room for undergraduates. The cost of a new building such as is contemplated would be about £500,000. It is obvious that the expense of either plan could only be met by a great benefaction. Advocates of the second plan consider that it would remedy certain admitted inconveniences in the present administration of the Library. In particular, they allege the unavoidable slowness in book-service, the restricted hours of opening, the limitation of access to the shelves by readers. It is, however, not admitted by the supporters of the former plan that these drawbacks could not be remedied under the alternative scheme, if sufficient funds were forthcoming. In either event, a revision of the catalogue, estimated to cost £100,000, is considered to be highly desirable. It is not proposed that under either scheme the Radcliffe Scientific Library, now a department of the Bodleian, should be moved from the Museum.

IN order to commemorate the work of that great educationist, the late Dr. A. H. Fison, Guy's Hospital Medical School and the Gilchrist Trustees founded the Fison Memorial Lectureship four years ago. The first lecture on "The Structure of Light" was given by Sir J. J. Thomson, and the second by the Very Reverend Dr. W. R. Inge on "Science and Ultimate Truth." The third lecture was delivered by Sir William Bragg on Mar. 13, at Guy's Hospital Medical School, under the chairmanship of Sir William Pope. In his introduction, Sir William Bragg described "The Structure of an Organic Crystal" as a "borderline subject in that it draws from physics the explanation of the new methods by which the structure is found; it relies on chemistry for valuable comparisons between its own determinations and the picture of the organic molecule which the older science is able to supply; and it looks forward to a fruitful connexion with the biological sciences in which the organic molecule plays so great a part."

SIR WILLIAM BRAGG's lecture was both a record of achievement and a statement of unsolved problems. X-ray analysis, which has shown on one hand that the structural formulæ of organic compounds are plans rather than diagrams, and has enabled the lattice constants of crystals to be measured with high accuracy, has still advanced insufficiently to permit of full interpretation of the diffraction pattern of such a relatively simple substance as naphthalene. It has shown that there is a definite structure in the normal aliphatic carbon chain, but cannot explain satisfactorily why even numbered chains occur more frequently in Nature than the odd members, and although it has proved that many bodies which were supposed at one time to be amorphous are really essentially crystalline, it still leaves as a curious fact that complicated molecules often produce a simple unit of pattern in the aggregate. A point stressed by Sir William in his concluding remarks was that, interesting and significant as the new results are in relation to molecular structure, biologically they are literally of vital importance. The lecture has been published by Messrs. Longmans, Green and Co., Ltd. (1/6 net).

IN his Friday evening discourse at the Royal Institution on Mar. 16, Prof. E. T. Whittaker discussed "The Quantum and Relativity Theories of Light." He stated that the classical theory of light,

created by Fresnel in 1816–23, and transformed into an electromagnetic theory by Maxwell in 1861–62, was believed at the end of the nineteenth century to be capable of accounting for all optical phenomena. Since then, a number of facts have been observed which appear to be irreconcilable with it, for example, the photo-electric effect; and a great and successful theory—the quantum theory of spectra—has been developed, which presents a picture of radiation quite different from that given by the electromagnetic theory of light. Dealing first with the last-named difficulty, Prof. Whittaker showed that it has been almost completely removed by the new wave-mechanics. In place of the 'stationary states' of the old quantum theory, which were interpreted as the description of particular orbits by electrons, we now have normal solutions of the wave-equation. In a normal solution, the electric moment of the atom does not vary with the time, and there is therefore no reason why, in the electromagnetic theory, radiation should be emitted. On the other hand, when the state of the atom is represented by a superposition of two normal solutions, the electric moment does vary with the time, and radiation is emitted until the atom arrives at a state represented by a single normal solution. Prof. Whittaker then discussed the difficulties raised by the photo-electric effect, and showed that the classical theory is not in contradiction with the capture by a single atom of a whole quantum of radiation, or the preservation of the identity of the quantum as it travels over great distances. The latter part of the lecture was devoted to the new theory of the five-dimensional universe and to the behaviour of light rays in a gravitational field according to the theory of general relativity. It is found that a light ray may be captured permanently by the gravitational field of a point-mass.

ON Monday, Mar. 19, at the Æolian Hall, a paper entitled "From the White Nile to Ruanda" was read before the Royal Geographical Society by Mrs. Patrick Ness, describing part of a journey through Africa from Cairo to Cape Town, planned and carried out by her in the winter of 1926–27, with impressions gained at different times before 1914, when accompanying her late husband on big-game shooting expeditions. The regions principally dealt with were the little known lands in the extreme south-west of Uganda; the volcano lands of the Mufumbiro Mountains in the heart of Africa; Lake Kivu and the interesting kingdom of Ruanda, which with Urundi is now mandated territory administered by Belgium under the League of Nations. The paper gave a picture not only of these beautiful equatorial uplands, but also of the various tribes met with, often curiously different though inhabiting the same localities, and again in some cases resembling each other in many ways though found hundreds of miles apart. To-day, when Africa is so opened up that motors can be driven from end to end, there still remain parts into which no car has penetrated, and on the route described from Uganda to the Belgian Congo, which climbs to more than 8000 feet, all loads are still carried on men's heads.

WE learn from a recent *Daily News Bulletin*, issued by Science Service of Washington, that the General Electric Company of America has made a vacuum tube which, when connected to a copper bar about ten feet long through a coupling system, acts as a tuned aerial circuit. The tube is five inches in diameter and is two feet long. The power taken is 15 kilowatts and the great bulk of this is radiated into space with a frequency of 50,000 kilocycles, that is, the radio waves have a length of only six metres. With such short waves, many curious phenomena are noticed in the neighbourhood of the copper bar. If one terminal of an ordinary electric lamp be put in contact with the copper bar, it lights up brilliantly. When a piece of copper lying on the floor is picked up, the fingers may be blistered although it appears cold. Doubtless the induced currents at this high frequency are all confined to a very thin outside layer of the metal. Cooking can be carried on inside a glass tube near the aerial. The waves also affect everyone who approaches too close to the copper bar; a warm glow all over is first felt, and then pains ensue in the limbs and joints. It is stated that after standing close to the aerial for fifteen minutes the body temperature is raised to 100° F., and thus an artificial fever has been induced. Dr. Whitney, the director of the G.E.C. Research Laboratory, says that if we had a perfectly harmless method of warming the blood, it might be of value to the medical profession. An apple placed on the end of a wire at some distance from the aerial was thoroughly baked in a few minutes. When the end of the aerial was touched with a metal tipped rod, a greenish-white arc arose at the point of contact to a height of about a foot. As many as three of these standing arcs, each without any visible return circuit, could be established simultaneously, each flame spluttering and sending out molten copper in all directions until it was blown out.

SIR JOHN RUSSELL, Director of the Rothamsted Experimental Station, will shortly leave England to visit Australia, where he is going at the invitation of the Australian universities to lecture on the applications of science to agriculture, especially to crop production, showing what science has done and is doing to assist the farmer. While there he will, at the invitation of the Commonwealth Council of Scientific and Industrial Research, visit some of the more important developments and soil reclamation schemes in progress, and discuss the problems with the Australian experts on the spot. He will also visit the chief centres of agricultural investigation, and among other things will discuss the possibility of exchange of information and rendering of mutual assistance between the British and the Australian agricultural investigators.

THE first dynamo test in the world was made in the winter and spring of 1878, in the hall of the Franklin Institute of Philadelphia, by Dr. Elihu Thomson and Prof. E. J. Houston. The tests were carried out on various types of dynamos in order to determine which was the most efficient. As a result of these tests, a Brush arc light generator was recommended

for purchase by the Franklin Institute. A celebration of the semi-centennial of these tests will be held in the Franklin Institute on the afternoon of Wednesday, April 18, in the hall of the Institute, when papers will be presented by Dr. Elihu Thomson, the survivor of the two who made the tests, and by Dr. Charles F. Brush, who invented the type of dynamo finally recommended. It is expected that representatives of the great electrical companies of the United States and Canada, as well as many scientific workers of these two countries, will be present to participate in this celebration. All scientific workers and members of scientific organisations of Europe who may be in the United States at that time will be heartily welcomed by the Franklin Institute.

ON Mar. 14 the Frank N. Meyer Medal for distinguished service in plant introduction was presented to Mr. H. N. Ridley, in recognition of the important part he played in establishing plantations of the Para rubber tree in the Oriental tropics. The presentation was made by the American Consul General on behalf of Mr. David Fairchild, president of the American Genetic Association, to whom the award is entrusted by the staff of the Office of Foreign Plant Introduction, United States Department of Agriculture. Mr. H. L. Washington, in presenting the medal, referred briefly to the pioneer work carried out by Mr. Ridley whilst Director of the Botanic Gardens, Straits Settlements, in securing seed of the Para rubber tree from the trees growing at Singapore, in order to start the plantations in Malay; to his work in raising improved kinds of the tree by selection, and to his early experiments in tapping. Appreciative references were also made to the part played by the Royal Botanic Gardens, Kew, in the original introduction of this tree from South America to the Far East.

J. P. AULT, commander of the yacht *Carnegie*, has contributed an interesting review of magnetic ocean surveys to the February number of the *Scientific Monthly*. Columbus is credited with the discovery of the magnetic variations of the compass; when seven days out from the Canaries, during his first voyage to America in 1492, he found that the compass needles had turned to the north-west of north, and on the following morning further to the north-west. Two hundred years later, substantial prizes were offered for improvements in navigational methods, and Edmund Halley, the astronomer, began his voyages in the *Paramour* "to improve the knowledge of the longitude and variations of the compass." As a result, he constructed and published the first magnetic chart of the oceans, his method of drawing lines through points of equal magnetic variation being still used on modern charts. During the two hundred years which have elapsed since Halley's voyages gross changes have taken place in the magnetic field. In London the compass needle pointed 11° east of north in 1580, in 1812 it was pointing 24° west of north, and it now points about 13° west of north. The causes of these changes are unknown; their explanation and the determination of the rates of change constitute one of the chief problems in terrestrial magnetism.

THE Carnegie Institution of Washington equipped and sent out the non-magnetic ship *Galilee* to the Pacific, to be followed by the yacht *Carnegie*, which has already sailed some 290,000 sea miles. It is proposed to sail on a seventh cruise in May next. Besides continuing the magnetic survey, it is proposed to carry out a series of determinations of the potential gradient of the atmosphere immediately above the sea, and to prosecute a carefully prepared programme of oceanographic research. By finding the density *in situ* of the water at various depths down to 2000 metres every hundred miles or so, it will be possible to arrive, by means of Bjerknes' circulation theory, at the components at right angles to the track of the voyage of the velocities of the various water layers, relative to each other. It is also proposed to make a survey of the phosphate content of the ocean waters, a matter of particular interest, since lack of this salt has been shown to limit plant life in the upper illuminated layers in the tropics and in temperate regions during the summer months, and upon such plant life—diatoms and peridinians—the rich animal life of the sea depends. Numerous other observations of biological and oceanographic interest are also to be made.

IN *Discovery* for March, Miss Moya Jowett describes the interesting but little known medieval town of Domme and its surrounding country in the valley of the Dordogne. Domme was at one time of considerable importance from the military and economic point of view, as the surrounding area was covered with dense forest, and the only safe method of trade and travel was by water. Near by is the castle of Simon de Montfort, here best known for his massacre of the Albigenses who then held the town. It was the outpost of English territory, and changed hands several times. Many interesting buildings of this period still stand and make the town well worth a visit; but an added attraction is its proximity to Les Eyziès, the centre and capital of the palæolithic cave district of the Dordogne. At the conclusion of her article, Miss Jowett informs her readers that arrangements are being made for a small party interested in archæology to visit Domme and Les Eyziès for a fortnight at Easter at a low cost. The party will stay for one week at Domme and for one week at Les Eyziès, and at the latter place will have the unusual privilege of being conducted over the caves by M. Peyrony. Particulars of the tour may be obtained through the Editor of *Discovery*.

ONE of the earliest uses of electricity was in connexion with lighthouse communication. Carbon arc lamps were employed, and both the lamps and the electric generators used needed constant supervision. A great step forward has recently been made by the use of gas-filled lamps for this purpose. We learn from the *Osram G.E.C. Bulletin* for February that the gas-filled lamps now in use are of very large size, some requiring four kilowatts to keep them in normal operation. The filaments operate at 80 volts, so the lead-in wires have to carry 50 amperes, and have a cross-sectional area of $\frac{1}{16}$ sq. in. The solution of the problem of making a vacuum tight seal between

glass and wire of this thickness required a year's research work. In the event of a lamp failing it is necessary that it be immediately replaced. This is done by having a reserve electric lamp, and in addition an emergency acetylene light. Such well-known lighthouses as those at Pendeen, Lizard, Hartland, Burnham, and Skerries have all been fitted with gas-filled lamps. In the case of the Lizard lighthouse, which originally contained an arc lamp working at 30 volts and having for a source of power one or two French alternators between forty and fifty years old, complete conversion of the plant was necessary. As the alternators were still sound, they were utilised and connected to the lamp by a transformer. The whole of the lighting equipment has been made automatic, and an automatic winding device has been added to the clockwork which rotates the lenses. These lamps have proved themselves trustworthy for lighthouse and lightship service and give economic results.

We much regret to announce the death, on Mar. 19, at the age of eighty-five years, of Sir David Ferrier, F.R.S., emeritus professor of neuropathology, King's College, London.

A large earthquake was recorded at Kew Observatory at 5 hr. 20 min. 51 sec. G.M.T. on Mar. 16. The epicentre is estimated to have been about 8400 miles away.

The appointments made by the Secretary of State for the Colonies during the month of February, in addition to those for the East African Agricultural Research Institute, Tanganyika Territory, which were mentioned in Nature of Mar. 17, include the following: Dr. H. Scott, entomologist, Iraq; Mr. J. L. Illingworth, curator and agricultural superintendent, Virgin Islands; Mr. C. B. C. Handley, assistant agricultural officer, Kenya; Mr. H. Marsland, cotton investigator, Agricultural Department, Tanganyika Territory; Mr. R. S. Kyle, veterinary officer, Tanganyika Territory.

At the annual general meeting of the Optical Society, held on Mar. 8, the following officers and new members of council were elected for the session 1928–1929: *President*, Dr. R. S. Clay; *Vice-Presidents*, Mr. D. Baxendall, Mr. H. H. Emsley, Mr. J. Guild, Mr. F. C. Watts; *Hon. Treasurer*, Major E. O. Henrici; *Hon. Secretaries*, Prof. A. F. C. Pollard and Mr. W. B. Coutts; *Hon. Librarian*, Mr. J. H. Suttcliffe; *Editor of Transactions*, Dr. J. S. Anderson; *New Members of Council*, Mr. O. Aves, Mr. T. Chaundy, Dr. C. V. Drysdale, and Mr. A. Whitwell.

The ninth International Congress of Psychology will be held at Yale University in New Haven, Connecticut, U.S.A., probably in August or September 1929. The officers of the Congress are as follows: President, J. McKeen Cattell, of New York; Vice-president, James R. Angell, of Yale University; Secretary, Edwin G. Boring, of Harvard University; Treasurer, R. S. Woodworth, of Columbia University; Foreign Secretary, Herbert S. Langfeld, of Princeton University; Executive Secretary, Walter S. Hunter, of Clark University; chairman of the Programme Committee, Raymond Dodge, of Yale University; chairman of the Committee on Arrangements, R. P. Angier, of Yale University. This is the first meeting of the Congress in America, and it is expected that it will be truly international in character. It is hoped in the United States that the appointment of some foreigners for lecturers and lectureships will be arranged near the time of the Congress, so that foreign attendance will be increased.

We are informed by the Smithsonian Institution of Washington that large editions of two maps of the world, showing the 387 stations from which data were obtained for "World Weather Records" (Smithsonian Miscellaneous Collections, Publication No. 2913), are available. In one of these maps the world is represented as an ellipse, parallels of latitude being parallel straight lines and meridians of longitude arcs, and the other shows the northern and southern hemispheres on a zenithal projection. Each map is on a sheet of about 11 in. × 16 in., and copies can be obtained on application to the Smithsonian Institution at 5 cents a sheet, or 4 dollars a hundred sheets.

The Kodak X-Ray Department will in future be known as the "Medical Department," as it includes in addition to the Radiography Section a Clinical Photography Section and a Medical and Surgical Cinematography Section. For work in the last section the 'Ciné-Kodak' is employed, and it has accessories which take pictures at four times the normal speed without increasing the rate of cranking, or one picture only at each revolution of the crank, thus allowing pictures to be taken at any desired slow rate. In conjunction with a microscope, this slow movement is specially useful in connexion with bacteriological and pathological work. Further details of these and of the Rheinberg colour filters for clinical microscopy, which in conjunction with the substage condenser, give differential colour illumination, are given in the December number of the *X-Ray News and Clinical Photography*, published bi-monthly by Kodak Limited.

The Streatfeild Memorial Lecture for 1927 was delivered last November before the Institute of Chemistry and past students of Finsbury Technical College by Mr. O. F. Bloch, and is just issued in pamphlet form by the Institute. Mr. Bloch took as his subject "The Chemist in the Photographic Industry," and after a personal tribute to Mr. Streatfeild and some general remarks, passed to the problems of light sensitivity and the latent image. He gave twelve facts or questions which must be accounted for or answered by any theory before it can be generally accepted. He then passed in short review the work that has been done in late years and the suggestions that have been made towards the solution of these problems.

Dr. James F. Norris, Director of the Research Laboratory of Organic Chemistry of the Massachusetts Institute of Technology, has undertaken the consulting editorship of the International Chemical

Series, published by the McGraw-Hill Book Company. Dr. Norris succeeds the late Dr. H. P. Talbot, who was also at the Massachusetts Institute of Technology, where he and Dr. Talbot had been associated for considerable periods since 1895. Dr. Norris was president of the American Chemical Society in 1925 and 1926.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A curator of the Art Gallery of Kingston-upon-Hull—The Town Clerk, Guildhall, Hull (Mar. 30). An assistant in the Department of Scientific and Industrial Research, chiefly to make translations and abstracts of articles dealing with radio-telegraphy—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (April 4). A woman accountant and lecturer on book-keeping at the Swanley Horticultural College for Women—The Secretary, Horticultural College for Women, Swanley, Kent (April 7). A secretary to the Association of Special Libraries and Information Bureaux—The Chairman of Council, Association of Special Libraries and Information Bureaux, 38 Bloomsbury Square, W.C.1 (April 9). A Principal of the Dudley Technical College—The Clerk to the Governors, Education Offices, Dudley (April 13). A junior scientific officer on the Air Ministry Scientific Research Staff, primarily for duty at the Royal Aircraft Establishment for research in applied physics, chiefly in connexion with aeronautical instruments—The Chief Superintendent, R.A.E., South Farnborough, Hants (April 13—quoting A.265). An adviser in agricultural economics for the Western (Bristol) Province—The Registrar, University, Bristol (April 14). Professors of geography, medieval history, Egyptian and oriental history prior to Græco-Roman times, and of classics and Græco-Roman history respectively, in the Egyptian University, Cairo—The Director, Egyptian Educational Office, 39 Victoria Street, S.W.1 (April 30). A professor of geology in the Egyptian University, Cairo—The Dean of the Faculty of Science, Egyptian University, Cairo (April 30). A second and mathematical master at the City of London School—The Secretary, City of London School, Victoria Embankment, E.C.4. A clinical pathologist at the Crichton Royal Mental Hospital, Dumfries—The Physician-Superintendent, Crichton Royal Mental Hospital, Dumfries.

Our Astronomical Column.

SKJELLERUP'S COMET.—News has been received from the Observatories of the Cape and Johannesburg, that this comet, which was so brilliant in December, has now been photographed in a dark sky on its emergence from the sun's neighbourhood; its photographic magnitude was 8·9, and Mr. Wood notes that he hopes to be able to follow it for a long time. Since most of the observations in December were somewhat wanting in precision, owing to the absence of comparison stars, these new observations will be of great value for improving the orbit elements. Out of the list of observed positions the following nearly simultaneous observations at the two observatories are selected; Cape, Feb. 11·11875 U.T., R.A. $18^h\ 58^m\ 32^s{\cdot}77$, S. Decl. 27° 0′ 43·7″; Johannesburg, Feb. 11·08398, $18^h\ 58^m\ 31^s{\cdot}01$, S. 27° 0′ 13·3″.

Dr. A. C. D. Crommelin has computed the following orbit:

$$\begin{array}{ll} T & 1927 \text{ Dec. } 18{\cdot}1671 \text{ U.T.} \\ \omega & \left.\begin{array}{l} 47\quad 8{\cdot}82 \\ \end{array}\right. \\ \Omega & 77\quad 14{\cdot}90 \;\; 1927{\cdot}0 \\ i & 85\quad 12{\cdot}81 \\ \log q & 9{\cdot}24579 \end{array}$$

The comet remains in high south declination until it is out of sight; but it should be visible for some months. The observations up to February give no indication of appreciable deviation from a parabola.

PREPARATIONS FOR THE NEAR APPROACH OF EROS IN 1931.—In less than three years, this little planet will approach the earth within some 16 million miles, which is not much more than half its distance early in 1901, when it made its nearest approach since its discovery in 1898. An extensive parallax campaign is already planned; the first essential is to obtain accurate positions of a large number of stars lying near the track of the planet; this work is being undertaken at many observatories, including Greenwich and Mount Hamilton. A *Daily News Bulletin*, issued by Science Service, Washington, reports that Dr. R. H. Tucker has determined the positions of 821 stars in the first series, and of 402 stars in the second series; the latter were observed in 77 working nights "during the best observing season at Lick Observatory in 30 years." British observers would give a somewhat less flattering report of last year's weather.

Eros is in opposition next September, in north declination 5°; but its magnitude will then be only 11, whereas it will rise to 7 in January 1931.

UNIVERSITY OBSERVATORY, OXFORD.—The *Annual Report* of the Visitors of the University Observatory, presented to Congregation on Feb. 28, directs attention to the progress of the catalogue of stars to the eleventh magnitude, for which the co-operation of eighteen observatories was secured at Paris in 1887. The Oxford Observatory was the first to complete its share in manuscript, though circumstances caused some delay to its production in type. After its completion it was found possible to render material assistance to the Vatican Observatory, the publication of the contribution of which is now in sight. The Director has undertaken the chairmanship of the international Committee charged with this work, the completion of which is now showing signs of possible attainment.

The connexion of the seismological work initiated by Milne, undertaken provisionally by Oxford in 1913, has become gradually established with the University Observatory. Fresh accommodation for the seismographs is being provided in the basement of the library, now in course of extension.

Dr. Fotheringham has detected numerical errors in the determined mass of Venus which have a bearing on terms in the sun's longitude. His work on the secular accelerations of the moon has been recently confirmed by the identification of the eclipse of Ur, 2283 B.C.

Weather conditions interfered materially with the joint eclipse expedition to Southport from the Radcliffe and University Observatories. Photographs, however, were taken, and the programme of work was successfully carried through.

Research Items.

Hawaiian Somatology.—The late Louis R. Sullivan, while in Honolulu in 1920–21, made a number of measurements of Hawaiians which it was his intention to study comparatively in relation to other Polynesian material collected under the auspices of the Bernice P. Bishop Museum and the American Museum of Natural History. This material has now been edited and arranged by Dr. Clark Wissler for publication as *Memoir 9, No. 4, of the Bernice P. Bishop Museum.* Dr. Clark Wissler has added comparative notes based upon the Polynesian material from Samoa, Tonga, and the Marquesas. In stature the Hawaiians are the shortest, next in order being the Marquesans and the Maoris. In cephalic, fronto-parietal, zygomatico-frontal, and zygomatico-gonial index, the Hawaiians lead, as they do in head width, minimum frontal, and begonial width. From this it appears that the Hawaiian face and head is relatively wide, whereas in transverse and vertical diameter the head and face are short. The nose is intermediate. Considering all measured characters as of equal weight, the Hawaiians resemble more closely the Tongans and the Marquesans than they do the Samoans. Hawaiians show more straight hair and more brown hair. They exceed in flatness of nose, the order of the transverse axis being Hawaiians, Marquesans, Samoans, Tongans.

Zoology in India.—In his presidential address to the section of Zoology of the fourteenth Indian Science Congress held at Lahore in 1927, recently published by the Asiatic Society of Bengal, Major R. B. Seymour Sewell remarked that in India zoology is still in the stage in which taxonomy must be the first line of research, but he emphasised the paramount importance to the country of the study of ecology and bionomics and hence of more field researches. He pointed out the advantages of team-work in the field by zoologists, botanists, and chemists, so that not only the fauna, but also the associated flora and the chemical composition of the soil and water might be investigated. Failing such collaboration, there is much that a zoologist should be able to do for himself; for example, the estimation of hydrogen ion concentration, the amount of dissolved gases, and the salinity of sea-water, for the operations involved have been simplified and standardised provided the necessary apparatus is available. He also referred to the importance of a study of meteorological conditions in relation to investigations of the fauna of Indian seas, and stated that there is evidence of long period oscillations, of the nature of 'seiches,' which bring up from considerable depths masses of water that have a higher salinity than the normal surface water, and hence exert a profound effect on the fauna. Superimposed on these long period oscillations of salinity is a double diurnal oscillation brought about by an upwelling from a depth of probably 50 to 100 fathoms, and there is evidence that this is accompanied by changes in the plankton. He referred to the vertical migrations of plankton recorded in European waters and expressed his doubts as to whether the small organisms could make their way in the time available from and to the levels to which they are said to migrate, in some instances 200 fathoms. He considers it highly probable that in Indian waters the 'migration' of the plankton is really largely a 'translation.'

Ectodermal Placodes in the Head Region of a Sparrow Embryo.—Mr. Frank Goldby (*Jour. Anat.*, vol. 62, 135-138; 1928) describes a remarkable series of ectodermal placodes which were found in a sparrow embryo. These placodes, six in number, were found on the right side only of the embryo, in series with the auditory placode, two posterior and four anterior to it. The asymmetry of the series, their irregularity in size, and the fact that they correspond to no adult structure, suggest that they are vestigial in character. Their position and their obvious arrangement in series with the auditory placode suggest that they represent traces of the acoustico-lateral system of anamniota. The occurrence of placodes of this kind in an amniote is unique.

Embryology and Musculature of Insects.—The greater part of the December issue of the *Quarterly Journal of Microscopical Science* is devoted to two papers on common insects. In the first of these, L. Eastham records his observations on the embryology of *Pieris rapæ*, rightly believing that an account of the developmental stages so readily obtainable will be helpful to teachers and advanced students. Cleavage begins within the first hour after oviposition, in sixteen hours the blastoderm is complete, at twenty hours the embryonic rudiment is distinguishable, gastrulation begins at twenty hours, and is completed from forty-eight to sixty hours after fertilisation. Of the nuclei resulting from cleavage, those destined to form blastoderm move peripherally to the cortical layer; the remainder are left in the yolk as vitellophags. The movement peripherally of the nuclei is attributed partly to a streaming of the cytoplasm which carries the nuclei. The development and changes in form of the embryonic rudiment are described. Gastrulation is effected by overgrowth of the middle plate by two lateral plates and the endoderm is formed as proliferations in the position of the future mouth and anus. In the second paper, Guy D. Morrison gives a detailed account of the muscles—including their histology and function—of the adult honey-bee. The musculature of all three castes is described, the histology and physiology of the nervous system, and the mechanics of respiratory movements are carefully considered.

Fission in Starfishes.—In notes on New Zealand starfishes (*Records, Canterbury Mus.*, 3, December 1927), E. W. Bennett supports the view that in those species in which the number of rays is more than five, this is due to reproduction by transverse fission. Out of 153 specimens of *Allostichaster insignis*, 132 were six-rayed or potentially so, and he states that fission undoubtedly occurs, this being indicated not only by the size and disposition of the rays, but also by the presence of a groove across the disc. It is equally certain that after fission the new arms are grown almost invariably in threes, which would account for the preponderance of six-rayed individuals. In *A. polyplax*, four new rays are produced after fission, and the characteristic number of arms in this species is eight. Autotomy has long been believed to occur in *Coscinasterias calamaria*, and the author states he has verified this from a specimen in an aquarium.

A Meristic Variation in a Female Nematode.—Mr. G. Henderson Cassidy, Hawaiian Sugar Planters' Experiment Station, Honolulu T. H., writes stating that in material collected by Mr. C. E. Pemberton in Menado, Celebes, and examined in Honolulu in November 1926 by Mr. Cassidy, were several specimens of the genus Dorylaimus, one adult female specimen of which, 1·05 mm. long, presented an unusual variation. It showed two vulvæ identical in formation,

presenting no abnormality of structure and both situated on the median line of the ventral surface 0·062 mm. apart. There were two reflexed ovarian tubes, the anterior arising from the anterior vulva and the posterior from the posterior vulva.

CHROMOSOME MUTATIONS IN GARDEN STOCKS.—In a combined study of the genetics and cytology of stocks (Matthiola) by Dr. Howard B. Frost and Mrs. Mann Lesley (*Jour. of Heredity*, vol. 18, No. 11), a series of trisomic mutations (with an extra chromosome) have been obtained, similar to those already known in Œnothera and Datura. The stocks have seven pairs of chromosomes. Four of the trisomic forms, called Smooth, Crenate, Narrow, and Dark, are of common occurrence, and apparently each contains a complete extra chromosome. In at least three others (Large, Slender, and Small) the extra chromosome is a fragment only. Among the progeny of Slender plants an occasional Narrow Slender mutant appears. This has, in addition to seven pairs of chromosomes, a large and a small unpaired extra. Resemblances between Small and Smooth suggest that the very small extra chromosome of Small is a fragment of the extra one found in Smooth. These mutants differ in earliness, flower-size, and to some extent in leaf-shape. Their offspring include tetrasomics (14 + 2) in which the peculiarities are more extremely expressed. Slender × Crenate gave one plant, the leaves of which combined the narrowness of Slender and the dentation of Crenate. It is said to have one extra chromosome, short like that of Slender, and another long, as in Crenate. These forms all show much sterility, and in the descendants of Crenate a form also with 15 chromosomes appears, called Crenatoid. This seems to bear the same relation to Crenate that *Œnothera semilata* does to *Œ. lata*.

PRECARBONIFEROUS PLANTS FROM AUSTRALIA.—Prof. W. H. Lang and Miss Isabel Cookson have just published a report on some very early Palæozoic plants from Victoria, Australia (*Memoirs of Manchester Lit. and Phil. Soc.*, vol. 71, No. 5). These plants have been collected from rocks generally regarded as of Yeringian (Upper Silurian) age. The most definite types of plants so far found are: (1) Large shoots with long linear leaves which cannot be closely compared with any known plant, and are of uncertain systematic position; (2) small-leaved shoots that have been closely compared with Thursophyton and more generally with Arthrostigma and *Psilophyton princeps*; (3) smooth-branched axes of various sizes, sometimes with axillary 'bud-like' structures, which have been closely compared with the various remains classed as Hostimella sp. It is considered that such an assemblage of plant remains, looked at in the absence of any information as to their position and locality, would suggest the Early Devonian flora, and perhaps the Middle rather than the Lower Devonian. The authors suggest that the so far scanty plant evidence should be used sparingly in determining stratigraphical successions, which should be delimited by the fauna when, as in this case, it is well represented. The history of the plants could then be related to this geological succession so determined.

INDIRECT EXCITATION OF SPECTRA.—The important observation of Prof. Paschen that Al II lines appear in the negative glow of a discharge from an aluminium cathode in pure helium, has been extended to a number of analogous cases by R. Frerichs (*Annalen der Physik*, vol. 85, p. 364). The ions of some metals the spark spectra of which had already been analysed, were produced by the process of 'sputtering,' and were then further excited by a transfer of energy from metastable atoms of helium, neon, or argon. It was found that the degree of excitation possible depended almost entirely on the energy of the inert gas, fewer spark lines appearing with argon than with either of the others. The principle so established was then applied to the still incompletely known spectrum of ionised copper, and should be capable of very considerable extension. A point of more general interest that is raised by this work is that the law governing the transfer of energy in a collision of the second kind is apparently more like that found to hold for ionisation by electron impact than that governing an inelastic collision at a resonance potential.

THE COSMIC RAYS.—Full details of their 1926 expedition to Bolivia have been published by Prof. R. A. Millikan and Dr. G. H. Cameron in the February number of the *Physical Review*. An outstanding feature of their report is the remarkable consistency which they have now succeeded in obtaining between measurements made with different electroscopes at various places, which is so good that the new results and the earlier Californian readings can all be represented by a single smoothed absorption curve. The progressive hardening of the rays in their passage through the air, which is shown by this graph, seems now to be definitely established, and corresponds to a spectral range of approximately an octave near 4×10^{-4} A. Their conclusion regarding the suggested influence of the Milky Way is that if it has any effect upon the cosmic radiation, the rays coming from it cannot be 6 per cent. greater or less than those coming from the portion of the heavens at right angles. A terrestrial origin in the shape of thunderstorms is even more unequivocally dismissed after their experiments in a sheltered valley in the High Andes, and in the midst of heavy storms at sea. The value now found for the ionisation at sea-level is 1·4 ions per c.c. per second, and is, so far as the investigations go, independent of the shape, wall-material, and volume of the three electroscopes employed.

MAGNETIC THEORY.—The *Proceedings* of the fourteenth Indian Science Congress held at Lahore in 1927, and recently published by the Royal Asiatic Society of Bengal, contains the presidential address to the Section of Mathematics and Physics on some recent magnetic theories, delivered by Prof. D. M. Bose. It deals in the first instance with the application of electron theory to magnetism, and the disagreement which exists between the magneto-mechanical effect as predicted by the theory and the measured effect. It is possible that this discrepancy may be due to the magnetic field produced by the spin of the electron about its own axis, a field which was postulated by Sir J. J. Thomson in his Silvanus Thompson Lecture to the Röntgen Society in June last. There is still disagreement between observers as to whether the susceptibility of a diamagnetic gas is proportional to the pressure, and the introduction by Weiss of $T - T_0$ in place of the absolute temperature T in the Curie law for paramagnetic substances has not been supported by observations. These show that T_0 may be negative although the theory makes it positive, and that for compounds of the same kind in which one atom is replaced by a more susceptible one, T_0 is decreased while theory predicts an increase. The magneton and the recent theories which predict the magnetons in a compound from its chemical formula are also dealt with.

AUTOMATIC SUBSTATIONS IN RAILWAY ELECTRIFICATION.—The electrification of the main line railways

in Great Britain has brought to the front the problem of the design and maintenance of automatic substations for the supply of electric energy to the trains. Experience has shown that with the usual automatic substations, frequent and lengthy visits by the maintenance staff have not infrequently been a feature of normal operation. The designer's aim, therefore, is to reduce the frequency and duration of these visits, and this necessitates departures from designs which have given every satisfaction in substations which have attendants. This problem is discussed in a paper read to the Institution of Electrical Engineers on Feb. 2 by H. B. Poynder. The chief problem is in connexion with the rotary convertors which have to convert the alternating supply into direct current. As the voltage required is 1500, they are connected two in series. In the early days of the working of an electric traction railway, short circuits on the track have to be regarded as normal operating occurrences. To guard against possible damage to the machines, apparatus for rapidly breaking the circuit has to be installed. To prevent overheating, some 10,000 cubic feet of air per minute has to be passed through each machine. The effect of forced ventilation is to carry with it a large amount of dust, especially in countries where sandstorms occur. As the deposition of dust is very deleterious when the substations are rarely visited, efficient air filters have to be provided. Wet air filters seem to be the best, as there is no fire risk and the air is cooled before it gets to the machine. As substations are usually in out-of-the-way positions, an alarm of fire is rarely given even when black smoke has been issuing for some time. A suggestion is made that a carbon dioxide plant should be installed for the protection of the substation which would operate when small quantities of smoke are present. Photoelectric cells balanced normally would distinguish between the light passed through two long tubes and so automatically release the valve of the carbon dioxide bottle when there was smoke in the substation tube.

NEW ELECTRIC LOCOMOTIVES.—On the electrified main lines of the German State Railways the permissible load on a pair of driving wheels has been increased to 20 tons and the maximum speed has been increased to 68 miles an hour. In order to take advantage of this change it is necessary to have a large motor output per axle. The driving of the axles by individual motors, or better by 'twin motors,' has been found to be the most economical. Two years ago the A.E.G. company supplied the State railways with a new type of electric locomotive having high tractive power and individual axle drive. It has given satisfaction in practice, and 33 locomotives of this type are now being constructed. The aggregate output of the motors on a locomotive on an hourly basis is 3700 horse-power, the weight of the locomotive being only about 110 lb. per rated horse-power. It is claimed in *A.E.G. Progress* for January that it is the lightest single-phase locomotive that has yet been built. Up to a third of full speed, the tractive effort measured at the circumference of the driving wheels is 49,000 lb. It moves easily up an incline of 1 in 8 and round a curve of 600 feet radius. The body of the locomotive is divided into three compartments. The central compartment contains the main motors and transformers, whilst the two end compartments form driving cabins with control gear. The roof of the machine cabin is divided into five parts so that the various parts of the electrical equipment can be dismantled from above. The ventilating ducts can be closed during heavy snow falls.

BUSCH MICROSCOPES.—A catalogue recently issued by Emil Busch, A. G., Rathenow, gives full particulars of an increased number of types of microscopes now being manufactured by the firm. These include several simple robust models suitable for students' use, as well as more elaborate outfits for biological and petrological routine or research work, and microscopes with body tube of extra large diameter suitable for photomicrography and projection. An interesting feature of the larger models is the fine focussing adjustment, which is effected by means of a spindle supported at both ends. A spiral thread cut on the spindle engages with a wedge-shaped nut. Rotation of the milled head on the spindle produces a lateral motion of the wedge and thereby raises or lowers the body tube through a pillar supported on the wedge by a steel roller. The catalogue also contains lists of objectives and eyepieces, illuminating appliances and various types of mechanical stages. A separate leaflet gives a description of a small portable microscope, the stand, stage, and tube carrier of which are cast in one piece. This instrument may be used for projection purposes, the base of the microscope being threaded and thus capable of being screwed on to the flange of the projection apparatus. Another pamphlet issued by the firm gives directions for the use of microscopes and accessories in the examination of opaque objects by reflected light, and also a description of various types of photomicrographic apparatus. Amongst these is a camera which can be easily attached to the upper end of the body tube of a microscope. The camera is provided with an observation tube which facilitates the focussing of the image and permits of its examination while the exposure is being made. The London agents for these instruments are Messrs. Emil Busch Optical Co., Ltd., 37 Hatton Garden, E.C.1.

INSULATING OILS.—Engineers are using at present a great many oils for insulating purposes. For example, the coils of high tension transformers are as a rule immersed in oil. Hitherto the work of oil refiners has been confined mainly to the production of a good lubricant. Up to the present the problem of producing an oil which will act satisfactorily as an electrical insulator has not been solved, although good progress has been made. Especially is this the case for the oils which are used to impregnate the insulating coverings of paper-insulated cables. For cable work it is most essential to keep the dielectric losses as low as possible, while for transformer and switchgear work this is not so important. In a paper read to the Institution of Electrical Engineers on Feb. 23 by T. N. Riley and T. R. Scott, the requirements for high voltage cables are briefly outlined. Experimental results are then quoted showing the bearing of the physical and electrical characteristics on the finished cable. It is necessary that the paper layers slide smoothly over one another when the cable is handled. It must therefore have the properties of a lubricant. The thermal conductivity of the oil must be high in order that the cable remain cool when working. Although the thermal resistivity of the paper fibre itself is usually less than that of the oil, yet the resistivity of paper contacts between layers of dried paper is of the order of five or six times that of the oil. Imperfect impregnation therefore greatly raises the thermal resistivity. The authors conclude that the elimination of gas 'pockets' in the dielectric is necessary. These spaces not only cause brush discharges and so produce burning and oil oxidation, but they also increase the thermal resistivity. Sensitive methods of measuring the electrical characteristics of the oils are given.

Diseases of the Douglas Fir in Britain.

AS is often the case with exotics, there have been one or two scares on the subject of diseases in connexion with the Douglas fir plantations in Britain. A fungus attack reported in a young plantation, when investigated, proved to be caused by an undescribed species of Phomopsis (*P. Pseudotsugæ* Wilson). Then a species of Chermes (*Chermes Cooleyi*) appeared in several parts of the country. A recent leaflet (No. 18) issued by the Forestry Commission, deals with a disease new to Britain, the Douglas fir leaf-cast disease (*Rhabdocline Pseudotsugæ* Syd). The disease is common on the Douglas in the United States, but until within the last few years it had not apparently been noticed on the east of the Atlantic. It has been found on the blue form of the Douglas fir (*Pseudotsuga glauca*) and on the interior dry belt or Fraser River form (*P. Douglasii* var. *cæsia*). Recently it has been also observed on the green Douglas (*P. Douglasii*). This fungus occurs on all forms of the Douglas in the United States, and occasionally becomes epidemic for a season or so. It usually only infests young trees, but attacks larger trees growing on poor quality soils.

Infested needles develop blotches on the under surface during the winter, and at a later date tissues of the leaf on the upper surface, directly above, turn a yellowish brown. By early spring these areas turn a purplish brown, which, contrasted with the green unattacked part of the needle, give the infested foliage a mottled appearance not unlike the resultant mottling produced by *Chermes Cooleyi*. In the latter, however, the presence of the small secretions of white wool on the under surface of the needles serve to distinguish this attack. In the case of the fungus, the mycelium is developed in the leaf and does not pass back into the shoot. About March the hyphæ become numerous on the lower surface of the leaf just beneath the two bands of stomata in the discoloured spots, and it is here that the fructifications are formed. In May the epidermis ruptures, disclosing an orange-coloured layer which bears the spores. Spores are liberated at the time the buds are opening, and infection takes place shortly afterwards on the young needles. Infected needles fall at all seasons of the year. Trees attacked for several years by this fungus may be almost entirely defoliated and may die.

The green Douglas appears to be the least subject to this fungus. So far, the disease has been reported from Peebleshire and from several counties in the south of England. At present it is deemed impossible to suggest any definite remedy, but, in the case of an attack appearing on a few young trees only, the advice is tendered that they should be removed and burnt. In the nursery, spraying with a solution of soap and Bordeaux mixture as practised in the United States is recommended.

In the case of infestations, such as those here mentioned on the Douglas, the real solution would appear to rest on sylvicultural considerations. The planting of pure blocks of rapidly growing exotics is, in many parts of the world, to court disaster in the long run, in one form or another; more especially when the behaviour of the exotic from the sylvicultural point of view, in its new environment, is by no means well understood.

Building Research.[1]

THE poet Cowper wrote the well-known couplet, "Knowledge is proud that he has learned so much; Wisdom is humble that he knows no more," and it was Tennyson who said, "Knowledge comes, but Wisdom lingers." These statements are indeed true of building science. The past centuries have witnessed an ever-increasing store of knowledge, wherein precedent, with the natural improvements added for the day current, shows the accretion of knowledge, though not necessarily an accretion of wisdom.

The work of the Middle Ages was largely empirical in nature, though we of to-day would hesitate to deny the wisdom of the ancients of Assyria, Egypt, Greece, and Rome in their palmy days of building activity. Forgetting for the moment the simpler constructive science involved in trabeate architecture, how else than by superior wisdom can we account for the survival of the magnificent relics to the present time—a survival that would have been far less mere relics had it not been for the fortuitous effects of bombardments and the criminal vandalism shown in using some of these buildings as mere quarries?

Though the monks may be credited as having been in the possession of a large amount of useful scientific knowledge in regard to building, as their stately cathedrals show us to this day, yet this knowledge lacked that admixture of wisdom which would have secured to their creations the same defiance of time as appertained to the earlier art. They could calculate to a certain degree the structural basis of the vaulting and groining, so as to promote the attainment of their aim, but the inadequacy of the results is made too painfully evident in these latter days. The poor quality of the stone, the inefficient counterforts and sundry other defects, entail the vast expenditure so frequently witnessed. Even after making allowances for altered conditions consequent upon tunnelling beneath the surface for railways and sewers and the deep excavations for commercial purposes, as well as allowing for the pollution of the atmosphere by reason of industrial processes, yet the charge of inadequate wisdom is justified in its entirety.

A welcome is therefore to be accorded to the present (if somewhat overdue) activity on the part of the Government, whereby scientific research into the capacity and quality of building materials is being undertaken; twofold in its nature, namely, curative research for the purpose of remedying accrued defects, and prophylactic research, which is wisdom in the highest degree, whereby preventive measures may be adopted in time.

The first Report of the Building Research Board, appointed by the Department of Scientific and Industrial Research, has recently been issued; brief as is the period during which the Board has been in existence, there is ample evidence of its utility.

The Board divides its operations into two main sections, (*a*) general research and (*b*) intelligence and special investigations; a reproduction of its 'labour tree' will best conduce to an appreciation of the method pursued:

Building Research

- General Research (The Science of Building)
  - Efficiency of Buildings
  - Weathering
  - Materials
  - Structural Strength
- Intelligence and Special Investigations
  - Information Bureau
  - Examination of Building Failures
  - Special Investigations
  - Publications

[1] "Report of the Building Research Board for the Period ended 31st December, 1926." (London: H.M. Stationery Office, 1928.) 2*s*.

The subject of weathering has been considered from the various aspects of chemical attack (including solvent action of rain); biological attack, bacteria, lichens, etc.; movements due to temperature and moisture changes; and frost.

It is somewhat on the lines of the bismuth meal, when we note how investigators employ the method of impregnation of stones with coloured resins as a means of tracing the porosity channels of the various stones. Sections of decayed samples upon examination thus enable the formation of sulphates to be studied. In research upon the transmission of chemical solutions as preservatives, it has been demonstrated that the crystallisation induced by evaporation from the face of a wall so impregnated is often a cause of decay; when perished mortar joints have been made sound, evaporation will, in following the line of least resistance, issue from the stone itself, and hence the decay.

Further, it was found that aerobic bacteria rarely penetrate more than an inch below the surface; research into anaerobic bacterial activity has yet to be undertaken. The Board considers, after investigation, that there is no reason to believe that beetles cause decay in stonework; they use the already decayed stone merely as a home, not as a nidus.

Cement and concrete have claimed the Board's attention, and it is shown that the rapid-hardening Portland and high alumina cements are far more impermeable than the ordinary Portland cement. It is shown, too, why the cracking in the cement should be prevented; for if water cannot penetrate the material, then soluble salts cannot be washed out, nor can the steel embedded in reinforced concrete be attacked.

The Board expresses its belief that the deleterious action of frost is not so noticeable in Great Britain as it may be elsewhere. A series of freezing tests upon stone, brick, and tiles indicated general agreement with those of Kreüger in Sweden, where, however, frost is often very disintegrative in its action.

The behaviour of stone preservatives in a town atmosphere is being tested with a series of stone piers, treated and untreated, some with 'dished' tops, others with weathered tops; they are set upon the roof of a Government building in London. Also an illuminating set of experiments has been conducted upon the relation between the wet and dry strengths of bricks and stones.

Most of the Board's work is carried out at its station at Watford, but some investigations are undertaken elsewhere, including the National Physical Laboratory, where an interesting test is being conducted regarding vibration in buildings and fatigue in materials, and also the effect of wind pressure on roofs. The subject of wind pressure upon bridges is also being investigated.

Table 4 is illuminating regarding the diminution of tensile strength which so frequently takes place in neat cement with increasing age; whereas the compressive strengths, shown in Table 5, indicate fairly steady increase. Incidentally, it may be remarked that, later on in the Report, there is some confusion in numbering the tables.

A very valuable branch of research deals with acoustics, hitherto so largely a matter of empiricism in practice. Architects and engineers may now, with some assurance of satisfaction, seek the advice of the Board in this respect; a notable case in point is the series of acoustical experiments undertaken for the Government of India for the new buildings at Delhi.

Limits of space preclude adequate justice being done here to the many or to any of the activities of the Board. We must rest content with a mere brief schedule of such matters as condensation, waterproofing, repairs to old painted ceilings, etc.; the use of wood-cements, wall boards, plaster substitutes, and asphalte; investigation into dry rot, etc. The survey is all too brief regarding an undertaking of which the ramifications are numerous and the labour is indefatigable.

PERCY L. MARKS.

Plankton Migrations.

DR. KENZO KIKUCHI, in a paper entitled "Notes on the Diurnal Migration of Plankton in Kizaki Lake" (*Journal of the College of Agriculture*, Imperial University of Tokyo, vol. 9, No. 3, Aug. 1927), recounts some interesting results arrived at by studying certain species in the plankton of Kizaki Lake in the Nagano Prefecture. The pump method was employed, about fifty litres of water being pumped from different depths at periodic intervals and strained through a plankton net. The number of each species was then counted and recorded. These included Cladocera, rotifers, rhizopods, and dinoflagellates, the Cladocera and copepods being specially studied. The lake lies at an altitude of 764 metres, the greatest length being three kilometres, the greatest breadth one kilometre. It is bordered by mountains and plains, and its greatest depth is 29 metres. The temperature ranges in August from 6°·2 near the bottom to 26°·6 at the surface, and in December from 5°·6 to 8°·2 C.

The diurnal migration was found usually to be most distinct in those species living at depths less than 10 metres. Thus *Polyphemus pediculus* and *Bosminopris deitersi* occur at maximum at a depth of 2 metres in the daytime and tend to come nearer the surface at sunrise and sunset, migrating downwards during the day and night. Their maximum near the surface is reached before midnight, after which there is a slight tendency to move downwards. *Daphnia longispina*, living at about 10 to 15 metres during the day, shows no tendency to migrate upwards in the summer, but may move downwards at night. In December, however, when it is spread out from the surface to near the bottom, it shows a slight movement upwards at night, the temperature in the upper layers being lower at that time.

Some interesting observations are made on the various stages from nauplius to adult of the copepod *Diaptomus denticornis*, which migrates upwards at night to attain its maximum at the surface before midnight. In August it was found that the younger the forms the nearer they are to the surface during the day and also the earlier do they reach the surface at night, whilst in the morning they leave the surface later than the older stages. Thus the young stages stay for a longer period near the surface than the older stages. In December there was no diurnal movement in the young forms which had a vertical range from the surface to 10 metres, although the adults still migrated towards the surface at night.

The dinoflagellate *Ceratium hirundinella* was found to range from 2 to 10 metres and to be especially abundant at 5 metres. It moves upwards at night and reaches a maximum at the surface shortly before sunrise.

Most of these migrations show better in August, the number of specimens falling considerably in December.

University and Educational Intelligence.

CAMBRIDGE.—Dr. L. Brecher, of Vienna, has been elected to the Yarrow research fellowship in science at Girton College.

Smith's Prizes have been awarded to W. L. Edge, Trinity College, for an essay on "Ruled Surfaces of the Fourth, Fifth and Sixth Orders," and to A. H. Wilson, Emmanuel College, for an essay on "The Two-Centre Problem in Wave Mechanics." Rayleigh Prizes have been awarded to J. A. Gaunt, Trinity College, for an essay on "The Foundations of the Debye-Hückel Ionisation Theory with Application to Gases," and to W. H. M'Crea, Trinity College, for an essay on "The Quantum Theory and the Specific Heats of Gases." The essays of H. P. Mulholland, Queen's College, on "Theorems on Power Series and Dirichlet Series," and of L. Roth, Clare College, on "Discriminant Varieties," are mentioned as being also of distinction.

Dr. Roughton's lectureship in the Department of Physiology has been entitled the lectureship in physico-chemical aspects of physiology.

The Council has reported to the University in favour of accepting for five years from the Committee of the Privy Council for Scientific and Industrial Research an increased offer of £2500 per annum for the maintenance of the magnetic research work now being carried on at the Cavendish Laboratory by Dr. Kapitza, Trinity College. The grant is to be administered by a committee consisting of the Cavendish professor, the University treasurer, Prof. C. T. R. Wilson, and a member appointed by the Committee of the Privy Council.

Further details of the will of the late J. E. Bles, already referred to in these columns, have now been published. The amount of the bequest, which is subject to the life interest of his widow, is likely to be above £30,000, in addition to instruments, books, and fittings and contents of Mr. Bles's private laboratory. The first object of the bequest is the foundation of a Charles Darwin professorship of animal embryology, to be studied and taught from a purely scientific aspect, as distinct from an economic, technical, or medical aspect. If when the money becomes available the University already possesses such a chair, properly endowed, the subject of the new chair shall be bio-physics, the application of physics to a study of living plants and animals. After every twenty-five years a consultative board is to decide on the subsequent application of the trust fund, provided that the income of the fund is devoted to the promotion of a branch of biology as a pure science and that none is devoted to the purposes of economic, technical, or medical biology.

DUBLIN.—The Senate of the University has approved the conferment, on the recommendation of the Board of Trinity College, of the honorary degree of Sc.D. on Dr. G. L. Streeter, Director of the Carnegie Institution of Washington, Baltimore, Maryland, and Prof. A. S. Eddington, Plumian professor of astronomy and experimental philosophy in the University of Cambridge.

LONDON.—Keddey Fletcher-Warr Studentships, each of the value of £200 a year for three years, have been awarded to Dr. G. F. J. Temple, for research on the application in integral equations to the study of vibrations and stability and to other problems of mechanics and mathematical physics, and to Mr. C. P. Snow, for the study of molecular spectra with special reference to molecular structure.

OXFORD.—A proposal has been started for the establishment of a Common Room or Club for the use of men who are members of the research or teaching staff of the Museum departments and similar institutions. The need for such a scheme is especially felt in the case of those workers who do not enjoy the usual privileges of fellows of Colleges. If sufficient support is forthcoming, it is intended to call a meeting of those concerned in order to elect a committee for the consideration of details.

The School of Geography and the Committee for Anthropology have published their respective programmes for the ensuing term. These include lectures and instruction on land forms of western Europe; chronological sequence in the Pleistocene period; methods of physical anthropology; human hybridisation; man and the Pleistocene epoch; primitive language in its relation to thought.

THE annual Congress of the National Union of Students, to be held at Oxford at the end of March, will be opened by Sir Michael Sadler, Master of University College, Oxford, with an address on "The Future of the Universities." Other speakers on the main theme of the Congress, "Quo Vadis?" will include Sir Oliver Lodge and Prof. Burstall, of the University of Birmingham. A discussion on "University Problems" will be opened by Prof. Patrick Geddes, of Montpellier. Mr. John Galsworthy has consented to speak on "Man and Beast" at a meeting of the University of London Animal Welfare Society to be held during the Congress.

As a result of a conference recently convened by the London School of Hygiene and Tropical Medicine, which was attended by representatives of the Colonial Office, the India Office, the Ministry of Agriculture, the Department of Overseas Trade, and many important business organisations with interests in the tropics, it has been decided to make arrangements at the School for courses of instruction in hygiene for men and women—especially employees of business firms and official bodies—proceeding to the tropics. Inquiries regarding the courses should be addressed to the Secretary, London School of Hygiene and Tropical Medicine, Malet Street, London, W.C.1.

SHORTLY after the death, on April 4 last, of Prof. D. A. Gilchrist, a fund was opened to establish a memorial commemorating his work while professor of agriculture at Armstrong College, Newcastle-on-Tyne. A sum of about £480 is now available for this purpose, and it is proposed to found prizes, one at the Newton Rigg Farm School and others at the School of Agriculture at Armstrong College. The latter will be available until the death of Mrs. Gilchrist, when a sum of £3000 comes to the College for two scholarships under Prof. Gilchrist's will; the memorial prizes will then cease, and the money be devoted to support a research exhibition tenable at the College.

THE Air Ministry announces that a number of openings are available for young men to be trained as pilots in the Air Force Reserve. Up to sixty candidates will be accepted. Applicants must be of good education and physique, but need not have had any previous flying experience. They must be more than eighteen and less than twenty-five years of age. Selected candidates, after passing an examination by a medical board, are nominated to commissions in the Reserve as pilot officers on probation. When undergoing training an officer receives, generally speaking, the same pay and allowances as an officer of the same rank on the active list. Further details can be obtained from the Secretary (S. 7. c.), Air Ministry, Adastral House, Kingsway, London, W.C.2.

Calendar of Customs and Festivals.

March 25.

FIFTH SUNDAY AFTER LENT, the ancient Passion Sunday, also known as Care Sunday. The word "Care" here refers to a custom of the north of England and Scotland of giving away and eating grey peas which have been fried in butter after being soaked overnight. These are called "carlings." The Sunday on which they were eaten at an entertainment was also called "Carle" Sunday. This custom has no obvious connexion with any explanation of "Care" Sunday suggested by ecclesiastical writers. It is not unreasonable to conclude that the name of an older custom has been adapted to a Church festival. "Carle," it is suggested, is related to "ceorl," a country fellow or labourer, which would make it a rural festival. The "carling groat" is a Yorkshire custom that every labourer should repair to the village alehouse to have a drink of ale free. Anyone who did not comply would succeed in none of his undertakings in the coming year. Another name for the day found in the Isle of Ely, was "Whirlin Sunday," when each family made "Whirlin Cakes." The day is therefore clearly linked up with some form of rejoicing. In some of the observances of "Carrying out the Death," cited by Frazer in "The Golden Bough," peas are specially mentioned as part of the feast which takes place after the procession. Brand, who refers to the dole of soft beans mentioned in the Roman Calendar as given away at funerals, and the use of peas and beans in the Parentalia, the Roman festival connected with the souls of the dead, also quotes Plutarch as saying that pulse was of the highest efficacy for invoking the Manes.

LADY DAY. THE ANNUNCIATION OF ST. MARY.—A festival which was always carefully observed in England. The Synod of Worcester, A.D. 1240, forbade all servile work on this day. An exception was afterwards made in favour of agriculture. If it fell in Lent it was postponed, as was customary; but the church of Notre Dame de Puy had the privilege of making it override Good Friday when it occurred on that day, and great indulgences took place in the church.

It is not surprising that a date of such importance in Christian belief should have appealed to the minds of the early Christians as a time which by its very sanctity would be the necessary occasion of other events of importance in sacred history. It was also the date of the Crucifixion; and in a set of ancient verses it is noted as a day on which many miraculous events took place: Adam was created; Abel, the first martyr and the first man to die, was killed; Melchisedek made his offering; Isaac was offered up; John the Baptist was beheaded; the penitent thief was accepted by Christ, and so forth. Martyrologies add the crossing of the Red Sea and the wiping of the face of Christ by St. Veronica. It will be remembered that the features of the Christ were imprinted on the cloth with which this was done.

The idea which underlies the Annunciation is one which has been familiar to students of primitive thought since the researches of Spencer and Gillen among the Arunta of Central Australia. It is now known that these tribes are not alone among primitive peoples in failing to appreciate the physiological facts of paternity. Among the Arunta it is believed that conception takes place solely by the entry of a spirit into the body of the future mother. It is from this idea that beliefs in reincarnation arise, as can be shown by a comparison of the various forms which they take. Among certain South African tribes, for example, even though they have advanced beyond the more primitive ideas of the Arunta so far as the physiological facts go, it is nevertheless believed that the spirit of an ancestor enters the body of the mother to animate her child, and usually it is known with certainty which of them is thus reincarnated.

ST. SIMON, boy martyr, A.D. 1475: ST. WILLIAM, boy martyr, A.D. 1144—two of a number of child murders for which the Jews were held responsible.

ST. SIMON, aged 29 months, was killed on Tuesday in Holy Week at Trent: ST. WILLIAM at Norwich, at the age of 7 years. The point of the accusation against the Jews was that the abduction always took place in Holy Week, the alleged intention being to crucify the child in simulation of the crucifixion of Christ. The first mention of the crucifixion of a boy by the Jews is in the Church History written by Socrates, who states that it took place about A.D. 414 at a place called Immestar in Syria. In England there were a number of cases—one of a child in 1160; a boy, Robert, at Bury St. Edmunds in 1181; and Hugh of Lincoln, whose fate is celebrated in a popular ballad, in 1255. In 1240 a Christian boy at Norwich was circumcised, and was about to be crucified when rescued. Further cases in Germany, France, Bohemia, and Russia are numerous down to modern times, though not all were boys, girls sometimes being murdered. An alleged case in Russia, just before the War, attracted widespread attention.

In addition to the charge of murder by crucifixion, it was sometimes alleged that the motive was to obtain blood for ritual uses at the Passover. In the case of St. Simon, a bowl of blood was discovered in a cupboard in the Synagogue, and it is usually alleged that the death of the victim is effected in accordance with Jewish ritual. It may be noted that the same accusation was brought against the Christians in the early days of the Church by Roman writers. There is no doubt that the medieval populace was influenced against the Jews by primitive superstition about the efficacy of blood and its use in ritual.

March 26.

ST. LUDGER, BISHOP OF MUNSTER, A.D. 1809.—A native of Friesland whose legend embodies a record of pagan birth customs. When Liafburg, his mother, was born, her grandmother on the father's side, still a pagan, was enraged that her daughter-in-law had borne no sons. She sent officers to take the babe from its mother's arms before she had had an opportunity to feed it, for it was the custom to kill a child before it had tasted earthly food. It was snatched from the arms of the officer by a servant, who hurriedly placed some honey in the child's mouth, which it swallowed. It could not then be killed.

March 30.

ST. REGULUS, BISHOP OF ARLES AND SENLIS, 4th Century.—An incident in his life illustrates the supersession of pagan by Christian shrines. When passing through Louvres, near Paris, he overthrew an idol of Mercury, and built a chapel dedicated to the Virgin.

ST. JOHN CLIMACUS, A.D. 606.—An early reference to the Wandering Jew is contained in the record that when St. John was entertaining 600 pilgrims on Sinai, a stranger habited in linen, after the ancient Jewish fashion, appeared among the attendants and vanished after the feast was over. St. John concluded it must have been Moses, who had revisited Sinai for a brief moment. Numerous Hebrew legends of a similar character call the mysterious stranger Elijah. Among the Arabs a similar undying man is known as El Khoudir, friend and instructor of Moses.

Societies and Academies.

LONDON.

Royal Society, Mar. 15.—**J. D. Cockcroft**: The design of coils for the production of strong magnetic fields. One of the most difficult problems in the production of magnetic fields of the order of half a million gauss is to construct a satisfactory coil. Even in the method developed by Kapitza, in which the field is only produced for a fraction of a second, the heating of the coil is a serious limitation, whilst the electromagnetic forces on the coil give rise to stresses in the copper of the order of 7000 kgm./sq. cm. beyond the elastic limit of ordinary copper. This paper develops methods for selecting dimensions of the coil which will produce the greatest field for given power input, and for fixed allowable temperature rise.

D. Jack: The band spectrum of water vapour. The band λ3428 has been analysed from new measurements. For this band the emitter has the same initial state as for band 3064, and same final state as for bands 3122 and 2875. Consequently, band 3428 corresponds to transition $0 \rightarrow 1$ of vibrational quantum number. The initial and final values of the moments of inertia for the vibrationless state are, $I_0' = 1 \cdot 632$ and $I_0'' = 1 \cdot 498$, *in units* 10^{-40} *gm. cm.*^{2}. *Corresponding* nuclear separations of an OH ion are, $r_0' = 1 \cdot 022 \times 10^{-8}$ cm., and $r_0'' = 0 \cdot 979 \times 10^{-8}$ cm.

R. d'E. Atkinson: Statistical experiments on the motion of electrons in gases. Various papers of Prof. Townsend and his assistants claiming results which are not reconcilable with the quantum theory are discussed. In particular, the presence of metastable states in the term-systems of the gases undermines, at two different points, a theory which has implicitly assumed their non-existence. The experimental methods employed are statistical, and introduce many unknown quantities, but within wide limits of obtainable accuracy no disagreement is found with the quantum theory.

Lord Rayleigh: The light of the night sky: its intensity variations when analysed by colour filter (3). The intensity of the light of the sky at night has been observed by collaborating workers at a number of stations scattered over the world. Colour filters were used to separate as nearly as may be the region of the green auroral from the red and blue regions of the spectrum on either side. The broad result is that the intensity in each component has the same general values and range of intensities (four or fivefold) previously found for England. Much of the variation is irregular, and has not been found to be correlated at the different stations. Five years' observation in England indicates a definite annual periodicity, which survives the process of averaging the same month (for example, February) for each year; amplitude of variation corresponds to intensity ratio of 1·6; maximum is in October. The scanty available evidence suggests a similar variation in the southern hemisphere, with opposite phase, maximum in April.

W. Wilson: Relativity and wave mechanics. The equations of motion of a charged particle can be derived from those of an uncharged (which represent a geodesic in space-time continuum) by substituting for the mechanical momentum an extended momentum. This suggests that we regard the world-line of the charged particle as a geodesic in 5-dimensional continuum. With this modified relativity theory as basis, a generalised form of Schrödinger's equation for a single particle is deduced.

A. E. H. Love: The bending of a centrally loaded plate supported at two opposite edges. The question is of some importance in connexion with the experimental determination of elastic constants, inasmuch as it has been proposed to determine such constants, especially of crystals, by measuring, by an interferential method, the central deflection of a rectangular plate, supported at two opposite edges, and bent by concentrated pressure applied at the centre of one of its faces. The object of the paper is to obtain such a formula in the case where the material is isotropic. The problem, a purely mathematical one, is solved completely, and calculated numerical values of central deflection are tabulated for various values of the ratio breadth to length, and for two values of Poisson's ratio for the material.

M. Nottage: Studies in adhesion (3). The adhesion-molecular composition curves of three sets of binary mixtures have been determined and compared with the corresponding melting-point-molecular composition curves. Transition points occur at corresponding points on the two sets of curves and are generally points of definite molecular composition.

Optical Society, Feb. 16.—**W. M. Hampton**: An investigation into the beam from a standard lighthouse lens. The distribution of light from a third order Fresnel panel was measured, using two different light sources, a standard petroleum vapour burner and a 3 kw. *lighthouse cruciform lamp*. A complete theoretical discussion of the factors affecting beam candle-powers is worked out and tables are provided for the calculation of the beam candle-power from any apparatus using any light source.—**R. Kingslake**: The 'absolute' Hartmann test. According to the ordinary methods of performing the Hartmann test, the assumption is made that all the rays cross the optical axis. As a matter of fact, this is very far from the truth, especially in the case of the large astronomical objectives and mirrors to which the Hartmann test is most generally applied. In the present paper a brief description is given of a modified test in which each 'ray' is treated on its own merits, and its absolute deviation from the ideal path is determined in both magnitude and direction. This method incidentally leads at once to the well-known criterion *T* of Hartmann, which is now generally adopted in the comparison of large telescopes.—**R. S. Clay** and **Sir Richard Paget**: A portable stereoscopic kaleidoscope. No new optical principles are made use of in this instrument. It differs from the ordinary kaleidoscope mainly in the fact that the mirrors are of sufficient size to enable objects to be viewed by both eyes and thus to see them in stereoscopic relief. The mirrors are front silvered and are mounted at an angle of 30°, one mirror being vertical. The objects, consisting of coloured silks, artificial flowers, etc., are arranged on a black velvet background on a drum, which is rotated at the open end of the mirrors, and lighted from one side by an incandescent lamp. The stereoscopic relief greatly adds to the charm of the resulting pictures.

Geological Society, Feb. 22.—**C. A. Matley**: The pre-Cambrian complex and associated rocks of southwestern Lleyn (Carnarvonshire). With a chapter on the petrology of the complex, by **E. Greenly**. The pre-Cambrian complex of Lleyn occupies the coastal strip from Nevin to Aberdaron and Bardsey Island, and is a detached 'region' (the Mainland region) of the Mona Complex of Anglesey. It is bounded on the east by a great thrust which has driven it over Ordovician strata and the Sarn granite. Its members are now correlated with those of Anglesey. The gneisses, several members of the bedded succession, the plutonic instrusions, and the 'Penmynydd zone of metamosphism' are all represented. The Holyhead group is absent. The gneisses are always found near

the boundary-thrust. Both their basic and their acid members are almost identical with those of Anglesey. Their crystallisation and foliation are older than the deposition of the bedded succession. Most of the region is occupied by the Gwna Group. Resting on the Gwna beds are some 300 feet of quartz-albite dust-rocks (Gwyddel beds). They may be a special facies of the Skerries group of Anglesey, with a representative of the Tyfry beds at their base. The gabbros are akin to those of Anglesey, and are regarded as plutonic intrusions belonging to the complex. The tectonics and foliation of the complex resemble in almost every detail those of the complex in Anglesey. Many basic dykes are exposed in the complex, of which the great majority are Palæozoic (post-Llandovery and probably post-Silurian), but earlier than the great thrusting movements after the close of Silurian time. Three Tertiary dykes have been found. The boundary-thrust is certainly a great rupture, which shows no sign of dying out at either end of the exposed part of the complex. The extent of its overdrive cannot be determined, but it should probably be measured in terms of miles, and may have been sufficient to sever the whole plexus of Palæozoic dykes in the complex from their roots.

Physical Society, Feb. 24.—**W. H. J. Childs**: Some methods of estimating the intensities of spectral lines. A critical account is given of methods of spectral photometry applied to the special case of the band spectrum of helium. With the method finally adopted, the line spectrum is photographed in the usual way, and the density of the line photographs is measured. For this purpose the plate is calibrated by illuminating the slit of the spectroscope in a special manner by a tungsten filament lamp, so that upon development the plate exhibits a number of images of continuous spectra of progressively increasing density. From these images may be ascertained (*a*) the relation between intensity of light and density of image, and (*b*) the relation between plate sensitivity and wavelength of the incident light. Density measurements are obtained by a simply constructed selenium cell microphotometer, with which the density contour of each line can be investigated.—**P. W. Burbidge** and **N. S. Alexander**: Electrical methods of hygrometry. Two methods are considered, depending on (1) the change in resistance of organic materials (cotton-wool and human hair) on exposure to water vapour; (2) the change in mobility of ions due to water vapour. In the first case the logarithm of resistance is proportional to the humidity, while in the second the effect produced is too small to permit accurate measurement. Neither method is suitable for general use.

Linnean Society, Mar. 1.—**A. M. Smith**: The Algæ of a bog: five years' observations. Observations were taken at approximately monthly intervals of the algæ of a small Sphagnum bog near Bradford between March 1923 and August 1927. Observations of the temperature and of the hydrogen ion concentration of the water were also made. Two main algæ associations were clearly distinguished: (1) the association of the Sphagnum pools and (2) the association of the mud pools and deeper ditches. After the drainage of the bog in 1923 the Sphagnum association decreased, and the long, slow choking of the bog channels which followed later was accompanied by the gradual extension of this characteristic association. The total quantity of alga in the bog varied with the quantity of water in the bog, and showed little evidence of any check due to low temperatures. The quantity of certain species, however, *e.g.* a sterile species of Mougeotia, showed signs of diminution due to low winter temperatures.—**C. Crossland**: Coral-reefs of Tahiti, Moorea, and Rarotonga. The reefs of Tahiti, in spite of their covering of coral and Lithothamnion, are not extending seaward. The sunk reefs are the eroded remnants of a surface barrier. The lagoons have been excavated in an originally continuous reef, and subsidence is not necessary for the formation of barrier reefs. The adjacent island of Moorea has tilted and drowned its southern coast, with no effect on the form of the reefs. Lagoons and passes probably had their first origins in earth-movements, radial and circumferential cracks opening in the reefs. In Moorea the reduced amount of alluvium brought down allows a more vigorous growth of coral in the lagoons, and the maritime flat is largely composed of coral and is not being washed away. Flats of elevated coral occur in Moorea, which afford another proof that there has been no recent seaward extension of the reef. Rarotonga is usually described as having a fringing reef only, but comparison with Moorea suggests that it once had a lagoon which is now filled in.—**E. Handschin**: Collembola from Mexico.—**W. O. Howarth**: The genus Festuca in New Zealand.

Institute of Metals (Annual General Meeting),[1] Mar. 8.—**G. L. Bailly**: The influence of dissolved gases on the soundness of 70 : 30 brass ingots. Treating the molten metal with nitrogen gave an ingot practically free from unsoundness due to gas. Comparative tests were made on samples of 70 : 30 brass treated with nitrogen, hydrogen, and sulphur dioxide, poured in a series of moulds giving different speeds of solidification, and again no evidence was obtained of unsoundness caused by gas evolution during solidification. It is concluded that if appreciable amounts of gases are soluble in liquid brass, the solubility in the solid state is sufficiently high to retain the gas in solution. The probability is, however, that the high vapour pressure of zinc in molten brass precludes the solution of gas by the alloy.—**A. L. Norbury**: The effect of quenching and tempering on the mechanical properties of standard silver. Standard silver (92·5 per cent. silver, 7·5 per cent. copper) as ordinarily annealed contains a considerable amount of copper (in which some silver is dissolved), distributed in the form of small particles throughout the silver solid solution matrix. By suitable heating (*e.g.* about half an hour at 770° C.) and quenching, these copper particles may be dissolved and retained in supersaturated solid solution in the silver. The alloy in the quenched condition is about 30 per cent. softer and 20 to 30 per cent. more ductile than it is in the ordinarily annealed condition. On suitable tempering the quenched alloy (*e.g.* about half an hour at 300° C.) its Brinell hardness increases by about 300 per cent., and its tensile strength by about 50 per cent., and its ductility falls by about 50 per cent., due to the decomposition of the supersaturated solid solution of copper in silver. The hardening on tempering is accompanied by a decrease in volume and is uniform. The alloy is more resistant to oxidation and tarnishing when in the quenched and tempered conditions than it is when in the annealed condition.—**J. Newton Friend** and **W. E. Thorneycroft**: An example of Roman copper 'soldering' and welding from Uriconium. A Roman iron ferrule from Uriconium appears to have been made by welding two small pieces of iron into a strip, bending it over, and joining the two ends with copper. This appears to be the first example of copper 'soldering' of Roman origin to be examined.—**J. Newton Friend**: The relative corrodi-

[1] Continued from p. 442.

bilities of ferrous and non-ferrous metals and alloys. Part I. The results of four years' exposure in the Bristol Channel. The metals examined included tin, lead, nickel, zinc, aluminium, and various coppers and brasses. Nickel, tin, and lead resisted corrosion remarkably well. Of the brasses, screw metal (1·37 per cent. lead) made the best showing. This was closely followed by the nickel-copper (1·75 per cent. nickel). A galvanised iron bar lost less in weight than either the iron or the zinc separately. The aluminium bar was very deeply pitted.—**T. E. Allibone** and **C. Sykes**: The alloys of zirconium. The structures of partial series of the alloy systems copper-zirconium to 35 per cent. zirconium, nickel-zirconium to 55 per cent. zirconium, and iron-zirconium to 30 per cent. zirconium, are given. In each case the system is eutectiferous, and inter-metallic compounds are formed. In the copper-zirconium system the compound Cu_3Zr is found; in the nickel-zirconium system two compounds, probably Ni_3Zr and Ni_4Zr are found in the range of alloys investigated. The solid solubility of zirconium in the pure metals copper, nickel, and iron is in each case very small (less than 0·5 per cent.)—**Tsutomu Matsuda**: On the quenching and tempering of brass, bronze, and aluminium-bronze. These copper alloys containing a proper amount of the second metals may be hardened by suitable heat-treatment. The nature of the temper-hardening was investigated by means of microscopic and dilatometric tests and electrical resistance measurements, and it was concluded that the hardening is accompanied by the separation of α from β or γ, or the decomposition of β or γ into eutectoid, or both of these changes, and probably due to the straining of the space lattice produced by those structural changes.

DUBLIN.

Royal Irish Academy, Feb. 13.—**R. Ll. Praeger**: On some doubtful species of the African section of the Sempervivum group.—**R. Southern**: Salmon of the river Shannon, 1924, 1925, and 1926. This report deals with results obtained from the examination of scales from rod-caught salmon taken at Killaloe, on the river Shannon, during 1924, 1925, and 1926. The proportion of one-year-old smolts is 40·4 per cent., of two-year-old smolts 58·8 per cent., and of three-year-old smolts 0·8 per cent. The average length of the one-year-old smolts is 9·7 cm., of the two-year-old smolts 14·5 cm. The most important group in the 1924 catch was that of the large spring fish, constituting 52·4 per cent. of the catch in numbers; whilst in the 1925 and 1926 catches the small spring fish predominated to the extent of 46·2 per cent. and 51·5 per cent. respectively. The proportion of fish which had previously spawned was 5·5 per cent., 11 per cent., and 4·1 per cent. in the three seasons. Spring fish comprise 80-90 per cent. of the total catch; large spring fish average 26 lb., small spring fish 13 lb. The high average weight of the Shannon salmon is due to the high coefficient of condition (ratio of weight to length) and to the high proportion of the old fish in the catch.—**Miss A. L. Massy**: The Cephalopoda of the Irish coast. Descriptions and particulars were given of the occurrence of all the species of Cephalopoda which have been found in Irish waters. They comprise 31 species and a larval form (Rynchoteuthion).

EDINBURGH.

Royal Society, Feb. 6.—**W. H. Lang**: The flora of the Old Red Sandstone of Scotland: a general survey. The paper dealt with the following types of plant-remains that can be authenticated by specimens. It is evident that the main horizons of the Old Red Sandstone of Scotland have distinct assemblages of fossil plants. Upper Old Red Sandstone—*Archæopteris hibernica* (Berwickshire), ribbed stems (corduroy plant), woody incrustations, and specimens suggestive of Cyclostigma and Archæopteris (Shetland). Middle Old Red Sandstone—*Psygmophyllum Brownii*, Rhacophyllum like fossil, ribbed stems, black woody stems, *Palæopitys milleri*, *Caulopteris Peachii*, Hostimella sp. (*Psilophyton robustius*, Kidston non Dawson), *Milleria* (*Psilophyton*) *Thomsoni*, *Milleria pinnata*, *Hostimella globosa*, *Hostimella racemosa*, *Pseudosporochnus Krejčii*, *Protolepidodendron Karlsteinii*, *Thursophyton Milleri*, *Hicklingia edwardi*, fructification (Hugh Miller's 'fern'), sporotypes. Also from the Rhynie Outlier—*Rhynia Gwynne-Vaughani*, *R. major*, *Hornea Lignieri*, *Asteroxylon Mackiei*, Pachytheca, Nematophyton, casts of large trunks. Lower Old Red Sandstone—*Arthrostigma gracile*, *Psilophyton princeps*, Pachytheca (Strathmore Sandstones); Nematophyton, Pachytheca, *Parka decipiens*, *Zosterophyllum myretonianum* (Carmyllie Beds).—**Sir Thomas Muir**: The theory of Jacobians from 1885 to 1919.—**D. M. Y. Sommerville**: An analysis of preferential voting.

Royal Physical Society, Feb. 27.—**J. S. S. Blyth**: Some observations on the relation of gonadic structure to comb growth in the fowl. Changes in the histological appearance of the gonad coincident with the springing of the comb in the juvenile male of the domestic fowl are described. The increased comb growth and vascularity occurred at a time when the luteal tissue had begun to degenerate rapidly and the production of intra-tubular cells in the prophase of the first meiotic division was approaching its maximum. The latter appears to be the most probable source of the stimulus, but it cannot yet be decided whether the influence exerted on the comb by the gonad is inherent in the cells at this particular stage of maturation or whether it arises from the general increase in cell activity at this time.—**I. J. F. Williamson**: Furunculosis in the Salmonidæ. In recent years the salmon and trout in some British rivers have been attacked by an epizootic disease, known as Furunculosis; this disease has occurred on the Continent since the end of last century, and has also been recorded in America. The cause of the disease is a micro-organism, *Bacillus salmonicida*, which produces a general infection and is found in the blood of diseased fish. The bacillus does not produce disease in warm-blooded animals, but the flesh of affected fish is discoloured and softened and unfit for consumption.

SHEFFIELD.

Society of Glass Technology, Feb. 18.—**D. Starkie** and **W. E. S. Turner**: Note on the ultra-violet ray transmission of colourless bottle glass. Each of eight commercial soda-lime-silica glasses showed a maximum transmission in the green or yellow regions, the percentage of light transmitted then falling off gradually in the violet and near ultra-violet regions until a wave-length of about 3300 A. was reached, when the percentage of light fell off very rapidly to the limit of transmission. The glass containing 0·05 per cent. Fe_2O_3 transmitted down as far as wave-length 2960 A. Four others, each containing 0·07 per cent. Fe_2O_3, transmitted down to 2995 A., whilst the pale green glass with 0·18 per cent. Fe_2O_3 had its limit at wave-length 3175 A. All the glasses, with the exception of the green one, transmitted farther down into the ultra-violet than the average window glass, the limit for which is at about wave-length 3100 A. As further illustrating the relation between transmission in the ultra-violet and iron oxide content, some pure glasses, of approximate composition 75 per cent. SiO_2,

10 per cent. CaO, 15 per cent. Na_2O, containing small accounts of iron oxide, were tested. The iron oxide content and the limit of transmission were: 0·005 per cent. Fe_2O_3, transmission to 2600 A.; 0·008 per cent. Fe_2O_3, transmission to 2660 A.; 0·015 per cent. Fe_2O_3, transmission to 2740 A.—**W. Singleton and R. C. Chirnside**: The analysis of opal glasses. The constituents commonly occurring in commercial fluoride glasses were dealt with briefly, but more detailed consideration was given to the determination of boron, zirconium, tin, zinc, and arsenic. Zirconium was determined as pyrophosphate, according to the method described by W. F. Hillebrand. Arsenic was determined after decomposition of the glass by means of hydrofluoric acid. The solution of the glass was neutralised by ammonia, made acid with hydrochloric acid, then the arsenic was precipitated as sulphide. This was filtered, dissolved in caustic potash solution, and the arsenic finally determined volumetrically by titration against standard iodine solution. Fluorine was determined as calcium fluoride in the usual way.

PARIS.

Academy of Sciences, Feb. 13.—**Laubeuf**: Safety apparatus in submarines. Detailed discussion and criticism of various forms of life-saving apparatus applicable to a submarine in cases of accident.—**d'Arsonval, Bordas, and Besson**: The climatological observatory of Mont-Revard. This observatory has been installed on one of the highest points of the Mont-Revard plateau (1522 metres), and is provided with maximum and minimum thermometers, temperature and humidity recorders, heliograph, rain gauge, anemometer and actinometer, readings being taken three times daily. The results of two years' observations are summarised.—**S. A. Janczewski**: Theorems of oscillation of regular homogeneous differential systems of the fourth order.—**J. Delsarte**: Functional linear transformations and non-Euclidean functional rotations.—**P. Fatou**: Certain systems of differential equations depending on a parameter.—**Maurice Janet**: A system of partial differential equations.—**L. Tumarkin**: The dimensional structure of closed ensembles.—**N. Bogoliouboff and N. Kryloff**: The method of finite differences for the approximate solution of the fundamental problems of mathematical physics.—**Frilley**: The spectrography of the γ-rays by crystalline diffraction.—**Francis Perrin and R. Delorme**: The measurement of the times of fluorescence of uranyl salts, solid and in solution. The luminescence of uranyl salts has all the characters of a simple fluorescence of long duration. The times measured are of the order of $1·0 \times 10^{-4}$ to $6·1 \times 10^{-4}$ sec.—**A. Piccard and E. Stahel**: The non-existence of the ether wind. A reply to some criticisms of Brylinski.—**P. Chevenard**: The electrical properties of ferro-nickels containing chromium. The allotropic transformation of iron-nickel alloys, rich in iron, is accompanied by an increase in the specific resistance on warming. The addition of chromium lowers the temperature of the allotropic transformation and the thermal hysteresis increases.—**Lucien Cavel**: Contribution to the study of activated sludge. Activated sludges lose their activity with increasing percentage of nitrogen: long aeration removes organic nitrogen and restores the activity. Activated sludges have not the same flexibility in use as bacterial beds, and are liable to be put out of action by changes in the composition of the sewage under purification.—**P. Carré**: The iodometric estimation of phosphoric acid, and the use of sodium bicarbonate in iodometry. In the presence of an excess of alkaline bicarbonate, the results are not exact, owing to the formation of iodate by the action of iodine on the bicarbonate.—**Paul Baud**: A method of manufacturing barium hydrate, starting with the carbonate. Barium carbonate and ferric oxide react at 1150°–1180° C., giving a product containing 56-58 per cent. BaO.—**R. Cornubert**: Orientation phenomena in α-methylcyclohexanone.—**D. Ivanoff**: The preparation of benzophenone by organo-magnesium compounds. The mechanism of the reaction between organo-magnesium compounds and their carbonated derivatives.—**C. and M. Schlumberger**: The discovery, near Hettenschlag, of a second salt dome in the plain of Alsace. This salt dome has been detected and its outline determined by an electrical method, based on measuring the mean electrical resistance of the soil on a thickness of the order of 100 metres.—**Daniel Chalonge**: Study of the ozone layer of the upper atmosphere during the night. The results, based on spectrometric data, show that the ozone layer is appreciably stronger during the night than during the day.—**H. Bellocq and Ch. Jacquet**: Magnetic measurements in the Basses-Pyrénées, Landes, and Gironde.—**Henri Labrouste**: Magnetic measurements in the north of France.—**Mlle. Eliane Basse**: Some Cretaceous fossil invertebrates from the southwest of Madagascar.—**Robert Lemesle**: Abnormal suberous formations in a Labiate (Hymenocrater).—**Mlle. M. L. Verrier**: The presence and structure of a retinal fovea in *Serranus cabrilla*.—**J. J. Thomasset**: Remarks on the canaliculæ of dental enamel.—**Charles Pérez**: The apparatus for attaching the abdomen to the thorax in decapods.—**F. Maignon and E. Knithakis**: The influence of watery diet on the urinary excretion of ketonic bodies in the dog.—**Léon Blum, P. Grabar, and Joseph Weill**: The influence of mineralisation on the osmotic pressure of the blood proteins.—**L. Ambard and F. Schmid**: Diuresis and osmotic pressure of the albumins.—**Louis Lewin**: An intoxicating substance, banisterine, extracted from *Banisteria Caapi*. The active principle has been obtained in crystals, of the composition $C_{13}H_{12}ON_2$. According to Merck, it is identical with harmine, extracted from *Peganum Harmola*, but its physiological effects are not identical with those of harmine. Banisterine may prove to have useful therapeutic applications.—**Ph. Joyet-Lavergne**: The oxido-reducing power of the chondriome.—**Lemoigne**: The formation of an orthodiphenol at the expense of glucides by certain soil bacteria.

GENEVA.

Society of Physics and Natural History, Feb. 2.—**W. H. Schopfer**: Researches on biochemical sexual dimorphism. The author has made a study of carotine from *Mucor hiemalis*, which contains a material with crystalline structure. Its culture in a known nutritive medium (maltose and asparagine) shows that the most marked dimorphism takes place when the ratio of total carbon to organic nitrogen is a maximum.—**Sw. and Th. Posternak**: (1) Contribution to the study of the configuration of inositol. (2) A natural optically active inositotetraphosphoric ester. It results from this study that besides the hexaphosphate of inosite existing in all the seeds studied, the wheat embryo contains in preponderating quantity a lævorotatory tetraphosphate.—**L. Duparc and E. Molly**: (1) The presence of kenyite on the Abyssinian plateau. (2) Tokeite, a new Abyssinian rock. The authors have collected between Nekami and Addis-Abeka a rock very nearly identical with kenyite from Kenya, discovered by Gregory. They have given the name of tokeite to a rock of the basalt family, with 43·6 per cent. of silica: its texture is porphytic holocrystalline.—**Eug. Pittard**: A mummified head (*tsantsa*) of the Jibaros Indians. It represents one of the smallest described; its horizontal circumference is 200 mm.

Official Publications Received.

BRITISH.

Journal of the Marine Biological Association of the United Kingdom. New Series, Vol. 15, No. 1, February. Pp. 364. (Plymouth.) 12s. 6d. net.

The Physical Society Proceedings. Vol. 40, Part 2, February 15. Pp. 37-70+8 plates. (London: The Fleetway Press, Ltd.) 7s. net.

The Junior Institution of Engineers. Journal and Record of Transactions. Vol. 38, Part 6, March. Pp. 261-316+x+iv. (London.) 2s.

Air Ministry. Aeronautical Research Committee: Reports and Memoranda. No. 1112 (Ae. 286): On the Influence of Supercharging on the Performance of Aeroplanes. By R. McKinnon Wood. (B.4. Engines 56, revd.—T. 2210, revd.) Pp. 14+5 plates. 9d. net. No. 1118 (E.26): Closed Vessel Explosions of Carbon Monoxide, Oxygen and Nitrogen Mixtures. By R. W. Fenning. Work performed for the Engineering Research Board of the Department of Scientific and Industrial Research. (I.C.E. 567.) Pp. 13+1 plate. 9d. net. (London: H.M. Stationery Office.)

Journal of the Chemical Society: containing Papers communicated to the Society. February. Pp. iv+253-528+x. (London: Gurney and Jackson.)

Journal of the Royal Statistical Society. New Series, Vol. 91, Part 1. Pp. 151+xii. (London.) 7s. 6d.

Ministry of Agriculture and Fisheries. The Practical Education of Women for Rural Life: being the Report of a Sub-Committee of the Inter-Departmental Committee of the Ministry of Agriculture and Fisheries and the Board of Education. Pp. 61. (London: H.M. Stationery Office.) 6d. net.

Quarterly Journal of the Royal Meteorological Society. Vol. 54, No. 225, January. Pp. 78. (London: Edward Stanford, Ltd.) 7s. 6d.

Agricultural Research Institute, Pusa. Bulletin No. 172: The Mechanical Analysis of Tropical Soils. By J. Charlton. Pp. 9. (Calcutta: Government of India Central Publication Branch.) 3 annas; 4d.

Memoirs of the Geological Survey of India. Palaeontologia Indica, New Series, Vol. 9, Memoir No. 2: Revision of the Jurassic Cephalopod Fauna of Kachh, Part 2. By Dr. L. F. Spath. Pp. 73-161+plates 8-19. (Calcutta: Government of India Central Publication Branch.) 1.14 rupees; 13s. 3d.

Nigeria. Sixth Annual Bulletin of the Agricultural Department, 1st August 1927. Pp. 264. (Ibadan: Department of Agriculture.) 5s.

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 4: The Bionomics of *Smynthurus viridis* Linn., or the South Australian Lucerne Flea. By F. G. Holloway. Pp. 28. Pamphlet No. 5: Liver Fluke Disease in Australia; its Treatment and Prevention. By I. Clunies Ross. Pp. 23. (Melbourne: H. J. Green.)

Journal of the Indian Institute of Science. Vol. 10A, Part 9: Studies in Intensive Bacterial Oxidation. The Oxidation of Ammonia to Nitric Acid, Parts i-iv. By Gilbert J. Fowler, Y. N. Kotwal, Roland V. Norris, S. Ranganathan and M. B. Roy. Pp. 97-116. 1 rupee. Vol. 10A, Part 10: *The Decomposition of Alkaline Earth Sulphates*. By L. A. Bhatt and H. E. Watson. Pp. 117-129. 12 annas. (Bangalore.)

Indian Journal of Physics, Vol. 2, Part 2, and Proceedings of the Indian Association for the Cultivation of Science, Vol. 11, Part 2. Conducted by Prof. C. V. Raman. Pp. 185-266. (Calcutta.) 3 rupees; 4s.

University of Toronto Studies. Geological Series, No. 25: Albertosaurus arctunguis, a new Species of Therapodous Dinosaur from the Edmonton Formation of Alberta. By Prof. W. A. Parks. Pp. 42+1 plate. (Toronto.) 1 dollar.

Report of the Rugby School Natural History Society for the Year 1927. (Sixty-first Issue.) Pp. 45. (Rugby.)

University, Hyderabad. Publications of the Nizamiah Observatory. Astrographic Catalogue 1900.0, Hyderabad Section (Part 2), Dec. −20° to −24°, *from Photographs taken and measured at the Nizamiah Observatory, Hyderabad*, under the direction of T. P. Bhaskaran. Vol. 6: Measures of Rectangular Coordinates and Diameters of 81,821 Star-Images on Plates with Centres in Dec. −22°. Pp. xxxix+270. (Hyderabad.) 15 rupees; 20s. net.

Proceedings of the Society for Psychical Research. Appendix to Part 108, Vol. 36, January. Pp. v+577-633. (London: Francis Edwards, Ltd.) 2s. 6d.

Ministry of Agriculture and Fisheries: Board of Agriculture for Scotland. Report on Dr. Serge Voronoff's Experiments on the Improvement of Livestock. By Dr. F. H. A. Marshall, Dr. F. A. E. Crew, Dr. A. Walton and Wm. C. Miller. Pp. 24. (London: H.M. Stationery Office.) 9d. net.

Colonial Agricultural Service: Report of a Committee appointed by the Secretary of State for the Colonies. (Cmd. 3049.) Pp. 47. (London: H.M. Stationery Office.) 9d. net.

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 66, No. 375, March. Pp. 241-340+xxxii. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

FOREIGN.

Department of Commerce: U.S. Coast and Geodetic Survey. Manual of First-Order Traverse. By Casper M. Durgin and Walter D. Sutcliffe. (Special Publication No. 137.) Pp. iv+133. (Washington, D.C.: Government Printing Office.) 30 cents.

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 37: Land-Grant Colleges, Year ended June 30, 1926. By Walter J. Greenleaf. Pp. vi+75. 15 cents. Bulletin, 1927, No. 38: Record of Current Educational Publications, comprising Publications received by the Bureau of Education during July-September 1927. Pp. ii+50. 10 cents. (Washington, D.C.: Government Printing Office.)

Researches of the Department of Terrestrial Magnetism. Vol. 6: Land Magnetic and Electric Observations, 1918-1926. Magnetic Results, 1921-1926, by H. W. Fisk; Magnetic, Atmospheric-Electric, and Auroral Results, Maud Expedition, 1918-1925, by H. U. Sverdrup. (Publication No. 175.) Pp. iv+524+13 plates. (Washington, D.C.: Carnegie Institution.)

A Photographic Atlas of Selected Regions of the Milky Way. By Prof. Edward Emerson Barnard. Edited by Edwin B. Frost and Mary R. Calvert. Part 1: Photographs and Descriptions. Pp. vi+184+58 plates. Part 2: Charts and Tables. Pp. iv+52+50 tables+50 charts. (Washington, D.C.: Carnegie Institution.)

State of Illinois. Department of Registration and Education: Division of the Natural History Survey. Bulletin, Vol. 17, Art. 1: Epidemic Diseases of Grain Crops in Illinois, 1922-1926. The Measurement of their Prevalence and Destructiveness, and an Interpretation of Weather Relations based on Wheat Leaf Rust Data. By L. R. Tehon. Pp. iii+96. Bulletin, Vol. 17, Art. 2: A Manual of Woodlot Management. By C. J. Telford. Pp. 97-104. Bulletin, Vol. 17, Art. 3: An Epidemic of Leeches on Fishes in Rock River. By David H. Thompson. Pp. 193-201. Bulletin, Vol. 17, Art. 4: The Plankton of Lake Michigan. By Samuel Eddy. Pp. 203-232. (Urbana, Ill.)

Smithsonian Institution: United States National Museum. Report on the Progress and Condition of the United States National Museum for the Year ended June 30, 1927. Pp. ix+221. (Washington, D.C.: Government Printing Office.) 25 cents.

Theophrastus: De Causis Plantarum. Book 1: Text, Critical Apparatus, Translation and Commentary. By Robert Ewing Dengler. A Thesis in Greek presented to the Faculty of the Graduate School of the University of Philadelphia in partial fulfilment of the Requirements for the Degree of Doctor of Philosophy. Pp. 149. (Philadelphia, Pa.: University of Philadelphia.)

Bulletin of the Experiment Station of the Hawaiian Sugar Planters' Association. Entomological Series, Bulletin No. 19: Studies in Tropical Wasps—their Hosts and Associates (with Descriptions of New Species). By Francis X. Williams. Pp. iv+179. Entomological Series, Bulletin No. 20: The Interrelationships of Insects and Round-worms. By R. H. Van Zwaluwenburg. Pp. 68. (Honolulu, Hawaii.)

University of California Publications. Bulletin of the Department of Geological Sciences, Vol. 17, No. 1: A Review of the Fossil Bird, *Parapavo californicus* (Miller), from the Pleistocene Asphalt Beds of Rancho La Brea. By Hildegarde Howard; with an Appendix, Statistical Identification as applied to *Parapavo*, by Frederick H. Frost. Pp. 62+13 plates. (Berkeley, Calif.: University of California Press.) 80 cents.

Proceedings of the United States National Museum. Vol. 72, Art. 5: A Bibliography of the Conodonts, with Descriptions of Early Mississippian Species. By Grace B. Holmes. (No. 2701.) Pp. 38+11 plates. (Washington, D.C.: Government Printing Office.)

University of Wisconsin Studies in Science. No. 4: The Optic and Microscopic Characters of Artificial Minerals. By Prof. Alexander Newton Winchell. With Determinative Tables for Identifying Artificial Minerals Microscopically chiefly by means of their Optic Properties. Pp. xv+215. (Madison, Wis.) 1.50 dollars.

State of Connecticut: State Geological and Natural History Survey. Bulletin No. 40: The Geology of the Shepang Aqueduct Tunnel, Litchfield County, Connecticut. By Prof. William Macdonough Agar; with a Chapter by Robert A. Cairns. Pp. 38+8 plates+2 maps. 50 cents. Bulletin No. 41: Guide to the Geology of Middletown, Connecticut, and Vicinity. By Prof. William North Rice and Prof. Wilbur Garland Foye. Pp. 137+3 plates. 1 dollar. (Hartford, Conn.)

Smithsonian Miscellaneous Collections. Vol. 80, No. 4: Religion in Szechuan Province, China. By David Crockett Graham. (Publication 2921.) Pp. 83+25 plates. Vol. 80, No. 8: Fossil Footprints from the Grand Canyon, Third Contribution. By Charles W. Gilmore. (Publication 2956.) Pp. 16+5 plates. (Washington, D.C.: Smithsonian Institution.)

Publications of the United States Naval Observatory. Second Series, Vol. 11: Results of Observations with the Six-inch Transit Circle, 1909-1918, reduced under the direction of J. C. Hammond, discussed by J. C. Hammond and C. B. Watts; Catalogue of 215 Stars for 1910.0 from Observations in the Years 1909-1910; Catalogue of 2499 Stars for 1910.0 from Observations in the Years 1911-1918. Pp. iii+712+5 plates. (Washington, D.C.: Government Printing Office.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 75: The Perennial Cultivation of Cotton, with special reference to the Cultivation of Ratoons in Egypt. By Dr. James Templeton. Pp. ii+81+11 plates. (Cairo: Government Publications Office.) 5 P.T.

United States Department of Agriculture. Technical Bulletin No. 48: The Western Cedar Pole Borer or Powder Worm. By H. E. Burke. Pp. 16. (Washington, D.C.: Government Printing Office.) 5 cents.

Diary of Societies.

FRIDAY, MARCH 23.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botany Department, Imperial College of Science), at 2.30.—R. S. Pearson: Forest Products Research: Research in Progress at the Laboratory at Princes Risborough.—J. F. Martley: The Work of the Oxford Branch.

PHYSICAL SOCIETY (Annual General Meeting) (at Imperial College of Science), at 5.—Ordinary Meeting:- W. D. Flower: The Terminal Velocity of Drops.—Satyandra Ray: On the Longitudinal Waves along a Rod.—J. J. Manley: On the Damping of Mercury Ripples.—Demonstration of *Die Rustermethode* (the Testing of Spherical Aberration by Means of Shadows in an Astigmatic Beam), by J. E. Calthrop.

SATURDAY, MARCH 24.

ROYAL SANITARY INSTITUTE (at Municipal Buildings, Taunton), at 10.30 A.M.—Discussion on Present Tendencies regarding Disinfection and on House Refuse Collection.

BRITISH MYCOLOGICAL SOCIETY (at University College), at 11 A.M.—Prof. E. S. Salmon and W. M. Ware: Two Downy Mildews of the Nettle. —Dr. E. J. Schwartz and Dr. W. R. Ivimey Cook.—Life History of a New Species of Olpidium.—Symposium on the Nomenclature of "Strains": Dr. W. B. Brierley, Dr. W. Brown, Dr. G. G. Hahn, Dr. H. Wormald.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Transformation of Matter (III.).
HULL ASSOCIATION OF ENGINEERS (at Technical College, Hull), at 7.15.—H. J. Young: The Uses of Metallurgy in Engineering.

MONDAY, MARCH 26.

INSTITUTE OF ACTUARIES, at 5.—T. F. Anderson and H. O'Brien: Notes upon Experiments with Actuarial Functions and Fourier's Series.
ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Prof. W. G. Fearnsides and W. H. Wilcockson: A Topographical Study of the Flood-swept Course of the Porth Llwyd above Dolgarrog.
INSTITUTE OF ACTUARIES, at 5.—T. F. Anderson and H. O'Brien: Notes upon Experiments with Actuarial Functions and Fourier's Series.
INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 6.30.—R. E. L. Maunsell: The Trend of Modern Steam-Locomotive Design (Annual Lecture).
INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—F. H. Rosencrants: Practice and Progress in Combustion of Coal as applied to Steam Generation.
ROYAL SOCIETY OF MEDICINE (Odontology and Electro-Therapeutics Sections), at 8.—Special Discussion on The Pulpless Tooth.—Speakers: —For Section of Odontology: F. Coleman, O. C. Morphy, A. T. Pitts, Dr. A. Livingston, St. J. Steadman, B. Mendleson, and A. F. MacCallan. For Section of Electro-Therapeutics: Dr. H. M. Worth, Dr. G. Murray Levick, Dr. M. Jones, Dr. J. F. Brailsford, N. Grellier, Dr. A. C. Jordan, and Dr. G. B. Batten.

TUESDAY, MARCH 27.

ROYAL DUBLIN SOCIETY (at Ball's Bridge, Dublin), at 4.15.—Prof. H. H. Dixon and T. A. Bennet-Clark: The Effect of Temperature on the Electrical Response of Plants.—W. D. Davidson: (*a*) The Rejuvenation of the Champion Potato; (*b*) A Review of the Literature dealing with the Degeneration of Potato Varieties.
ROYAL SOCIETY OF ARTS (Dominions and Colonies Meeting), at 4.30.
ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.—Prof. D. W. Calmalt-Jones: New Zealand Views on Goitre.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. J. Collier: Epilepsy (Lumleian Lectures) (II.).
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: The Behaviour of Animals (VI.).
INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Annual General Meeting.
SOCIETY OF CHEMICAL INDUSTRY (Yorkshire Section) (jointly with Hull Chemical and Engineering Society) (at Photographic Society, Grey Street, Hull), at 6.45.—Discussion on Some Aspects of the Oil Cake and Feeding Stuffs Industry:—R. A. Bellwood: Fish Meal as a Food for Cattle, Swine, and Poultry.—H. Thompson: The Analytical Aspect of the Oil and Seed Crushing Industry.—G. Milne: Oil Seed Residues in Animal Nutrition.—T. Andrews: Some Aspects of the Fertilisers and Feeding Stuffs Act.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—M. Sargant-Florence: Colour Co-ordination.
INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre—Dublin) (at Trinity College, Dublin), at 7.45.—R. B. Matthews: Electric Ploughing.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Sir Arthur Keith: Human Remains discovered by Sir Aurel Stein in Ancient Cemeteries of the Taklamakan Desert.
ILLUMINATING ENGINEERING SOCIETY.—Discussion: Various Aspects of Street-Lighting.

WEDNESDAY, MARCH 28.

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts), at 11 A.M. —Presentation of Institution Premiums to H. J. R. Biles and W. C. S. Wigley.—Admiral of the Fleet Lord Wester Wemyss: Presidential Address.—Sir John H. Biles: The Present Position of the Question of Fuel for Ships.—At 3.—J. F. King: Bending and Loading of Ships.
ROYAL SOCIETY OF MEDICINE (Comparative Medicine Section), at 5.—T. Dalling, J. H. Mason, and W. S. Gordon: (*a*) Intradermic Tuberculin Testing in Cattle; (*b*) Transference of Maternal Immunity in Sheep.—J. W. Trevan: The Present State of Knowledge of Sex Hormones.—H. J. Parish: B.C.G. Experiments in Guinea-pigs.—C. C. Okell: Diphtheria Infections and Diphtheria Immunity in Horses.
INSTITUTION OF CIVIL ENGINEERS (Students' Informal Meeting), at 6.30. —R. F. Legget: The Limitation of Concrete as a Material in Construction.
INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—J. C. Stewart: Modern Mould Loft Practice.
SOCIETY OF CHEMICAL INDUSTRY (Newcastle Section) (at Armstrong College), at 7.30.—W. E. Billinghame: Emulsions, their Scope and Application.
MERSEYSIDE AQUARIUM SOCIETY (at 1 Falkland Road, Egremont), at 7.30. —A. G. Thtis and W. Mallinson: Demonstration of the Making of Tanks.
EUGENICS SOCIETY (at Linnean Society), at 8.—Dr. F. D. Turner, Lady Askwith, and others: Segregation and Sterilisation.
C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (in Grotrian Hall, Wigmore Street, W.1), at 8.30.—Debate. C. Pilley will maintain: That he agrees the Roman Catholics are right in opposing Dr. Marie Stopes. Dr. Marie Stopes will oppose.
BRITISH ASTRONOMICAL ASSOCIATION (at Sion College, Victoria Embankment).

THURSDAY, MARCH 29.

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts), at 11 A.M. —Eng.-Capt. A. Turner: A Note on Experimental Diesel Engines.—At 12. —Presentation of Bust of the late Sir Philip Watts, by the Right Hon. Winston Churchill.—E. H. Mitchell: Design and Propulsion of Fast Double-ended Screw Vessels.—At 3.—E. L. Champness and F. McAlister: Further Notes on the Relative Strength of Fine and Full Cargo Vessels.—W. Sprague, and the Staff of the William Froude Tank: An Experimental Comparison of the Performance of Model Propellers working in Air and in Water.—At 8.—Prof. E. G. Coker: Stresses in the Hulls of Stranded Vessels.—G. H. Hoffmann: The Effective "I" of H.M.S. *Wolf*.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. J. Collier: Epilepsy (Lumleian Lectures) (III.).
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15—Group-Capt. M. Flack: The Physiological Aspects of Flying (II.).
CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—A. H. A. Gem: Physical Training in its Effect upon the Development of Children.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—F. Lydall: The Electrification of the Pietermaritzburg-Glencoe Section of the South African Railways.
INSTITUTION OF LOCOMOTIVE ENGINEERS (at 296 Vauxhall Bridge Road S.W.1), at 6.—J. Clayton: Engine Failures.
SOCIETY OF DYERS AND COLOURISTS (Midlands Section) (at University College, Nottingham), at 7.30.—Prof. F. M. Rowe: "Azoic Colours."
CHEMICAL SOCIETY, at 8.—A. H. Dickins, W. B. Hugh, and G. A. R. Kon: The Chemistry of the Three-carbon System. Part XVII. α-cyclo-Hexylideneacetone and -methylethyl Ketone.—F. Challenger and A. T. Peters: The Nitration of Aromatic Thiocyanates and Selenocyanates. —F. Ashworth and G. H. Burkhardt: Effects induced by the Phenyl Group. Part I. The Addition of Polar Reagents to Styrene and the Behaviour of the Halogenated Ethylbenzenes.—E. B. R. Prideaux and C. B. Cox: On Selenium Tetrafluoride.
BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (jointly with Psychiatry Section of Royal Society of Medicine) (at 1 Wimpole Street, W.1), at 8.15.—Symposium on The Etiology of Alcoholism. Dr. B. Hart and Dr. E. Mapother for Psychiatry Section, Royal Society of Medicine; Dr. E. Glover and Dr. H. Crichton Miller for Medical Section, British Psychological Society.
INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch).—Capt. H. P. M. Beames: The Reorganisation of Crewe Locomotive Works.
INSTITUTION OF MECHANICAL ENGINEERS (Cardiff Branch).—J. McCarthy: Rubber, and its Uses in Engineering.

FRIDAY, MARCH 30.

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts), at 11 A.M.—Lt.-Col. V. C. Richmond: Some Modern Developments in Rigid Airship Construction.—G. S. Baker and J. L. Kent: Experiments on the Propulsion of a Single-Screw Ship Model.—At 3.—W. G. A. Perring: The Vortex Theory of Propellers and its Application to the Wake Conditions existing behind a Ship.—J. Tutin: Cavitation.—J. L. Taylor: Statistical Analysis of Voyage Abstracts.
INSTITUTION OF LOCOMOTIVE ENGINEERS (Manchester Centre) (at College of Technology, Manchester), at 7.—W. G. Smith: Some Features of the Mechanical and Electrical Equipment of the Port of Manchester.
JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—C. F. Adams: Locomotive Maintenance.
GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—A. G. Davis: The Geology of the Clapham-Morden Railway Extension.—Miss Helen M. Muir-Wood: A New Brachiopod, *Discinisca ferroviæ*, from the Woolwich Beds.—E. M. Venables: The London Clay of Bognor.
INSTITUTE OF METALS (Sheffield Local Section) (in Non-Ferrous Section, Applied Science Department, Sheffield University), at 7.30.—Dr. W. H. Hatfield: Non-Ferrous Metals in relation to Ferrous Metallurgy.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Ernest Rutherford: Radioactive Atoms and their Structure.

SATURDAY, MARCH 31.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 3.—B. E. Houle: The Installation of a Booster Fan.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Transformation of Matter (IV.).

PUBLIC LECTURES.

SATURDAY, MARCH 24.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. E. Marion Delf: Light and Life.

MONDAY, MARCH 26.

GRESHAM COLLEGE, at 6.—G. P. Bailey: Modern Science and Daily Life: High and Low Temperatures.

THURSDAY, MARCH 29.

UNIVERSITY OF LEEDS, at 8.—A. N. Shimmin: Economics in Everyday Life: The Cost of Corporate Life.

FRIDAY, MARCH 30.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.15.—Dr. R. E. Stradling: "Balbus built a Wall" (Bossom Gift Lecture).

CONFERENCES.

MARCH 28 TO 31.

GERMAN BALNEOLOGICAL CONGRESS (at Baden, near Vienna).

MARCH 29, 30, AND 31.

TUBERCULOSIS SOCIETY AND SOCIETY OF SUPERINTENDENTS OF TUBERCULOSIS INSTITUTIONS (in Dunn Laboratory, Oxford).
March 29, at 2.—Discussion on Lupus and its Treatment.
March 30, at 10 A.M.—The Potentially Tuberculous Child.
At 2.—The Treatment of Hæmoptysis in Pulmonary Tuberculosis.
March 31.—Discussion on Intestinal Tuberculosis.

SATURDAY, MARCH 31, 1928.

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Modern Thought.

APPRECIATIVE reference has been made from time to time in our columns to volumes in two comprehensive and stimulating series in which theories and problems of ancient and modern life are surveyed, and suggestive ideas are presented. In one of these series, having the general title "To-day and To-morrow," about sixty volumes have now been published, while in the other—"Benn's Sixpenny Library"—about fifty have been issued, and apparently more than five times that number are eventually to appear. It is not practicable for every addition to these series to be noticed within the limits of space which a weekly journal of science is able to devote to reviews; nevertheless, we are glad to direct especial attention to the two series, because of the number of volumes in them dealing with scientific and other aspects of modern civilisation.

If the function of literature is to unify life and to show men its meaning, "Benn's Sixpenny Library" is a definite contribution to literature. It is also a distinct refutation of the suggestion that cheapness and nastiness are necessarily synonymous. Moreover, it is not an exaggeration to say that the series comprises, in clearly printed and useful form, the most interesting and advanced thought of to-day. The volumes on the atom and on relativity are typical examples of how modern scientific developments can be written so that he who runs may read. Through the whole range of the series there is clearly discernible the thread which binds human knowledge together in significant unity. Whatever may be our view of religion, either as divine inspiration or as mere guesswork concerning our origin and destiny, here are outlines of the great systems which have influenced, and are influencing, the world. Here, too, so that we may understand and pardon even those tendencies and qualities which may appear most unpleasing to us, are historical sketches of Italy, China, India, and Russia.

While, however, it is to history and religion that we may look for causes and explanations in the sense that we would examine more material environment, it is in that mirror of their laughter and tears and their strivings and failings which ordinarily we call literature, that we shall find presented the real character of a people. English, French, and Russian literatures form, therefore, an important part of the series. Intermingled with, growing out of, and in turn guiding all these expressions are the trades by which we

live and the political and economic ideas by which we are governed. None is wholly neglected. The books, therefore, give us a broad vision of human life investigating and modifying its environment, spinning its theories of life and death, recording its ambitions and its disappointments, and dreaming its dreams of the ultimate beauty it so blindly seeks.

The extraordinary progress made by science in increasing our control over Nature has been conditioned and deeply marked by an inevitable trend towards specialisation. More and more we come to see that, while specialisation is essential, it is full of danger. More and more power is placed in human hands, but those who discover that power frequently pay little attention to the ways in which it will be used. They have little time to observe what their fellows are about, and they have still less time to peer into the future and to attempt to visualise the kind of world their united efforts are making; and yet their responsibility as members of a civilised community is enormous. They would hesitate to present a bottle of nitric acid, prettily yellow and delectably fuming, to a nursery full of small children; but they offer equally dangerous gifts to an equally primitive world.

While these absorbed specialists may be so oblivious of the tremendous significance of their tasks, the confused, sprawling, and self-cancelling thing called public opinion is just as uninformed concerning the world which might be made out of such devoted labour. Neither man of science nor layman has the time or the opportunity fully to follow the intricacies of civilisation's myriad activities, and to form any adequate conception of where they are all leading.

It is not too much, therefore, to say that the "To-day and To-morrow" series (London: Kegan Paul and Co., Ltd., 2*s.* 6*d.* net each volume) is aptly named and fulfils a definite need. The books are not ponderous tomes crammed with the hieroglyphics and sometimes incomprehensible jargon of a jealously guarded technique. They are small, well printed, and deal in fascinating sweeps with what may yet be our destiny. It is difficult to select from them, but separate notices of several have already appeared in our columns: of those now before us, we would especially indicate the three which deal with the future of the Press, of Labour, and of Government. Upon the development of all three rests the attainment or otherwise of the dreams and aspirations of both scientific worker and layman.

Tempests and Man.

Great Storms. By Carr Laughton and V. Heddon. Pp. viii + 251 + 13 plates. (London: Philip Allan and Co., Ltd., 1927.) 10*s.* 6*d.* net.

WITHIN comparatively recent times, the calculating wisdom of man has progressed far in the process of rendering Nature innocuous in her evil moods; so far, indeed, that legends declaring her majesty and portraying man trembling on his own hearth, the sport of elements which he cannot restrain, are rapidly going out of fashion. A materialistic age is satisfied to substitute formulæ proving that Nature's latest gesture is only such another trick as might have been expected, and to devise rules by following which we may so fortify ourselves structurally as to give her only a remote and local chance of being dangerously unpleasant.

The shearing of romance and healthy superstition from Nature is to be regretted. Security for its own sake is not a good thing, and in Great Britain we have lately so far magnified our own importance in the universal scheme of things that an unduly wet summer fills the whole community with unrighteous indignation, and the overflowing of the Thames is considered not so much an act of God as a breach of faith on the part of the Government.

The present volume, which reverts to more romantic days, is welcome. It is beyond hope that it will fill the breast of the modern reader with that humility which was wont to be born in the wake of storms of old, but at least it will confirm what Nature is capable of doing, and what, in spite of man's ingenuity, she continues to do in those 'foreign parts' which are the special target of her fury.

As might be expected, the book has a strong flavour of the sea. Familiar titles appear among the twelve chapters—"Armada Gales," "The Last Voyage of the *Elizabeth*," and "After Trafalgar"; but the recounting of these naval epics by authors who are obviously well qualified to speak both for the sailor and the meteorologist is well worth while. What the large and then unknown factor of wind meant to the sailing ships of England, Spain, and Holland in their struggle for sea supremacy is described in vivid narrative, although to the landsman, inclined to be impatient with an era when ships of the line resembled in shape alone the giants of to-day, the authors may appear to have been so liberal with nautical detail that the main theme is from time to time submerged.

Reading of the unceremonious interventions of

the Storm King who in Armada days frequently converted a promising naval engagement into an ignominious *sauve qui peut*, we are led to speculate on the might-have-been in a less windy and weather-beaten world. A very interesting and instructive chapter—"Storms in History"—rather favours the opinion that the course of political development from the earliest civilisation has been oriented in a very minor degree, if at all, by tempests of whatever variety. This very debatable point is not now likely to be decided. It would be a fascinating research, however, granted a long enough span of life, to work out a probable map of the world based on the assumption that Noah had not been incommoded by a flood, or that fine and not stormy weather prevailed when certain historical battles were fought, or that, say, less vigorous convection had obtained at the time when hailstones resulted in the Treaty of Bretigny. Unfortunately, the effect of a severe storm on air navigation does not come within the scope of the book. Remembering the providential failure of a Zeppelin raid—a meteorological success in a negative sense—we cannot doubt that storms may yet make history.

There is an excellent account of what is rated the greatest storm ever experienced in the British Isles, that of November 1703. There seems to be every reason to suppose that this storm does take pride of place, but we would feel happier in our estimate if more official records and something resembling a Beaufort scale had been available to curb the overwrought imagination of the sufferers. The centre of that storm passed near to Liverpool. Lately, as a culmination of the furious gales already recorded in 1928, the wind at Liverpool attained a speed of 104 m.p.h., but this latter-day gale is unlikely to receive more than an honourable mention. It may be that the surface obstacles to-day are too many and too stout to give the wind a fair chance. However, the storm that introduced Addison to fame and incited Defoe to count 17,000 trees blown down in Kent, certainly merits a place in history.

In chapters dealing with the West Indian hurricanes, the China Seas typhoons, and the world's "Windy Corners," the meteorology of the winds is happily blended with descriptive narrative. An illuminating account of the Tay Bridge disaster and of the subsequent inquiry finds a suitable place. The theme is varied by a chapter on historical volcanic storms, in which Nature's most awe-inspiring and most destructive efforts are presented in realistic language.

A lighter note is struck in the final subject—winds and superstitions—an engrossing chapter on those mythological associations which for centuries have exercised the force of religion on the mind of the seaman.

The book adds the advantage of historical fact to the entertainment of a novel, and will make a general appeal. The meteorologist will find much of special interest and, incidentally, a vindication of his own calling if such were needed nowadays; for whereas to-day, with ships hundreds per cent. more seaworthy, weather reports and gale warnings are considered indispensable to navigation, it appears that the conservative skipper of Piddington's time, rather than accept that gentleman's Law of Storms and sail for safety, frequently sank both his pride and himself in a cyclone.

The prevalence of January and February in the dates associated with historic storms, and the fact that the worst damage could nearly always be attributed to the venom of a 'secondary,' suggest that, meteorologically, 1928 has upheld tradition. In the light of recent happenings, particular interest attaches to the reference to flood tides on p. 6, where the authors' remarks on the chance of a northerly gale driving water into the cod of the North Sea to cause a Thames flood seem to have been prophetic.

A uniformly high literary standard is combined with popular treatment and a wealth of detail which is highly diverting. The general presentation is excellent and the illustrations are well chosen. Mr. Cecil King, R.I., may have taken a rather rough view of the sea; but his drawings convey the required impression, and in the circumstances few will be found competent to offer authoritative criticism.

E. TAYLOR.

Physiology in Great Britain.

History of the Physiological Society during its first Fifty Years, 1876-1926. By Sir Edward Sharpey-Schafer. Pp. iv + 198. (Cambridge: At the University Press, 1927.) 15s. net.

THIS "History of the Physiological Society" has been written by its only surviving and still active original member, Sir Edward Sharpey-Schafer, who undertook it as a labour of love, and has succeeded in presenting a wonderfully attractive account full of biographical details and human touches. The thumb-nail sketches of deceased members are illustrated by small portraits let into the page in the position of an illuminated initial letter; many of the photographs of the earlier members present them with a youthful appearance

unfamiliar even to those who are now of an age when superannuation and retirement are in the near offing. The notices themselves have the charm conveyed by personal knowledge and kindly humour: thus, "Foster's success was, however, not due entirely to his influence over the younger Cambridge biologists (Gaskell, Balfour, Langley, Newell, Martin, and Sheridan Lea), but quite as much to the power he had of influencing senior members of the University, who were not long in recognizing that a prophet had arisen amongst them who would make the bones of biological science, which had become very dry in Cambridge, live again." The occasional reproduction of signatures at meetings and dinners adds a further interest to what is, among other things, a dictionary of physiological worthies.

This story of the Society and its members, with a general record of its scientific activities, begins by showing how British physiology, which in the middle of the nineteenth century was far behind that of France and Germany, began to rise to its present high position. Prof. William Sharpey (1802–1880), anxious to improve the teaching of physiology at University College, London, enlisted Michael Foster's services as professor of practical physiology; this appointment of "the actual begetter of the Physiological Society" was pregnant with importance to the future of physiology in England. In 1870, Foster went to Trinity College, Cambridge, as prælector in physiology, and Burdon-Sanderson took his place at University College, succeeding Sharpey in 1874.

The conception of the Physiological Society two years later was primarily the result of the anti-vivisection agitation, an example of *Ex malo bonum*. Its object as defined in the first rules was to promote the advancement of physiology, and to facilitate the intercourse of physiologists, which it has done in a remarkable manner by providing opportunities for preliminary discussion and helpful criticism of work and the formation of pleasant friendships. The influence thus exerted by intimate personal contact and overcoming the disadvantages inherent in the otherwise inevitable system of work in the lonely furrow must obviously have been most valuable. Michael Foster's genial personality was a great asset in bringing together workers not only in Great Britain, but also from abroad, and as bearing on this, Sir E. Sharpey-Schafer's account may be quoted of Foster, when president of the British Association at Dover in 1889, welcoming and saluting *more gallico* the president of the corresponding French Association.

Among the founders of the Physiological Society were George Henry Lewis, who, with George Eliot, was concerned in the establishment of the prælectorship in physiology at Trinity College, Cambridge, Francis Galton, William Bowman, T. H. Huxley, F. W. Pavy, W. H. Gaskell, F. M. Balfour, Gamgee, Klein, Langley, and G. J. Romanes, who, at one time intent on taking orders, veered round to entire scepticism, and eventually returned to religious orthodoxy. A very important outcome of the Society's enthusiasm was the *Journal of Physiology*, which, largely by the liberality of the late A. G. Dew-Smith, was started in 1878 and first edited by Foster; it was taken over in 1893 by J. N. Langley, who also became its proprietor and was a model editor until his lamented death in 1925, when the financial responsibility was resumed by the Society, and an editorial board of four members, with Sir Charles Sherrington as chairman, was appointed.

At the end of 1880, the most important feature of the Society—the special afternoon meetings for the demonstration of physiological work—was instituted; at first it was understood that there should not be any sort of publication of these activities, which were to be private and confidential, and more intended to elicit remarks and criticisms of work in progress than with any idea of preliminary publication of accomplished research. Later, in 1883, it was resolved to print and publish as the *Proceedings of the Physiological Society* any communications which members might desire in the *Journal of Physiology*. These *Proceedings* show that all important advances in physiology made in Great Britain during its existence have in the first instance been brought before the Society, and thus form a record of which any society might be proud.

The Kinetic Theory.

Statistical Mechanics with Applications to Physics and Chemistry. By Prof. Richard C. Tolman. (American Chemical Society Monograph Series.) Pp. 334. (New York: The Chemical Catalog Co., Inc., 1927.) 7 dollars.

THE younger generation is not infrequently reproached with lack of respect for its scientific fathers. The complaint is probably unfounded, but, even if it were a just one, the younger chemists at least might plead that they had in some ways been set a bad example. The atomic theory is the keystone of chemistry: two generations ago the mechanics of atoms and molecules was worked out with the very minimum of assumptions which increasing knowledge might invalidate, but the results

of this great achievement were more or less ignored for a generation. Only now are the kinetic theory and statistical methods coming into their own; and yet this branch of knowledge is a peculiarly important one. Nearly everyone, with or without particular philosophical reservations which his attitude towards the theory of knowledge may dictate, believes in the existence of molecules which move and in some way exert influences upon one another. Moreover, even idealists will admit that within the narrow confines of scientific realism a certain coherence may be achieved by introducing a quantity called energy. Statistical mechanics, which provides a means of determining such important matters as the distribution of energy among molecules, and its rate of transfer, without intimate knowledge of the nature of molecular interactions, is a magnificent compromise between the rather cold agnosticism of thermodynamics and that kind of more detailed theory which at present would be premature and doomed to failure.

Prof. Tolman's book contains both a systematic derivation of the principal results of the kinetic theory and an account of many applications. It differs from most other books on the subject in giving special prominence to the discussion of chemical reaction velocity.

Many methods of treatment are possible: the method of statistical mechanics in its classical form, the exposition of which is the first object of the book, is the most general, and in many ways the most rigid and fruitful, but it is, of course, not the least abstract. The important statistical laws are sometimes more easily derivable in special forms. Perhaps for this reason the book may appeal more to physicists interested in chemical problems that to chemists anxious to equip themselves with an important weapon. However, the first two chapters begin at the beginning: and in Chap. ii. there is a brief treatment of general dynamical principles, including Lagrange's function and Hamilton's equations. This part would be made much more useful by a little illustrative expansion.

The third chapter deals with phase spaces, ensembles, and Liouville's theorem. The ergodic hypothesis is discussed in an interesting way—illustrating that physical intuition can seldom be dispensed with in mathematical physics. In the following three chapters the Maxwell-Boltzmann law is derived and applied. Points of special interest here are the discussion of the approximation involved in introducing Stirling's theorem, an illuminating account of deviations from the most probable distribution, and a neat treatment of equipartition.

The remaining eighteen chapters are grouped by the author under the headings: Introduction of the quantum theory; application to molecular processes; the rate of physical-chemical change; and conclusion.

One of the most pleasing things about the book is the amount of actual physical and chemical information contained in the sections devoted to the applications of the fundamental method. The style is lucid, and there is a welcome frankness about underlying assumptions. Nothing makes for obscurity more than their surreptitious introduction, the reader being left to infer a logical necessity. The Einstein treatment of radiation is, for example, often given in a very puzzling form. Tolman, in the course of an excellent section on radiation, discusses clearly the nature of the assumptions made in introducing the two emission coefficients.

A great chemist once said "Physical Chemistry is all very well but it does not apply to organic substances." On p. 152, Prof. Tolman is to be observed giving the chloroform molecule three hydrogen atoms and one chlorine atom—without invalidating his argument; which is something of a *revanche*!

Research in the Cotton Industry.

Research in the Cotton Industry: a Review of the Work of the British Cotton Industry Research Association up to the end of 1926, carried out under the direction of the late Dr. Arthur William Crossley. Edited by Dr. Robert H. Pickard. Pp. xv + 80 + 10 plates. (Manchester: Shirley Institute, 1927.) 5*s*.

THIS book is a very readable report of five years' progress in industrial research carried out by the British Cotton Industry Research Association under the direction of the late Dr. A. W. Crossley, and may be considered as a memorial and tribute to him, who devoted the last days of his life to one of the most arduous of tasks, namely, the focusing of scientific talent on the problems of an industry in which the field of such endeavour is anything but clear.

The chief difficulty with which the industrial, as distinct from the academic, research worker has to contend is the suitable propounding of the result of his work; for not only must he provide a complete record for the benefit of other workers on his subject, but he must also endeavour to see that in some way the practical information made available may be comprehensible to the non-scientific industrialist. Unfortunately, these two objects cannot easily be

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reconciled, as each requires its own particular treatment, and compromise is practically impossible. Hitherto, the Shirley Institute memoirs have taken the form of scientific papers, and those who have read the publications of them in the *Journal of the Textile Institute* will no doubt appreciate the difficulty experienced by the layman in picking out the salient points of such reports, cloaked, as they must be, in scientific terms, and written in a precise but, to him, somewhat dull manner. The language of the research worker is not the language of the man in industry. The need, therefore, has been for what one might call a 'popular' exposition of the results achieved in connexion with the various problems that have been tackled; and the book under review satisfies this need in a most successful manner, and is a credit to those responsible for its publication.

In the introduction reference is made to various special cases of difficulty which have been successfully dealt with, and it is at once made clear what a very large field of fundamental research has had to be covered. Two of the most important factors governing the quality of textiles are uniformity and consistency, and it is natural, therefore, that a considerable amount of time should have been given to determining to what extent the shortcomings in these respects can be attributed to the raw material itself. The physical and chemical characteristics of a great variety of cottons have accordingly been investigated (Chap. i.), and, in addition, problems appertaining to bacterial and fungal infection during conditioning have been tackled.

The researches in spinning and doubling (Chap. ii.) have been largely devoted to studies of the effect of various processes on the physical properties of the products, and attention has also been given to devising improved methods of carding and drafting.

Good sizing is of very great importance to the weaver and to the finisher, and has received its fair share of attention. Reference is made (Chap. iii.) to investigations carried out to determine what factors influence successful treatment of the material, and how the danger of mildew infection can be reduced to a minimum.

Chap. iv. may disappoint some because of its brevity; but the Association appears, rightly, to have deferred work on weaving proper until the fundamental properties of cottons and yarns have first been systematically studied. Even so, it is recorded that work on the problems of the manufacturing section of the industry is now in hand, and would seem to give promise of some interesting results.

Chaps. v., vi., and vii. refer to researches on bleaching, dyeing, and finishing, among which might be mentioned those on the loss of weight in scouring; the removal of oil, rust, and other stains; the causes of tendering during bleaching; the effect of mercerisation on hair dimensions; the effect of variations in raw material on its reaction to dyeing and finishing; and on the schreinering process.

In Chap. viii. are described some of the instruments that have been designed and made at the Institute to enable the work outlined in this book to be prosecuted.

W. E. MORTON.

Our Bookshelf.

Flora of West Tropical Africa: the British West African Colonies, British Cameroons, the French and Portuguese Colonies south of the Tropic of Cancer to Lake Chad, and Fernando Po. By J. Hutchinson and Dr. J. M. Dalziel. Prepared at the Herbarium, Royal Botanic Gardens, Kew, under the supervision of the Director. Published under the Authority of the Secretary of State for the Colonies. Vol. 1, Part 1. Pp. x+246. (London: The Crown Agents for the Colonies, 1927.) 8s. 6d.

THIS new work, the result of the collaboration of two officers of the Kew Herbarium, will be very welcome to all interested in the flora of west tropical Africa, as well as to systematic botanists in general. In its handy form it will be in greater daily use by the field worker in that region than the monumental "Flora of Tropical Africa," indispensable as that work is for reference. The area covered is a wide one, and includes not only British possessions and mandated territories, but also some administered by the French and the State of Liberia.

The present part contains the Gymnosperms (two only) and rather more than half the families of the Dicotyledons. The systematic arrangement adopted is that devised by one of the authors, Mr. J. Hutchinson, which was published in 1927 in his book "The Families of Flowering Plants." The system is explained in a brief note on p. 42, and its sequence displayed on pp. 43 and 44.

The descriptive part has been condensed by adopting the arrangement, already in use in several similar works, of descriptive keys for the genera and species. This is a convenient method for the field worker and has the merit of saving space, a very desirable quality in unsettled countries where transport facilities are lacking. The value of the work is greatly enhanced by about a hundred excellent detailed figures illustrating the most typical plants of the more important genera. Some of these are from drawings by Mr. Hutchinson, but the majority are the work of Mr. W. E. Trevithick.

An outline map indicates the area comprised. Several pages of the preamble are devoted to an interesting record of botanical exploration in

the several countries included, and it also offers a comprehensive bibliography. Finally, one is thankful for a handy glossary of botanical terms illustrated with a number of illuminating figures.

The key to the families is entirely artificial, and follows that, now becoming familiar, devised by Mr. Hutchinson and employed in his earlier work already referred to above. C. E. C. F.

La question eugénique dans les divers pays. Par Dr. M. T. Nisot. Vol. 1. Pp. 513. (Brussels: Librairie Falk Fils, 1927.)

Dr. Nisot has had the useful idea of collecting all the available information on eugenic activities and tabulating it by countries. The present volume contains the information for Great Britain, the United States, and France, and is introduced by a comprehensive historical sketch. Volume 2 is promised shortly, and will include the facts for most other nations.

The author has, it must be confessed, thrown her net rather widely. Not only does she include eugenics in the usually accepted sense of attempts to improve the germplasm of the race; not only birth-control, and the regulation of immigration, which both obviously can have potent effects for good or for evil upon that germplasm; but also all sorts of activities devoted to improving the health and conditions of the individual, such as organisations for combating venereal disease, tuberculosis or alcoholism, the education of mentally subnormal children, infant welfare centres, and so forth. It seems a pity that these were included. For one thing, they have no direct eugenic bearing in any proper sense of the word, and for another, if they are included, why are not all organisations aimed at ameliorating the conditions of life included? Venereal disease, in spite of the possible transmission of the causative agent to the offspring, is not an affair of eugenics, but of public health; and if the education of mentally deficient children is included, why not education in general? As matters stand, the presence of these sections in the book only confuses the issue.

On the side of eugenics proper and of the associated topics of birth-control and immigration control, however, the book will be found very useful. It is extremely desirable to have such sources of information available. The historical account for each country, though brief, is valuable; and nowhere else in convenient form will be found a statement of what organisations exist in each country.

O povaze věcí. Napsal Sir William Bragg. Přeložili Prof. Dr. Antonín Šimek a Dr. Hannah Šimková-Kadlcová. Pp. 136 + 32 tabulky. (Prague: Jednota Československých matematiků a fysiků, 1927.) Kč. 22.80.

Of the three Czechoslovak universities, those at Prague and Brno possess faculties of science. The University of Prague dates from 1347, but the Masaryk University of Brno, at which Dr. Šimek is professor of physical chemistry, was only founded after the War. It has therefore no traditions, and before schools of research are established it has been necessary for such leaders as Prof. Šimek to inculcate the spirit of scientific inquiry both by their academic lectures and by presenting the students with a literature in their own language.

Instead of writing a new book, Prof. Šimek has elected to translate Sir William Bragg's "Concerning the Nature of Things," which was the subject of his Royal Institution juvenile lectures in 1923. These lectures, Prof. and Mrs. Šimek point out in the preface to their translation, were inaugurated by Michael Faraday, and are models of approaching the subject to young minds since they retain and stimulate scientific accuracy. The high standard set by Faraday, for example, in his "Chemical History of a Candle," has been maintained by his successors, and Prof. Šimek was so impressed with the inspiration to be derived from those by Sir William Bragg that he decided to translate the book for the benefit of his own students.

Of additional interest is the fact that the last chapter on the nature of crystals deals with the results obtained by Sir William and Prof. W. L. Bragg in their X-ray studies of crystal structure. Prof. Šimek enthusiastically compares the lectures to Lucretius's poem "De rerum natura," with the important difference that the present work is no idle fantasy, but rests upon the sure foundation of scientific fact. J. G. F. Druce.

Elementary General Physical Science. By W. R. Jamieson. Pp. xi + 63 + 88 + 147 + x + 16 plates. (Melbourne and London: Macmillan and Co., Ltd., 1927.) 8*s*. 6*d*. net.

'Science for All' is the reaction against undue specialisation in the schools, but there is the danger of making the subject so discursive that it ceases to be science. Mr. Jamieson's attempt to provide a broader survey of science for Australian schools consists in the main of an account of some of the great discoveries in chemistry, physics, and astronomy, with adequate and interesting historical details; while every opportunity is seized to introduce pieces of information. Thus, thirty-seven pages on energy include the spectrum, voltaic cells, Gay Lussac's law of volumes, oxidising agents, hydrocarbons, isomorphism, magnetism, galvanometers, dynamos, radium, lenses and telescopes, and end with the periscope of a submarine. While much can be said in favour of such a course, we suggest that to sacrifice depth of culture to obtain breadth is not a scientific method of producing a good harvest.

Chemistry. By W. H. Barrett. (Clarendon Science Series.) Pp. viii + 151. (Oxford: Clarendon Press; London: Oxford University Press, 1927.) 5*s*. net.

Mr. Barrett's book gives a clear account of some of the simpler chapters of chemistry, with indications of their bearing on everyday life. There is a good chapter at the end on the modern theory of atomic structure. The book is suitable for the general reader who wishes to obtain some idea of modern chemistry.

Letters to the Editor.

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Liquid Stars and Atomic Volume.

THE problem of the general state of matter at high temperature is so fundamental in stellar physics that I venture to pursue the discussion with Dr. Jeans (NATURE, Feb. 25, p. 278). I would first thank him for his reply to my letter, which, though I differ from it on a number of points, deals fairly with the questions raised. I still believe I was not exaggerating in saying that Jeans's theory requires that the ions (in giant *M* stars) should be so large that they jam at densities $\frac{1}{100}$ that of air. Jeans wishes to amend this to 80 × air. But my figure represents the order of magnitude of the central density of Betelgeuse according to the usual gas model, and he has himself said that the star contracts as a gas until there are substantial deviations from the gas laws in the central regions. To form his liquid core of higher density it would seem that Betelgeuse must have contracted as a gas to $\frac{1}{20}$ its present radius, and then for unexplained reasons thrown out a gaseous envelope filling the present volume. Or starting from his liquid core of density 80 × air, we have to face the problem of balancing on this a gaseous atmosphere containing much less mass and subject initially to 8000 times the gravitation of the ordinary model. I think that to achieve this Dr. Jeans will have to depart much more widely from current theory than he intended.

Again, Dr. Jeans favours the hypothesis that long-period variables are pulsating stars. Like others, he finds this supported by the relation of period to density. It is well known that the periods and densities fit approximately if the usual densities are accepted; but the agreement will not be maintained if the dynamical behaviour is determined by a liquid core of density 8000 times greater. The high density and comparative incompressibility would make the period much too short.

Accordingly, I do not give up my point that Dr. Jeans requires the ions to have diameters 50 times greater than the ordinary neutral atoms. For the rest of this letter, I am content to accept his own estimate of diameters 50-80 times the diameter of the electron system in the Bohr model, which he agrees is "a bit perplexing," but will not admit as "certainly wrong." May I protest that the words "certainly wrong" were not used in this connexion in my letter? They were applied to one of his defences (or suggestions) beginning with "we might, in any case, expect," referring therefore to current knowledge and not to unforeseen developments of atomic theory. The expectation was one which would seem very plausible to most readers, who naturally think that the classical electrostatic repulsions between the ions, by tending to prevent unduly close approaches, have effect equivalent to atomic volume. When, however, the attractions between ions and electrons are included and the whole correction to the pressure is calculated according to the general methods (set forth clearly in Jeans's "Dynamical Theory of Gases"), it is at once found that the electrostatic forces actually give the reverse effect to atomic volume. The material accordingly remains as compressible as (or more compressible than) a perfect gas until the density is so great that non-classical reactions become important. There we come to more doubtful ground, but the general cause of the atomic volume effect in ordinary gas seems fairly clear. It is not the ions, but the bound electrons which set a limit to the packing. One quantum orbit or one unit cell of phase-space is required for each electron. With increasing density the cells become filled, and ultimately we should be unable to proceed further without squeezing electrons out of the material. Alternatively, if the electrons are endowed with high energy extra cells of phase-space corresponding to high velocities become available, and the congestion is relieved. In this way high temperature obviates the congestion that gives rise to atomic volume effects.

With ions distant 50-80 times their own diameter and any number of intervening quantum orbits lying vacant, there is no approach to the congested condition. I think that a quantum physicist confronted with such a problem would not hesitate to treat it by classical perturbations in accordance with the Correspondence Principle. Dr. Jeans seems to be demanding something which goes against not the details, but the broadest principles of the quantum theory. Even the broadest principles may of course need amendment, and it would be rather pleasing if astronomical results were definite enough to dictate amendment; but I have devoted part of my former letter to challenging Jeans's argument that considerations of stability make the liquid star theory *compulsory*. To my mind the main interest in the theory of the constitution of the stars lies in connecting the laws and conclusions reached by physicists with those discovered in astronomy; if once we begin modifying the former, the investigation loses definite aim and takes on a speculative character. If a new astronomical theory provides its own rules for atomic volume, it may equally well provide its own rules for the absorption coefficient, etc.

With regard to the significant features of the Russell diagram, which Jeans believes to be explained by his theory, I admit his counter charge that I am waiting for something to turn up. It is possible in cosmical theories to be too precipitate.

A. S. EDDINGTON.

Observatory, Cambridge,
Mar. 7.

I CAN only adhere to my original views as to atomic diameters. Prof. Eddington tries to challenge my position by arguments based on "the usual gas model." By this I think he means his own gas model, which is of a very special and restricted type, and by no means characteristic of the general gaseous configurations of a star. I believe his difficulties arise solely from the defects of his own model.

Eddington's model is developed from the assumption that the generation of energy per unit mass G is connected with the coefficient of opacity k by the relation

$$G = \frac{1}{\rho r^2}\frac{d}{dr}\left[\frac{1}{k}\int_0^r \rho r^2 dr\right] \times \text{constant}.$$

This seems to me an extraordinarily artificial relation. As Russell has repeatedly pointed out, it makes G violently negative in the outer layers of the star, so that these re-destroy the energy created in the inner layers, only a small balance escaping from the star as radiation. I think I am right that the reason why Eddington adopted this surprising value for G was merely that it makes the equations integrate out with amazing ease—in fact, just like a Tripos problem.

When this special value for G is discarded, the problem of gaseous stars becomes far more complex. I have given partial solutions in the *Monthly Notices of the Royal Astronomical Society* (1925 and 1926), and a fuller solution appears in a book, "Astronomy and

Cosmogony," shortly to be published. Eddington's model gives a central density uniformly equal to 54·4 times the mean density. My general solution shows that with energy generated fairly uniformly throughout the star's mass, this factor is increased to anything from 88 to infinity, according to the star's mass. A very rough calculation (*Mon. Not. R.A.S.*, **87**, p. 40) gave the central density of a gaseous Betelgeuse as 2, or 1600 times that of air, as against the $\frac{1}{1000}$ that of air given by Eddington's model. This was before I was contemplating liquid stars, and I was worried to find that the density was inconsistent with the gas laws being obeyed. I lay no stress on the actual value; indeed, other calculations have given 0·1 and 0·04. My point is that when the special restrictions of Eddington's model are discarded, his dynamical case against liquid stars disappears. No gaseous envelope need be "thrown out," for it is already there in a gaseous star with any reasonable generation of energy, and is 'balanced,' not only against 8000 times but even against 160,000 times the gravitation of Eddington's restricted model.

The high central density is a consequence of the large mass of Betelgeuse. If Eddington had produced a star of low mean density and small mass, I could not have met his objections. It is, I think, significant that no such stars exist. The theory of liquid stars explains that such stars cannot exist, because they would be unstable, and so accounts for the observed gap between giants and dwarfs.

Similar considerations apply to the long-period variables, since these also are very massive. The density is more uniform in a liquid star than in a gaseous star, so that the period–density law is better obeyed. I think that Eddington's argument as to "dynamical behaviour" contains a further fallacy, as can be seen by passing to the limiting case of an incompressible core of high density; the pulsations become purely atmospheric and have long, not very short, periods.

I agree with Eddington about the electrostatic forces and quantum dynamics. I never meant, however, to suggest that, other things being unchanged, rising temperature could increase effective diameters. What I had meant to suggest, as a conjecture, was that, as successive ionisations occurred, it might increase the ratio of effective diameter to Bohr-diameter, this being all I needed. I am sorry if I did not make this clear. If, as I think, stability considerations rule out gaseous stars, then all this becomes unimportant; the theory of liquid stars is also freed from the speculative taint Eddington sees attached to it. Indeed, it becomes the obvious high road of progress, as is also suggested by the fact that stars break up under rotation in the manner of liquids, not of gases.

J. H. JEANS.

A New Injection Mass—Rubber Latex.

THE principle applied in the utilisation of rubber latex as an injection mass is the fact that the latex of the rubber tree—*Hevea brasiliensis*—coagulates to form rubber in the presence of dilute organic acids such as acetic or formic. After tapping the rubber tree, the collected latex may be preserved in a fluid condition by the addition of ammonia, and I believe it is exported from Ceylon preserved in this way. The latex which I used in my first injections was obtained more than three years ago, when ammonia to the extent of 5 per cent. was added to it, and although, standing so long, it had become creamy at the surface, it regained its normal fluidity on shaking. Latex is of the consistency of milk, so no difficulty arises in its introduction into blood-vessels or its penetration into the finer capillaries.

It is advisable to wash the blood out of the vessels of a newly killed animal with normal saline to which a trace of sodium bicarbonate has been added. The latex may then be injected with a syringe, glass injection-pipette, or in the case of small animals with a hypodermic syringe. When the injection is complete the canula or needle is withdrawn from the vessel, and a drop of acetic acid on the wound will close it with a clot of coagulated rubber. Also, if any small vessels have been cut in the preliminary dissection to expose the vessel for injection, bleeding can be stopped by sponging the cut part with acetic acid. The injected fluid is converted into rubber on the immersion of the animal in dilute acetic acid, which quickly penetrates the tissues and coagulates the latex. Although general coagulation commences so soon as the latex is acid to phenolphthalein, it is not complete until there is a slight excess of acid; and I find that in the case of whole animals the process is hastened by pouring 20 per cent. acetic acid into the body cavity. In this way the fluid mass is converted into an elastic solid, which, even in the smaller vessels, possesses amazing strength and elasticity.

If pure latex is used the resulting injections are white, but better results may be obtained by using it as a vehicle for different colouring masses. Carmine dissolved in ammonia and added to the latex gives very good results. Prussian blue becomes grey when mixed with ammoniacal latex, but regains its blue colour when the acid is added for coagulation. Specimens injected with Prussian blue are best preserved in spirit, for the colour tends to transude in formalin and stain the surrounding tissues. Methyl blue gives good results, but methylene blue and methylene green cause coagulation of the latex. As latex is not a viscous fluid, the use of solid precipitates such as French blue, red-lead, or mercuric iodide as colouring masses presents difficulties, for if much precipitate is added the physical action of the finely divided solid causes coagulation, and if a little is added it quickly precipitates itself, either before use or to one side of the blood-vessel. These difficulties may be overcome by adding glycerine to the latex. One volume of glycerine to three or four of latex gives a medium sufficiently viscous to prevent rapid sedimentation and of a sufficiently high rubber content. The colouring mass should be mixed with the glycerine first, and this mixture stirred into the latex.

The following are a few of the formulæ I have found useful:

Carmine Latex Mass.

Carmine	2 gm.
Ammonia	5 c.c.
Water	5 c.c.

Break the carmine up to a fine powder in a mortar and add the ammonia and water, stirring until a dark but clear solution is obtained. 1 c.c. of this carmine solution should be added to every 30 c.c. of latex required, and an injection mass is obtained which will keep indefinitely. I find this the most useful injection mass.

Methyl Blue Latex Mass.—5 c.c. of a 2½ per cent. solution of methyl blue in water should be added to every 25 c.c. of latex. The injection mass is of a pale blue colour, but becomes bright on the addition of the acetic acid.

Prussian Blue Latex Mass.

Prussian Blue	1 gm.
Glycerine	5 c.c.
Latex	25 c.c.

Prepare Prussian blue by adding a strong solution of ferric chloride gradually to a concentrated solution of potassium ferrocyanide, filter the precipitate through fine silk, wash in water, and dry. 1 gm. of the dry solid should be ground up in a mortar with 5 c.c. glycerine, which mixture should be stirred into the latex.

My preparations have been mainly of those vertebrates used in my practical classes—frogs, lizards, pigeons, and rats, and one invertebrate which I injected —*Achatina fulica*, the giant African land snail—made a successful preparation. Prof. A. G. Smith, professor of anatomy at the Ceylon Medical College, assisted me in the injection with carmine-latex of a human fore-limb which had been previously injected with formalin by the method usually adopted for such subjects. He has dissected the preparation and finds that the latex injection shows up the vessels as well as the ordinary red lead method, with the additional advantage that the smallest vessels can be dissected to their ultimate distribution without breaking. On account of the formic acid present in commercial formalin, specimens which can only be injected after preservation should be preserved in non-acid formalin, prepared by the addition of 5 gm. borax to every litre (W. R. G. Atkins, *Jour. Marine Bio. Ass.*, **12**, No. 4, 1922).

A few of the advantages of this technique are the following: There is no danger of solidification of the mass before the injection is complete, as so often happens with warm injection masses; the injection mass does not extravasate; the vessels are strengthened without rigidity, allowing an extensive dissection or exploration after injection; and, even if the walls of the vessel are damaged in the subsequent dissection, the solid rubber core of the vessels remains. From one point of view this method is like de Fol's metagelatin method, but coagulation is much easier with latex, and the resulting rubber is strong and elastic. It does not appear to be applicable to material for sectioning, but I have found it ideal in the preparation of museum specimens, for class demonstrations, and ordinary dissections of vascular systems.

I have to thank Mr. E. C. de Fonseka, Colombo, for supplies of latex, and also the Rubber Research Scheme here for latex, and in particular its chemist, Mr. T. E. H. O'Brien, for information regarding coagulation. He says, regarding supplies of latex, that it is doubtful whether there are any general importers into England, except to fulfil specific orders, but he thinks that the Rubber Growers' Association, Incorporated, 2 Idol Lane, Cheapside, E.C.3, would be willing to supply or arrange for supplies for experimental purposes.

D. R. R. BURT.

Ceylon University College,
Colombo, Feb. 22.

The Ovarian Hormone.

THE problem of the prevention and interruption of pregnancy by physiological means is attracting considerable attention at the present time, and several investigators are reporting results of importance. Some, however, would seem to be unaware of similar work already carried out. It was in 1925 that I first reported that pregnancy could be interrupted by the injection of the so-called œstrous hormone (*Biol. Ges. zu Wien*, Dec. 7, 1925). At that time I was using extracts prepared by Heinlein and Hohlweg, and others prepared and used by Steinach, Heinlein, and Wiesner in earlier investigations. Fellner (*Wr. klin. Wschrift*, 1926) raised the objection that the effect of these extracts might be due to the action of non-specific substances included therein. By using highly purified extracts, prepared for the most part by Dohrn and his co-workers, I was able to remove this objection, since abortion was produced in rats, guinea-pigs, and mice, even when small doses, 0·0002 mgm., were administered. Injections of many times this quantity of other substances (lipoids) produced no effect. Since more units (mouse-units) are required when moderately pure extracts are used, it is reasonable to assume that in these cases the effect was due to the specific action of the hormone.

The working hypothesis which has guided me in this work is that there exists a certain correspondence between the phases of the sexual cycle and the level of the œstrous hormone. It will be recalled that the genitalia of those animals which have a diphasic sexual cycle (rats, mice, guinea-pigs, cattle, sheep, dogs, etc.) exhibit two successive states. The uterus and other organs first pass through the sexual (œstrous) phase and then through the reproductive phase (pregnancy or pseudo-pregnancy). As both phases are occasioned by the endocrine functioning of the ovary (as is definitely proven in the case of pseudo-pregnancy), the question arises as to what the mechanism is that is responsible for the change from the first to the second phase. Two possibilities present themselves. There might be a change either in the quality of the ovarian hormone or else in the manner in which the uterus and other genitalia react to the follicular hormone.

During preliminary experiments, it was found to be impossible to provoke the typical phenomena of the first or sexual phase by injection of œstrous hormone during pregnancy. This result seemed to indicate that the change from first to second phase was due to an altered power of reaction on the part of the genitalia to the follicular hormone. But in the spayed female it was found to be impossible to provoke the exhibition of the phenomena of the reproductive phase even when using large quantities of œstrous hormone and under conditions similar to those that operate in the case of the normal animal (coitus, etc.). It was assumed, therefore, that this œstrous hormone is but one of the factors constituting the ovarian hormone—the α-factor—and that for the production of the second phase the action of another factor, the β-factor, is required. The α-factor certainly plays a certain rôle in the production of the second phase, since it can be demonstrated that the genitalia react to it in a specific fashion during the second phase. It would seem to follow from this that the greatest production of œstrous hormone occurs during that stage when no œstrus appears (*i.e.* pregnancy), and that with the progress of pregnancy the amount increases. The indications are that there appears to be both a change in the production of hormone with the incoming of the β-factor, and also in the manner in which the genitalia react to the α-factor.

Since any stage of pregnancy (embryonic development) depends on a certain anatomical and functional state of the uterus, and since this state of the uterus depends on the hormonic level, any artificial raising of the hormonic level will produce a state within the uterus which is unfitted to the stage of development reached by the fœtus. For this reason abortion follows injection of one of the factors of the ovarian hormone.

By the same means it is possible to inhibit pregnancy. The first phase can be prolonged by injection of the α-factor, with the result that the uterus does not pass into the second phase, and so no preparation is made for the arrival of the ovum.

These observations apply only to the case of animals with a diphasic cycle. They do not hold in the case of man, monkey, and rabbit, forms with a

monophasic cycle, for no separate first phase exists in these, the whole cycle consisting of a series of changes comparable only with pseudo-pregnancy. Menstruation is nothing else than the termination of pseudo-pregnancy, and has nothing whatsoever to do with œstrus and œstrous bleeding. The complete monophasic cycle is to be compared with the second phase of the diphasic cycle.

In all monophasic animals, however, the α-factor plays an important rôle. Every stage of pseudo-pregnancy (pre-menstruum) and pregnancy corresponds to a certain level of the α-factor (Zondek, Smith, etc.). By raising the level of the α-factor artificially, there is produced a stage more advanced than that appropriate to the stage of development of the embryo.

B. P. WIESNER.

Animal Breeding Research Department,
University of Edinburgh.

Prices of Periodical Scientific Publications.

THE high prices that are being charged by certain Continental publishers for scientific journals issued by them brings up the very serious question of the steps which must be taken by learned societies, institutions, and individuals against these extraordinary prices. The journals are wanted for reference by research workers all over the world, but their prohibitive prices are in many cases making it impossible for most institutions to continue subscribing to them, while for a great majority of individual workers to purchase single volumes at £7 7*s.* to £8 8*s.* is absolutely out of the question. A great amount of material is apparently available for publication, as three to four volumes of various journals are issued every year. The prices for subscription of different volumes are not on a regular rate, but an arbitrary price is fixed for each part of the different volumes. This results in the subscription for various journals amounting to as much as £20 a year.

I give below a few cases with the actual printed prices of the volumes for the year 1927. *Ergebnisse der Anatomie und Entwicklungsgeschichte*, which up to vol. 22 for 1914 (issued in 1916) was published by J. F. Bergmann, Wiesbaden, and was taken over by the combine of publishing firms of J. F. Bergmann, Munich, and Julius Springer, Berlin. It now forms the third part of *Zeitschrift für die gesamte Anatomie*. The last volume, 27, issued in November 1927, consists of 1104 pages with 271 text-figures; there are no plates. The price of this volume is 168 Reichsmarks, or roughly £8 8*s*. The price of three volumes of *Zeitschrift für Anatomie und Entwicklungsgeschichte*, issued during 1927 and forming part I of the above-mentioned series, comes to Reichsmarks 405, or £20 5*s*.; the price per volume would work out roughly at £7. The volumes of *Wilhelm Rouxs Archiv für Entwicklungsmechanik*, issued during 1927, cost Reichsmarks 380, or £19, and the price of a single volume varies between £5 5*s*. and £7. The two volumes of *Zeitschrift für Zellforschung und mikroskopische Anatomie*, issued during 1927, cost Reichsmarks 240, or £12.

The above publications are all issued either by Bergmann and Springer or by Springer alone. The case of *Archiv für Naturgeschichte*, issued by the Nicolaische Verlag, Berlin, is no better. Of the two volumes of this serial, more than a dozen parts are issued every year at an average price of Reichsmarks 30 to 36, and the average cost of the serial works out at about £20 a year. For comparison one might refer to journals like *Zoologische Jahrbücher* or *Archiv für Protistenkunde*, prices for the different volumes of which vary between 60 and 80 marks, or £3 to £4. The size of text and number of illustrations, both in the form of text figures and plates of these serials, would compare very favourably with any of the journals mentioned above.

The cost of printing has undoubtedly gone up since the War, but are these exorbitant prices justified? And can various institutes and societies, with their moderate grants or income, continue subscribing to these journals? I am afraid it is practically impossible for many institutions, like the Zoological Survey of India, which has complete sets of all the journals mentioned above, to continue subscribing to them much longer, unless the prices are materially reduced or their library grants are increased. In the interest of workers, could not various bodies like the Royal Society of London, the Zoological Society of London, and other similar institutions, take up the matter and consider what steps can possibly be taken to deal with the difficult situation?

BAINI PRASHAD.

Zoological Survey of India,
Indian Museum, Calcutta.

The Oldoway Skull.

I HAVE recently returned from Germany, where by the kindness of Dr Hans Reck I was enabled to examine the Oldoway skull and skeleton found by him in 1913 in what was then German East Africa—now Tanganyika Territory—and I have also fully discussed the geological and palæontological evidence as to its age with Dr. Reck himself.

The object of my visit was to see how nearly the Oldoway skull compared with, or how it differed from, the fossil human skulls which I brought back from Elmenteita, Kenya Colony (see NATURE, July 16, 1927, p. 85).

With Dr. Reck's permission I am able to make the following statement about the Oldoway skull, though of course I may not give any measurements, as Prof. Mollison of Munich is now preparing a detailed report of the skull and skeleton for publication.

All the following statements are the result of my own personal examination of the skull and of my discussion with Dr. Reck.

(1) The Oldoway skeleton lay in a crouched position on its right side beneath undisturbed alluvial deposits belonging to the last pluvial period. The crouched position of the body certainly suggests burial, but if it was a burial it was quite certainly not from the present land surface, but from an earlier surface, for at least 3 metres of undisturbed alluvial strata lay above it. Dr. Reck inclines to the idea that the body became embedded when the deposits were forming under marshy conditions, for no trace of even a shallow grave was found.

(2) The undisturbed deposits lying above and below the skeleton were very rich indeed in mammalian remains. These, while including a number of forms such as eland and oryx, which are indistinguishable from living species, nevertheless consist—so Dr. Reck tells me—to more than 50 per cent. of extinct fauna. The latter includes a number of hitherto unknown genera and species of antelope; a new sheep; numerous remains of an elephant closely allied to *Elephas antiquus* which has been named *Elephas antiquus Recki*; extinct hippopotamus and rhinoceros; and a three-toed horse closely allied to hipparion. Despite the last-mentioned animal—which he considers as a survival from Pliocene or earlier times—Reck regards the deposit as belonging to the end of the Pleistocene.

(3) The human skull from Oldoway very closely resembles some of my fossil skulls from Elmenteita, which, I suggest, also belong at latest to the beginning

of the last pluvial period. It is most decidedly non-negroid, having a long leptorrhine nose, a very long upper-face and a premaxilla of unusual length, with a correspondingly deep palate. All of these characters are found in my Elmenteita skulls.

(4) I could see no sign at all of the suggested artificial chipping of the teeth which is one of the reasons why the Oldoway skull has been considered by many as a recent Bantu burial in fossiliferous deposits. I was only able to examine the upper jaw, as Dr Mollison was away from Munich at the time of my visit and the lower jaw was locked up in his room. Recent photographs of the mandible, however, betray no evidence of chipping at all.

It is thus clear that Dr. Reck's find is in close agreement with the Elmenteita evidence, and it indeed looks as though an early form of *Homo sapiens* lived in East Africa before the last pluvial period, accompanied by numerous animals now extinct.

A full report dealing with the human remains and the associated industries found during last year's expedition is in course of preparation.

L. S. B. Leakey.

Feb. 28.

Strong Electrolytes.

In the original form of the Debye-Hückel theory, the solvent enters only as the medium, having a certain dielectric constant, through which the electric forces between the ions act. In his extension of the theory to concentrated solutions (*Physikal. Zeitschrift*, **26**, 93; 1925) Hückel discussed at some length the effect of the electric field of the ions on the solvent molecules, and pointed out that polarisable molecules tend to congregate round an ion where the electric field strength is greatest, thereby tending to displace other ions from its vicinity. Hückel considered that the effect of this behaviour was obtained by introducing into the equations "the phenomenological law that the dielectric constant of the solution diminishes with increasing electrolyte concentration." While his equations were capable of reproducing the activity coefficients of salts, even in concentrated solutions, using constants obtained from the data themselves, it is doubtful whether these constants have the postulated relation with the dielectric constant lowerings actually produced by electrolytes (*cf.* Harned, *J. Amer. Chem. Soc.*, **48**, 326; 1926).

A more direct calculation might be made by making use of the result (*see* G. H. Livens, "Theory of Electricity," 1926, p. 82) that the work done by an element of dielectric of volume δv, in going from a position where the electric field is zero to one in which the field strength is E and the polarisation P, is

$$\delta v \int P dE = \frac{\epsilon - 1}{2} E^2 . \delta v,$$

assuming proportionality between P and E.

When an ion is brought up from a great distance to a point in the vicinity of a given ion it displaces a quantity of solvent molecules having the same volume. Thus the total work done by an ion of volume Δv in reaching a point where the potential is ψ is

$$e_1 \psi + \frac{\epsilon - 1}{2} . E^2 . \Delta v,$$

and the Debye equation

$$n_1 = n_{10} e^{-\frac{e_1 \psi}{kT}}$$

is replaced by

$$n_1 = n_{10} e^{-\left(\frac{e_1 \psi}{kT} + \frac{\epsilon - 1}{2} . \Delta v . \frac{E^2}{kT}\right)}.$$

By the use of Poisson's equation we get

$$\nabla^2 \psi = -4\pi \Sigma e_1 n_{10} e^{-\left(\frac{e_1 \psi}{kT} + \frac{\epsilon - 1}{2} . \Delta v . \frac{E^2}{kT}\right)},$$

or to a first approximation

$$\nabla^2 \phi = \kappa^2 \psi . e^{-\lambda (\nabla \psi)^2},$$

where κ has the usual meaning and $\lambda = \frac{\epsilon - 1}{2kT} . \Delta v$.

I have been unable to obtain a solution to this equation, and I should be grateful for any suggestion as to how a solution (approximate or otherwise) might be obtained.

J. A. V. Butler.

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Edinburgh.

The Atomic Spectral Lines Associated with the Band Fluorescence of Alkali Metals.

The band spectrum of sodium in the visible region consists of two systems, one in the red on the longer wave-length side of the yellow D lines, and another stronger one in the green on the shorter wave-length side of these lines (R. W. Wood, *Phil. Mag.*, **18**, p. 530; 1909). Potassium possesses two similar band systems (J. C. McLennan and Ainslie, *Proc. Roy. Soc.*, **103**, p. 304; 1923). It is now known that the bands on the red side belong to a triplet system, $^3P \rightarrow {}^1S$, and those on the blue side to a singlet system, $^1P \rightarrow {}^1S$. This results from alkali *molecules* having in their normal state two outer electrons like the *atoms* of the alkaline earths.

These band groups can be obtained on the spectrograms of the light emitted by metal vapours that have been rendered fluorescent. By illuminating sodium vapour with the blue-green radiation of sunlight, for example, the light giving the bands on the short wave-length side of the D lines is emitted throughout the vapour. When spectrograms are taken of this emitted fluorescent light, it is always found that they include the yellow *atomic* lines of sodium in addition to the *molecular* fluorescence bands. This feature characterises the fluorescence spectrum of sodium even when the incident light stimulating the fluorescence is wholly free of the wave-lengths 589 and 330 $\mu\mu$, and therefore could not *directly excite the atomic lines.*

A still more remarkable feature of these fluorescence spectrograms is that the D lines appearing on them are very broad even at low temperatures (200°-300°) and at moderate pressures ($p <$ 1 mm. at 300° C.).

The information recently acquired regarding the dissociation of homœopolar molecules through the investigation of band spectra enables us to account satisfactorily for these features. The emission of the atomic resonance lines is the result of the dissociation of the excited molecules. Molecular dissociation can take place when the energy associated with a quantum of the absorbed light is greater than the energy, V_r, corresponding to the atomic resonance potential plus the energy, D_r, representing the heat of dissociation.

In the case of sodium, D_r amounts to the equivalent of 1·3 volts, and in the case of potassium to 0·6 volts. If U be the energy equivalent of the quantum of the light absorbed, the excess energy represented by $U - (V_r + D_r)$ would appear in molecular dissociation as kinetic energy of the atomic products of such dissociation, and this kinetic energy in turn would account for the abnormal width of the D lines.

The considerations presented above also afford an explanation of why the absorption of red and green

spark-line radiation does not bring about the emission of the yellow D lines from sodium vapour. Work is in progress to develop the ideas expressed above.

J. C. McLennan.
Richard Ruedy.

The Physical Laboratory,
University of Toronto,
Feb. 7.

The Sligo Artefacts.

A letter in Nature of Jan. 28 definitely establishes the human origin of the Sligo flakes, but the last sentence of the letter seems to suggest some mystery concerning their cultural age. In view of this it may not be superfluous to refer to the accompanying photograph (Fig. 1) which Mr. A. W. Stelfox has kindly lent us. The photograph (Fig. 1) was taken by Mr. R. W. Welch and shows a primitive limestone anchor similar to many that are still manufactured and used by the fishermen on the west coast of Galway. These anchors are made near the coast, and the resulting flakes are left lying about along with larger discarded stones, all showing traces of their undoubted 'humanity.' Although no such anchors are now made at Rosses Point, it is highly probable, if not certain, that such stone anchors were made there, and also at many other parts of the Irish coasts one or two hundred years ago. In all probability the present beach on which the Sligo specimens were found was not in existence even a thousand years ago, so the possibility of the Sligo flakes being debris from primitive stone anchors should be taken into consideration when attempting to fix their cultural age.

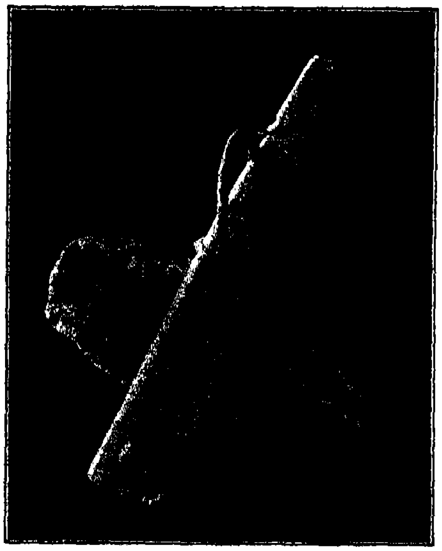

Fig. 1.—Primitive anchor, a heavy stone in wooden clamp, still used by Aran Islanders, west coast of Galway.

These facts are no doubt known to the five signatories of the letter referred to, yet we think it worth while to place on record any evidence which might assist in the elucidation of the cultural age of the artefacts in question.

L. S. Palmer.
J. Wilfrid Jackson.
W. O'B. Pierce.

College of Technology,
Manchester, Mar. 1.

Factors which determine the Occurrence of the Green Ray.

The recent discussion of the green ray which has been appearing in Nature prompts me to put on record a new theory of the phenomenon which occurred to me several years ago, but which I have refrained from publishing in the hope of securing proof. First let me say most emphatically that the phenomenon is real and not an illusion or after-image. No person trained in the observation of optical effects, both real and subjective, who has seen the phenomenon at its best, will have any doubt about its reality. There is also no question in my mind but that the usual explanation (atmospheric dispersion) is quite correct. The main question to answer is, Why is it seen so seldom, even under conditions which appear to be the most favourable ?

I have crossed the ocean some thirty times and have looked for the 'ray' at every favourable opportunity, by which I mean clear sky, no haze or clouds on the horizon at sunset, and a calm sea, and yet I have observed it on only three or four occasions, and only once when it was really striking. This occasion was on an eastward trip of the *Homeric*, sailing from New York on June 6, 1925. The colour of the vanishing edge of the sun at sunset was a vivid emerald green, about the colour of a railroad signal light. On other occasions on which I have observed evidence of the phenomenon, the colour change was from red or orange to lemon yellow.

It seems possible that the determining factor is the relative temperature of the air and the ocean. Warm water and cool air would flatten the trajectory of the light rays, and cause the sun to set abnormally early. This is the type of refraction in cases of desert mirage, in which case the curvature of the rays is reversed. With cold water and warm air, on the contrary, the normal gradient of refractive index would be increased, the curvature of the rays augmented, and sunset would be delayed, giving a greater opportunity for atmospheric dispersion to come into play.

Through the courtesy of Capt. Parker, of the *Homeric*, I have been furnished with data regarding the air and water temperatures on this trip. On the day on which we observed the ray, the temperatures of air and water were practically the same at sunset. On the other three favourable evenings, on which we failed to see any trace of the phenomenon, the ocean was from twelve to fourteen degrees warmer than the air at sunset. I hope that this note may prompt future observers of the green ray to secure data on the air and water temperature, both for occasions on which it is not seen, as well as those on which it is well marked.

R. W. Wood.

Johns Hopkins University,
Baltimore.

A New Type of Secondary Radiation.

If we assume that the X-ray scattering of the 'unmodified' type observed by Prof. Compton corresponds to the normal or average state of the atoms and molecules, while the 'modified' scattering of altered wave-length corresponds to their fluctuations from that state, it would follow that we should expect also in the case of ordinary light two types of scattering, one determined by the normal optical properties of the atoms or molecules, and another representing the effect of their fluctuations from their normal state. It accordingly becomes necessary to test whether this is actually the case. The experiments we have made have confirmed this anticipation, and

shown that in every case in which light is scattered by the molecules in dust-free liquids or gases, the diffuse radiation of the ordinary kind, having the same wave-length as the incident beam, is accompanied by a modified scattered radiation of degraded frequency.

The new type of light scattering discovered by us naturally requires very powerful illumination for its observation. In our experiments, a beam of sunlight was converged successively by a telescope objective of 18 cm. aperture and 230 cm. focal length, and by a second lens of 5 cm. focal length. At the focus of the second lens was placed the scattering material, which is either a liquid (carefully purified by repeated distillation *in vacuo*) or its dust-free vapour. To detect the presence of a modified scattered radiation, the method of complementary light-filters was used. A blue-violet filter, when coupled with a yellow-green filter and placed in the incident light, completely extinguished the track of the light through the liquid or vapour. The reappearance of the track when the yellow filter is transferred to a place between it and the observer's eye is proof of the existence of a modified scattered radiation. Spectroscopic confirmation is also available.

Some sixty different common liquids have been examined in this way, and every one of them showed the effect in greater or less degree. That the effect is a true scattering and not a fluorescence is indicated in the first place by its feebleness in comparison with the ordinary scattering, and secondly by its polarisation, which is in many cases quite strong and comparable with the polarisation of the ordinary scattering. The investigation is naturally much more difficult in the case of gases and vapours, owing to the excessive feebleness of the effect. Nevertheless, when the vapour is of sufficient density, for example with ether or amylene, the modified scattering is readily demonstrable.

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Feb. 16.

Land-locked Salmon.

THE term 'land-locked' is generally used for fresh-water colonies of salmon, such as that from the River Otra described in NATURE of Mar. 17, and from Lakes Wenern and Ladoga, and even for the Canadian Ouananiche. The word is, in my opinion, misleading, indicating that the colony is cut off from the sea, which is not always true, and that it owes its formation to this circumstance.

The fact that Lake Wenern has a stock of salmon indicates that it was formerly accessible from the sea; when the falls first became impassable to ascending fish they could scarcely have prevented fish from descending had they wished, so that none would be left. It seems clear that in the days when the lake was accessible from the sea, and salmon went through it to spawn in its tributaries, some of the smolts that descended into the lake found it to be a sufficiently good substitute for the sea to stay there, and so founded a non-migratory race, which became isolated later. Similarly with the River Otra; some of the smolts reaching the Bygglandsfiord were tempted to stay and feed on the abundant pelagic crustacea, and founded a dwarfed race of lake-salmon, that was isolated when the falls became impassable.

The trout forms fresh-water colonies in every river and lake that it enters, and for this species the term 'land-locked' is never used. On this side of the Atlantic the salmon generally leaves such colonisation to the trout, and itself forms fresh-water colonies only in exceptional circumstances, either in very large lakes with abundance of fishes, or in rivers or lakes with such quantities of parr-food that it is tempted to prolong the parr life. In America, when there are no trout, the salmon form fresh-water colonies more readily.

C. TATE REGAN.

British Museum (Natural History),
S.W.7, Mar. 17.

Anomalous Groups in the Periodic System of Elements.

IN a paper which will shortly appear in the *Rend. Accad. Lincei*, I have calculated the distribution of the electrons in a heavy atom. The electrons were considered as forming an atmosphere of *completely degenerated* gas held in proximity to the nucleus by the attraction of the nuclear charge screened by the electrons. Formulæ were given for the density of the electrons and the potential as functions of the distance r from the nucleus.

In continuation of the previous work, I have applied the same method to the study of the formation of anomalous groups in the periodic system of elements. From the density of the electrons and their velocity distribution, one can easily calculate how many electrons have a given angular momentum in their motion about the nucleus, that is, how many electrons have a given azimuthal quantum number k.

It is known, for example, that the formation of the group of the rare earths corresponds to the bounding of electrons in 4_4 orbits, that is, to the presence in the atom of electrons with $k=4$. Now it follows from the theory that electrons with $k=4$ exist in the normal state only for atoms with atomic number $z \geq 55$. This agrees well with the empirical result that the group of the rare earths begins at $z=58$ (cerium).

Similarly, the bounding of 3_3 electrons with $k=3$ corresponds to the anomaly of the first great period beginning at $z=21$ (scandium); according to the theory, electrons with $k=3$ should appear in the atom just at $z=21$.

Further details will be published later.

E. FERMI.

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Rome.

Activation of Ergosterol at −180° C.

WITH reference to the letter in NATURE of Mar. 24, p. 452, from Dr. Bills and Mr. Brickwedde, on the activation of cholesterol at liquid oxygen temperature, we may mention that we are now studying the production of vitamin D from ergosterol by ultra-violet radiation at various temperatures, and have obtained intensely active products at −180° C. from weak alcoholic solutions immersed in liquid oxygen, as well as at higher temperatures up to +78° C. Details will be published shortly. Our results therefore are similar to those of Bills and Brickwedde, and are made with the pure provitamin instead of with 'cholesterol.'

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Recent Progress in Theoretical Physics.

By H. F. BIGGS.

WHEN an army is making a rapid advance over fresh ground it is not the time to make an elaborate survey of the territory conquered, but on the other hand sketch maps, however provisional and imperfect, of the main lines of advance and the chief points of attack, are all the more useful to the soldier in the field and interesting to the newspaper reader at home. What follows is an attempt to draw such a sketch map for some important recent work in physics.

The most remarkable thing about present-day physical theories is the strange dual nature all the components of matter and energy seem to exhibit. Thus no sooner does Bose (*Zts. f. Phys.*, **26**, 178; 1924) show that Planck's law of temperature radiation can be derived by treating quanta $h\nu$ as if they were particles with momentum $h\nu/c$, than Einstein (*Berl. Ber.*, 261; 1924) follows suit by applying Bose's method to the molecules of a material gas, supporting his procedure by treating his molecules as equivalent to wave-trains after the fashion of L. de Broglie. A new statistical principle is introduced by Bose, but it will be easier to explain this after we have considered the rival principle commonly called the Fermi-Dirac statistics. This latter principle may be stated in a few words as the extension to quantised translational motion of Pauli's prohibition, by which no two electrons in an atom can have exactly the same set of quantum numbers.

But how are translational motions of particles to be quantised? This question can be most easily answered by considering the de Broglie waves of our particles (L. de Broglie, *Ann. de Phys.*, **3**, 22; 1925; or Biggs, "Wave Mechanics," p. 22). A moving particle is equivalent to a train of waves (ψ-waves) the wave-number of which is p/h, where p is the momentum of the particle and h is Planck's constant. The components, too, of the momentum are proportional to the wave-numbers along the co-ordinate axes, that is, to the number of waves per centimetre cut by the axes respectively. Thus we write

$$N_x = p_x/h, \quad N_y = p_y/h, \quad N_z = p_z/h \qquad (1)$$

The elastic rebound of a molecule from a boundary wall is now equivalent to the reflection of ψ-waves from the wall, since the laws for angles are the same, and thus an ideal gas in an enclosure with perfectly elastic walls is replaced by a field of ψ-waves in an enclosure the walls of which are perfectly reflecting for these waves. This only means that if there is to be no progressive motion of particles or radiation through any surface drawn in a gas, the wave-system must be a stationary system such as would be formed by trains of waves reflected to and fro at the surface. The problem of velocity distribution in a gas is then closely related to the Rayleigh-Jeans problem of finding the number of degrees of freedom or modes of oscillation in a given volume of a continuous medium. (See Jeans, "Dynamical Theory of Gases," chap. xvi.; 1921.)

A less mathematical argument than the usual one may be used, and is more appropriate to the case in hand. Let the oblique lines in the diagram (Fig. 1) be the traces of wave-fronts in the original train and in a train formed by reflection at some vertical wall, the full lines representing crests and the dotted lines troughs. Then the reflecting walls must be either in positions such as w, w, if at nodes of the standing waves, or W, W, if at antinodes. In either case, a line drawn normal to the planes must cut a whole number of *half*-waves. Thus in a rectangular box, with edges a, b, c, cm. parallel to the axes, $2aN_x$, $2bN_y$, $2cN_z$ must be whole numbers,

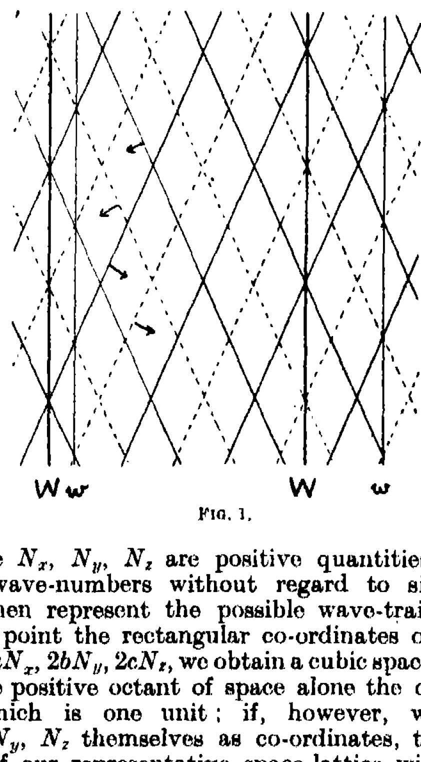

FIG. 1.

where N_x, N_y, N_z are positive quantities giving the wave-numbers without regard to sign. If we then represent the possible wave-trains each by a point the rectangular co-ordinates of which are $2aN_x$, $2bN_y$, $2cN_z$, we obtain a cubic space-lattice in the positive octant of space alone the constant of which is one unit; if, however, we take N_x, N_y, N_z themselves as co-ordinates, the unit cell of our representative space-lattice will be a rectangular parallelepiped of dimensions $1/2a$, $1/2b$, $1/2c$, and finally by (1), the possible *momenta* of particles in the box will be represented as to the absolute magnitude of the components by the points of a space-lattice in the positive octant the unit cell of which measures $h/2a$ by $h/2b$ by $h/2c$.

It will be noticed that we have thus quantised the linear momentum of a particle in our box in almost the same way as de Broglie quantised the angular momentum of an electron describing a circular orbit. In our case, it is the number of half-waves along the length, breadth, or depth of the box that must be a whole number; in de Broglie's case, it is the number of waves counted 'round the orbit.' In both cases quantisation expresses the

existence of a steady state, or, from another point of view, the existence of a single-valued function ψ.

We can now see clearly how we are going to get the theory into relation with classical and 'classical-quantum' statistical dynamics. But first we must take a rather different space-lattice for our possible momentum-points, not occupying only the positive octant of space but also extending symmetrically on all sides of the origin. We evidently get the same number of points up to a given maximum value P of the momentum if we take, instead of a spherical octant of radius P, a whole sphere of radius P, provided we multiply the volume of our unit momentum cell by 8, making its edges now h/a, h/b, h/c, instead of half these lengths. Then the unit cell in the momentum-space for a particle in a box abc will have the volume h^3/abc, and the unit cell of the 6-dimensional phase-space with co-ordinates x, y, z, p_x, p_y, p_z, will have the volume h^3. It will not be necessary, however, for our purposes to fuse the real space and the momentum space into a 6-dimensional continuum, but it will be more convenient to keep the conceptions of the two spaces distinct.

Now so far we have postulated no statistical principle whatever, but have left it quite indeterminate *how many particles* there may be to each point of our momentum space-lattice. Leaving until later the Bose-Einstein principle and the classical principle of assigning these numbers, we will follow out some consequences of the answer that arises most naturally from our train of reasoning, namely, that *no two particles can have the same lattice point*, that is, no two particles can have the same momentum in the same direction—and in particular, even at the zero of temperature when the system has radiated all the energy it can radiate, only one particle can have zero momentum or zero energy. This is the Fermi-Dirac principle (Fermi, *Rend. Accad. Lincei*, **3**, 145; 1926; Dirac, *Proc. Roy. Soc.*, A, **112**, 661; 1926). It must hold for the same reason that the similar Pauli principle holds for the electrons in an atom, though what this reason may be is a puzzle. One may perhaps hazard the guess that if two molecules or two electrons had the same wave-trains, or oscillations the same in all but phase, they would no longer be the distinct entities of our experience, the discreteness of motions being thus very intimately bound up with the atomic nature of matter itself.

This reasoning of course is quite right only for *structureless* particles which alone can be fully represented by the oscillation of a scalar such as ψ; it should hold, therefore, for a monatomic gas for all phenomena that are not influenced by atomic structure, but for the spinning electron there may be *two* electrons instead of one per lattice point, as in the Stoner atomic scheme. The statistical principle is just the same, but the representation loses a little in *Anschaulichkeit*.

For a true particle we may now state the principle thus: *The product of the real space available per particle and the least momentum space which must be assigned to each particle is h^3.* The first consequence of this is that at the zero of temperature the actual momenta of the particles will not be zero, but their representative points will be close-packed, occupying all those points of our lattice which lie closest to the origin or zero of momentum with one cell of volume h^3/V per particle. Thus, if we have N particles confined within V cubic centimetres, their momentum space will have the volume Nh^3/V; and since the shape of this volume will presumably be spherical (for N large), we can easily calculate the energy. For if P be the radius of this sphere, we have, to find P

$$(4\pi/3)P^3 = Nh^3/V,$$

and the kinetic energy of a particle with momentum p is $p^2/2m$, so that dividing the total energy

$$\frac{V}{h^3}\int_0^P 4\pi p^2 dp \frac{p^2}{2m}$$

by the number of particles

$$\frac{V}{h^3}\int_0^P 4\pi p^2 dp,$$ we get for the mean energy

$$\frac{1}{2m}\cdot\frac{3}{5}P^2 \text{ or } \frac{3h^2}{10m}\left(\frac{3N}{4\pi V}\right)^{\frac{2}{3}}.$$

A striking application of this result was made by R. H. Fowler (*Mon. Not. Roy. Astr. Soc.*, **87**, 114; 1926; see also Eddington: "Stars and Atoms," Oxford, 1927, Appendix) to the dense matter of the companion of Sirius, showing that even when such matter has radiated all the energy it can, and has cooled down to the absolute zero, the 'free' electrons, of which (as regards number and energy) it is chiefly composed, have a mean energy corresponding to equipartition energies at something like 10^8 degrees.

Some of the mysteries of matter in its more familiar forms can also be illuminated by this principle in the most hopeful way. Thus Pauli (*Zts. f. Phys.*, **41**, 81; 1926) shows that the small paramagnetism of metals can be accounted for by treating the free electrons as magnetic molecules of a gas near the absolute zero. For corresponding temperatures are inversely as the masses of the particles concerned, so that to the helium molecule at 5° abs. corresponds electron gas at about 36,000°. If then we start filling up the lattice points with electrons, two go to each point, and these have opposite orientations, so that the resultant magnetic moment must be zero, to the first approximation. Pauli pursues the analysis further and derives Curie's law (kT = const.) for the susceptibility and finds absolute values which promise to agree well with observation when we know better the intrinsic diamagnetism to be assigned to the various atoms.

More recently, Sommerfeld (*Naturwiss.*, **15**, 825; 1927) has attacked other hitherto baffling problems of electronic phenomena in metals with very promising results, building on the Drude treatment by mean free paths, but using the Fermi-Dirac statistics instead of the Maxwell statistics of Lorentz. The great stumbling-block of the negligible contribution of the electrons to the specific heat is surmounted at the first stride, since the degradation or high quantisation of the electronic motions gives a value for the specific heat which

vanishes at 0° abs. (in accordance with Nernst's theorem) and at ordinary temperatures is only of the order $R/100$, which is quite compatible with observation. The formulæ for the electric and the thermal conductivity depend on the mean free path and cannot yet be satisfactorily checked, but in their ratio, the Wiedemann-Franz coefficient, this unknown divides out, and the result, $\frac{\pi^2}{3}\left(\frac{h}{e}\right)^2 T$, which is the classical formula with the numerical factor $\pi^2/3$ instead of 2, agrees exactly with the observed mean for the various metals. This, however, is not quite so conclusive as it sounds, since even the seven best metals differ among themselves by 8 per cent. Still more convincing are the results for thermoelectric phenomena, which all come out of the right order, where the classical theory is wrong by very large factors on any reasonable assumptions.

It should be noted that Sommerfeld introduces no arbitrary quantities at all, and the only quantity he uses which varies from metal to metal is the number of electrons per cubic centimetre, which he puts equal to the known number of atoms. One interesting result of this procedure is that the contact potentials come out, for the most part, correct in magnitude but wrong in sign. In other words, an electron would escape from its fellow electrons alone at the given density with a *positive* energy equal to the *work that must be done* to get it out from an actual metal containing the same number of positive atoms with the electrons. Thus, with an obvious notation,

$$W_e = W_a - W_e, \text{ or } W_a = 2W_e.$$

This at once suggests an analogy with the familiar theorem that the potential energy is minus twice the kinetic energy for particles obeying the inverse square law (Sommerfeld, "Atombau," Appendix). For the interactions (if this word can be used at all) of the electrons which cause them to obey this new statistics seem to have nothing to do with their ordinary electrostatic repulsions, so that W_e calculated by the statistics will presumably correspond to kinetic energy, and W_a to potential energy.

There can be no doubt that this paper of Sommerfeld's forms the first[1] step in the true theory of metallic conduction, and that the preponderating factor in these phenomena depends on this statistical behaviour of the electrons without regard even to the structure of the metallic crystals. The next step, as Sommerfeld remarks, will be to improve on the assumption of a constant mean free path and to discover how this quantity depends on the velocity of the electrons and on the temperature.

Let us now return to the question of the different possible statistical principles and trace out the connexion between them. All statistical problems can be regarded as depending on the number of ways a number of objects can be put into a number of boxes with different labels under various rules. For gases the objects have until now been molecules and the boxes cells of phase space. Classically, the cells are taken equal in size, the intrinsic probability of a molecule being in one of these cells is the same for any cell, and finally the cells are made infinitely small. In the classical quantum theory of Nernst and many other workers, the only difference is that the cells are not made infinitely small but have the finite size h^3; they still are regions of equal size and of equal probability. But for both the new statistical principles the point of view is entirely different; we consider, not into which cell we put a particle, but how many particles a cell contains. On the Fermi principle, each cell may contain one particle, but not more, and it is further assumed that to contain one particle and to contain no particle are equally probable states for a given cell. In terms of objects and boxes, it is the cells that are now the objects, and there are only two boxes, which have equal chances of receiving a given object (*i.e.* cell), one labelled 'no particle' and the other 'one particle.'

As we have seen, there seems to be some sort of intelligible reason for this principle, but the Bose-Einstein principle is thoroughly baffling[2] as to reasons, though easy enough to express. It runs: *It is equally probable that a cell will contain any number of particles.* Or, with the cells still as objects, the boxes of equal probability are labelled *0 particle*, *1 particle*, *2 particles*, and so on. Jordan (*Naturwiss.*, **15**, 636; 1927)[3] illustrates the application of the three principles to the simple case of two particles and two cells by this diagram (Fig. 2).

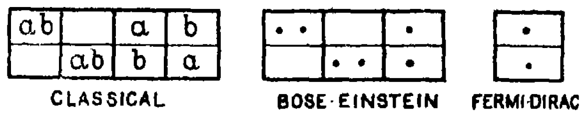

FIG. 2.

In the classical quantum theory we can suppose the particles named a and b. Then the arrangements with both in the first cell and with both in the second cell will have one complexion each and will be equally probable, while the arrangement with one in each cell will have two complexions and will therefore be twice as probable. On the Bose principle, on the contrary, the particles have lost all individual distinction and can be represented by mere dots. The arrangement with one particle in each cell has then only one complexion and has the same probability as either of the arrangements with both particles in one cell. On the Fermi principle the only possible arrangement is with one particle in each cell. Then, on any theory, once

[1] This is not quite fair to Lindemann, who some time ago suggested that the electrons form a nearly rigid space-lattice among themselves (F. A. Lindemann, *Phil. Mag.*, 29, 127; 1915). So they do, but it is in the momentum space, not the real space.

[2] See, however, a short and most suggestive paper by Brillouin (*Comptes rendus*, 184, 589; 1927), in which he shows that in the Bose scheme the probability of a quantum getting into a cell is *greater* the more quanta there are already in that cell. It is like the game of chain-tig, in which the more boys there are in the chain the greater is the chance of their adding to their number. This is only a fanciful way of putting the fact that the greater the radiation density corresponding to a certain energy-jump, the greater is the probability of the radiation provoking another such jump, as in Einstein's proof of Planck's law in 1917.

[3] In this and a paper in the previous number Jordan gives a most comprehensive review of the progress of the new theories in the last two years, with a full bibliography.

the intrinsic probability is settled, the steady state of maximum probability can be found by the familiar methods.

We have seen that the Fermi principle can be used for electrons not attached to particular atoms, and Fermi in his original paper (*l.c.*) showed that it gave what is probably the true equation of state for a monatomic gas at low temperatures, while Einstein's application of Bose's statistics to gases led to curious results not confirmed by experiment. It seems, therefore, that Bose's original application of his statistical principle to quanta is the only permissible one. Why quanta indistinguishable in every respect should be capable of coexisting when electrons are not is by no means obvious. Quanta seem to be much more indifferent to each other's existence than material particles, which perhaps has something to do with their own indifference to life, or rather their readiness to undergo metempsychosis.

Obituary.

Dr. F. Raschig.

Dr. Friedrich Raschig, whose numerous scientific investigations in the domain of chemical technology covered a remarkably wide range and whose interests were not restricted to purely technical problems but were devoted to public welfare, passed away on Feb. 4 at the comparatively early age of sixty-four years.

We are indebted to the *Chemiker-Zeitung* for some points in Dr. Raschig's life. Born on June 8, 1863, at Brandenburg, Raschig's interest in scientific work was awakened while still at the *Realgymnasium*, where he came under the influence of Prof. Müller, director of the *Zeitschrift für physikalischen und chemischen Unterricht*. After studying at the Universities of Berlin and Heidelberg, he became assistant in the University chemical laboratories in Berlin and was afterwards appointed chemist to the Badische Anilin und Soda Fabrik. During this period many publications, dealing chiefly with compounds of nitrogen and sulphur, appeared under his name. In 1891 he started a factory for the manufacture of phenol, but soon afterwards he resumed his studies of the reactions involved in the lead-chamber process for the production of sulphuric acid. The lengthy controversies aroused by this work no doubt did much to stimulate further research in this important field. He also devoted much attention to the reactions of sulphurous anhydride and the sulphites.

Dr. Raschig discovered a technical method of preparing hydroxylamine, and his investigation of chloramine led to his well-known process for the manufacture of hydrazine, a compound of considerable interest, which had previously been discovered by Curtius, whose death occurred only a few days after that of Raschig. The latter also elaborated many useful volumetric methods of analysis and was an authority on the manufacture of synthetic phenol and the distillation of coal-tar. Dr. Raschig took an active part in municipal and political life, and in 1924 was elected a member of the Reichstag.

The issue of the *Physikalische Zeitschrift* for Dec. 15 contains a photograph and a short account of the life and work of the late Prof. A. Gockel, of Freiberge, Switzerland. Gockel was born in November 1860 at Stockach in Baden, where his father was a secretary in the Post Office. After attending the Gymnasium at Constance he was in turn a student at the Universities of Freiburg in Baden, Würtzburg, Carlsruhe, and Heidelberg. He graduated in 1885 and held teaching posts in secondary schools for ten years. In 1895 he became assistant to Prof. Kowalsky at the University of Freiberge, Switzerland, and in 1901 was appointed lecturer, two years later extra professor, and in 1910 ordinary professor of cosmical physics. In 1921–22 he acted as Rector of the University. He died on Mar. 4 of last year. He married in 1902 the daughter of his colleague Baumhauer, professor of mineralogy. The whole of his scientific publications deal with atmospheric phenomena such as thunderstorms, radiation, and electromagnetic waves, and his work carried him to the shores of the Mediterranean and into the Sahara. His papers are characterised by the carefulness of their deductions.

We regret to announce the following deaths:

Prof. W. Steadman Aldis, formerly professor of mathematics and principal of the College of Science, Newcastle-on-Tyne, and later of Auckland College, New Zealand, on Mar. 7, aged eighty-nine years.

Mr. W. B. Croft, who taught mathematics at Winchester College for many years, and was widely known for his interest in early work on radiotelegraphy and in optics, on Mar. 23, aged seventy-six years.

Prof. W. W. H. Gee, formerly professor of pure and applied physics at the College of Technology, Manchester, and author of papers and text-books on physics and electro-chemistry, on Mar. 3, aged seventy years.

Dr. F. S. Luther, emeritus president and formerly professor of mathematics of Trinity College, Connecticut, on Jan. 4, aged seventy-seven years.

Mr. E. W. Maunder, for many years Superintendent of the Solar Department of the Royal Observatory, Greenwich, on Mar. 21, aged seventy-six years.

Dr. Richard Pribram, emeritus professor of chemistry in the University of Prague, whose work on the optical rotation of organic substances and on the relationship between physical properties and chemical constitution is well known, aged eighty years.

Prof. Herbert M. Richards, professor of botany in Barnard College, Columbia University, and scientific director of the New York Botanical Garden, on Jan. 9, aged fifty-six years.

Mr. A. Shoolbred, author of "The Flora of Chepstow" (1920), a well-known local botanist and horticulturist, on Jan. 25, aged seventy-five years.

Prof. Eilhard Wiedemann, well known for his writings on the history of physics and formerly professor at the University of Erlangen, at the age of seventy-six years.

News and Views.

SUNDAY next, April 1, is the three hundred and fiftieth anniversary of the birth of William Harvey, of imperishable memory, physician and student, prophet of a new world of knowledge through his demonstration of the mechanism of pulsation of the heart in man and animals. Of yeoman parentage, born at Folkestone, Harvey died at Lambeth on June 3, 1657. He was buried at Hempstead, in Essex. Let us not forget, also, that the present year marks the three hundredth anniversary of the issue of Harvey's immortal work, "Exercitatio anatomica de motu cordis et sanguinis in animalibus," published at Frankfort in 1628. It was a small quarto, in Latin, of seventy-two pages, and from the press of William Fitzer, of Frankfort. Previously, Harvey had, in his Lumleian lectures, delivered before the Royal College of Physicians, London, in the spring of 1616, explained his discovery of the circulation of the blood. But his views met with such mixed reception that he was deterred from publishing any treatise on the subject until much later. In this connexion Aubrey tells us that he had heard Harvey say "that he fell mightily in his practice; 'twas believed by the vulgar that he was crack-brained and all the physitians were against him." In the year 1648 another edition in Latin, of 215 pages, appeared at Rotterdam. Afterwards, spreading the wonderful news still farther, came a book of 123 pages in small octavo—"The anatomical exercises of William Harvey concerning the motion of the heart and blood, with the preface of Zachariah Wood, physician of Roterdam. To which is added Dr. James De Back, his discourse of the heart, physician in ordinary to the town of Roterdam. London, 1653": and the tide of issue rose until all civilised centres and all the teachers knew what had happened. So began, after long delay, man's intimate acquaintance with himself.

THE tercentenary of the birth of Harvey, alumnus of Caius College, Cambridge, and the University of Padua, was celebrated in London fifty years ago by the Royal College of Physicians at a banquet given in their own apartments in Pall Mall. There it was that Huxley, in a remarkable speech, full of tender sympathy and enthusiasm, referred to Harvey's book as "that little essay of fifty pages which no physiologist of the present day can read without wonder and delight." Our readers will find an account of the proceedings in NATURE of June 6, 1878. It may here be mentioned, also, that a statue of the great physician, executed by Mr. Albert Bruce Joy, was unveiled at Folkestone and dedicated to the town by Prof. (afterwards Sir Richard) Owen, on Aug. 6, 1881. There is a famous portrait of Harvey in the possession of the Royal College of Physicians, by Cornelius Jonson van Ceulen; a copy of this hangs in the apartments of the Royal College of Surgeons. The Royal Society also has a portrait, after De Reyn. The National Portrait Gallery has a portrait by an unknown painter.

IN Great Britain and in the United States, numberless friends and admirers of Major-General A. W. Greely, arctic explorer, join in congratulations on the celebration of his eighty-fourth birthday, which occurred on Tuesday last, Mar. 27. Born at Newburyport, Mass., he was educated there at a high school. In early youth Greely enlisted as a volunteer private soldier, serving in the Civil War, 1861–65; afterwards he joined the regular army and was appointed to the signal branch. Following prolonged work of distinction, he succeeded General W. B. Hazen in 1887 as chief signal officer, with the rank of brigadier-general. Under Greely's supervision an enormous amount of telegraphic installation was carried out in Alaska in 1900–1904. General Greely is the author of many technical and popular works in geographical science, meteorology, and climatology.

So far back as 1881, Lieut. Greely, as he then was, took command of an Arctic expedition organised to meet the plan of establishing circumpolar stations in accordance with recommendations adopted at the *International Geographical Congress held at Hamburg* in 1879. During two years the party, comprising a complement of twenty-five, made their headquarters at Discovery Harbour, Grinnell Land, crossing thence to the Polar Sea and reaching farther north than previously recorded. But disaster attended these pioneers. The vessels of the third relief expedition, which arrived at St. John's, Newfoundland, on July 7, 1884, carried only seven survivors of those who had long been without succour from the outer world in Smith Sound, and had, one by one, succumbed to hunger and hardship. All journals and observational data had been carefully preserved. The Royal Geographical Society recognised Greely's eminent services for science by the award of its Founder's gold medal. The Marquis of Lorne, then president, entrusted the gift at the Society's anniversary meeting in 1886 to Mr. Phelps, the United States Minister, who emphasised that the story of the heroic effort by which the medal had been won would not pass away with his generation, nor perish with the memory of living witnesses; it would remain on the page of history.

PROF. H. BRERETON BAKER selected an experimental theme for his presidential address before the Chemical Society at its annual general meeting on Mar. 22, the title of his discourse being "Constitution of Liquids: some new Experiments." Determinations of the vapour density of liquids which have been dried with phosphorus pentoxide for periods varying from two to ten years show quite clearly that the process of drying results in an increased molecular aggregation; thus the molecular weight of bromine rises from 160 to 242, of benzene from 78 to 126, of carbon disulphide from 76 to 137, of methyl alcohol from 32 to 90, etc. Believing that the molecular aggregation of the bulk of the liquid is even greater than that represented by the vapour density, on account of fractional distillation, Prof. Baker has also developed a modification of Berthelot's method of determining the latent heat of evaporation of a dry liquid, whereby the liquid does not come into contact

with the atmosphere. The latent heat for dry benzene per gram was found to be 58 instead of 83, and the boiling-point was 94° C., so that by the application of Trouton's rule the molecular weight of the dry benzene was 136 instead of 78. The view that the removal of water from liquids leads to increased molecular complexity is thus supported by four classes of experimental data, namely, rise of boiling-point, change of surface tension, increase of vapour density, and increase of latent heat of evaporation.

DISCUSSING the reason for these manifestations, Prof. Baker referred to Sir J. J. Thomson's hypothesis of the variation in the attractive force between the constituents of a molecule, due to the proximity of a drop of a liquid with a high specific inductive capacity. Since ionisation favours drop formation, the effect of heating such ionisation-producing substances as lime, thoria, or radium bromide in a reactive gaseous mixture containing traces of water should be to promote combination, an assumption which was found to be justified when a mixture of hydrogen and nitrous oxide was examined in this way. Further, it should be possible, even in the presence of water but in the absence of facilities for its condensation, to stabilise large molecules and to increase the number thereof above that corresponding normally with a given temperature. The application of a potential difference of 400 volts between platinum plates immersed in benzene has, indeed, been found to produce this effect, the benzene then boiling at 92° instead of 79·6°, and having a molecular weight two or three times as great as the normal value; hexane and carbon disulphide behave similarly. Prof. Baker emphasised the preliminary nature of the experiments which he described, but it is evident that if further work on these lines is confirmatory we shall have, for the first time, an explanation of the rôle played by water in changes of molecular association in liquids. Prof. Baker is succeeded in the presidential chair of the Chemical Society by Prof. J. F. Thorpe.

APPROXIMATELY 550,000,000 acres, or 28·9 per cent. of the total land surface of 1,903,200,000 acres in continental United States, exclusive of Alaska, is classed as forest land. It must not be supposed, however, that the whole of this area produces timber at the present day. The estimate includes vast areas which have been so devastated by careless lumbering and by fires that decades must elapse before they are likely to produce crops of economic value. This class of land includes roughly 81,000,000 acres widely scattered over the country, particularly in the northern and south-eastern States. Of the other 469,000,000 acres, about 80,000,000 acres is woodland, covered with a more or less open stand of poor growth which yields fuel, fencing, and some building material. It is not considered that these areas will ever be capable of producing saw timber on a commercial scale. The productive forest, according to this estimate, covers more than 389,000,000 acres, though this area must have been considerably reduced in the last few years. When the English first settled in the country, three centuries ago, the extent of forest was far greater, especially in the eastern, south-eastern, and central States. About 822,000,000 acres were originally covered with timber forest, and another 1,000,000 acres were lightly wooded with juniper, piñon pine, mesquite, stunted oak, and other species.

THESE figures are of interest in connexion with the afforestation work now being undertaken in the United States. According to a *Daily Science News Bulletin* issued by Science Service of Washington, the area of the national forests was increased during the past fiscal year by 41,214 acres net. With the separation of the Ocala National Forest, formerly a division of the Florida National Forest, as a distinct unit, there are now 160 national forests in the country, situated in 32 States, Alaska and Porto Rico. The total net gain in national forest area was not so large as in several preceding years, due partly to the fact that a considerable acreage was transferred by special Acts of Congress to national parks. Net reductions in area were shown in Alaska, California, Colorado, Nevada, New York, and South Dakota. The largest increase was in Pennsylvania, amounting to 65,274 acres. Washington was second with 63,084 acres, and Wyoming third with 42,494 acres. The figures demonstrate the scale of the task before the United States if a forest area at all commensurate with the requirements and the consumption of the people is to be built up.

MR. FRANCIS RODD has published in the *Times* of Mar. 19 and 20 a brief account of fresh evidence bearing upon the origin of the Tuareg which he has obtained on a recent expedition to Air in the Sahara. This journey was undertaken with the object of investigating the ethnology of these veiled nomads for whom in his previous researches, of which the results were published in 1926, he had suggested the possibility of a derivation from the eastern Mediterranean, and further, that they had moved southward to the Air Mountains from a more northerly position and assumed their characteristic veil somewhere between 600 and 1000 B.C. The evidence now brought to bear upon this question is, in part, that of rock drawings at Air which have now been examined for the first time. The suggested eastern Mediterranean origin was based upon the identification as Tuareg of certain of the Libyans captives in Egyptian paintings and of certain Libyan tribes in Egyptian records from the Fifth to Nineteenth Dynasties as ancestors of the Tuareg on the ground of identity of names. One of the difficulties hitherto felt in the identification, for example, of a Nineteenth Dynasty picture of a captured Libyan chief, has been the fact that a headdress of ostrich feathers is worn instead of the veil. The petroglyphs of Air now show what is apparently an identical headdress. Further, the association of Tifinagh, the Tuareg script, with the petroglyphs, connects them definitely with the Tuareg and not with the previous negroid population of Air. The inscriptions are almost certainly names and patronymics. It follows that so late as the tenth century A.D., the Tuareg, then recently come to Air, were drawing portraits of themselves similar to those

drawn by the Egyptians of the Nineteenth Dynasty of the North African peoples west of the Nile.

THE electricity scheme for Central England has now been published. It is the third scheme which the Electricity Commissioners have devised and communicated to the Central Electricity Board. The area covered is more than 7000 square miles and has a population of five million. It extends from Stoke-on-Trent and Mansfield on the north to Tewkesbury and Buckingham on the south, and from Newark and Oundle on the east to Shrewsbury and the Welsh border on the west. There are 46 public generating stations in the area. These include the large stations of the Birmingham Corporation and the stations of the Shropshire, Leicestershire, and West Midlands Power Companies. The problem of the Electricity Board is to consolidate, standardise, and improve these networks. In this area the sale of electricity per head of the population last year was about 146 units. Assuming that the present rate of growth continues, then in 1940 the output will have reached 540 units per head. Of the 46 generating stations in the area, 19 are taken as 'selected' stations. In order that the networks may be most advantageously interconnected by underground cables or overhead wires, it is necessary that the frequency of their supplies should be standardised. The standard frequency is 50, but both the Birmingham Corporation and the Shropshire Power Company generate at 25. It has been agreed to allow for the present the 25 frequency supply to a few generating stations, but when circumstances make it desirable, the change over to the standard frequency will gradually take place. Sir John Snell has stated that from 1925 to 1926 the average price of supply in this area was 1·48*d*. per unit, and that in three or four years it would be less than a penny. It has to be remembered, however, that when large industrial undertakings can be supplied direct from the power-stations through high-voltage lines, the ordinary house consumer has his supply through these lines and in addition through machinery which reduces the pressure and through low-pressure distributing mains. He may look forward to getting his electricity at 3*d*. or 4*d*. a unit, but the industrial consumer may get his at less than ½*d*. per unit.

AT the present time electrical energy is generated in Great Britain mainly in two ways. The first and commoner method is to use steam turbines and coal-fired boilers. The other is done from waste-heat stations which employ gas engines worked from blast furnaces or from coke-oven gas. Sometimes also steam turbines are worked from waste-heat boilers. In a paper read to the Institution of Electrical Engineers on Mar. 15, W. T. Townend pointed out the advantages of combining the production of electrical energy with that of coal by-products. Waste-heat stations are now fairly common on the north-east coast and in the midland mining centre of England. The Electricity Act of 1926 will have a far-reaching influence on the prosperity of the country, as it will doubtless lead to cheaper electricity and to a greater use of the coalfields. There is a possibility of reducing unemployment by encouraging the mining industry to co-operate not only in the supply of fuels but also in that of surplus electrical energy. It has been suggested that if a large increase be made in the quantity of by-products, the world's markets will become saturated and the selling-price would be reduced. If, however, the public be convinced that electricity provides the cheapest and cleanest mode of cooking, there is little doubt that its use would become almost universal. This would save household coal, but hot water would still be required. This could be generated by any well-known type of slow-combustion stove capable of burning coke. Mr. Townend gave other considerations to show that the disposal of coke in the future need not present great difficulties. The attitude of the British Government towards the pre-treatment of coal is generally supposed to be that if the process is a success then private capital will be rapidly forthcoming for its development. Mr. Townend thinks it illogical for the coal distillation industry not to be given State support, seeing that by the 1926 Act the State has given guarantees in connexion with the capital required for the 'grid' mains. In his opinion both are for the common good.

THE New Zealand Institute publishes a *Reference List* of the Scientific Periodicals in the Libraries of New Zealand. The list is compiled by Gilbert Archey, the Curator of the Auckland Museum. By co-operation with those in charge of the principal libraries in New Zealand, thirty-one in number, the compiler is able to state, in regard to each of the periodicals indexed, in which libraries the volumes may be found, and whether each set is complete. We are told that certain sets are incomplete, but are not told which are the missing volumes or parts. It would not have been difficult to add this information. The compiler states, however, that the libraries are gradually acquiring the missing volumes needed to complete their sets. The arrangement of the *Reference List* is in the first place geographical by Continents and States in alphabetical order. It is only within each country that the references are arranged according to subjects. It would have been much more convenient had the various sciences been taken as the primary subdivisions. As the list stands, it will be difficult for anyone to be sure that he has found all the periodicals dealing with a particular subject. As an example: An entomologist will find 37 journals devoted to entomology distributed under the headings United States, Hawaii, New York, Belgium, France, Germany, Great Britain, Italy, Russia and Switzerland. But without careful scrutiny, he will never be certain that he has not overlooked some entomological journals. We congratulate the Curator of the Auckland Museum, however, on a useful piece of work carefully executed.

THE Department of Entomology of the British Museum (Natural History) has received from Capt. K. J. Hayward, of Villa Ana, Argentina, a fine specimen of *Megasoma janus*, one of the giant horned beetles, of which it is believed that only two examples, both imperfect, have ever before reached Great

Britain. The legs of this insect, when fully extended, cover a space of about six inches from front to rear. Acquisitions in the Department of Geology include type-specimens of Carboniferous Corals from Yorkshire, presented by Prof. R. G. S. Hudson; three plaster casts of type-specimens of starfishes from the Lower Devonian, near Goslar, presented by the Director of the Preussische Geologische Landesanstalt, Berlin; type and figured specimens of Ammonites from the Gault of Southern England, presented by Dr. L. F. Spath. The most important recent addition to the mineral collection is a set of very large specimens of crystallised spar from the Snailbeach mine near Minsterley, Shrewsbury, bequeathed by the late Mr. William Oldfield. They were set up in his garden, but not having been piled up to form a rockery or built into walls, as is often the fate of such specimens, the crystals have not been bruised and damaged. The eight specimens, with a total weight of just over 23½ cwt., consist of slabs measuring up to 5 ft. 6 in. by 3 ft. 6 in. These are covered with two-inch cubes of galena, together with smaller crystals of zinc-blende and copper-pyrites. Only in exceptional cases are specimens of this size raised, for they have no metal value.

An important development of research in the Antarctic regions is announced in the *Norges Handels og Sjöfartstidende* for Feb. 18. Consul Lars Christensen has decided to establish a radio and meteorological station on Bouvet Island, with the co-operation of the Norwegian Meteorological Institute. This will be an important step in the direction of carrying out Mr. R. C. Mossman's plan for supplementing the South Orkneys meteorological station (established by him on Dr. Bruce's *Scotia* expedition in 1903 and taken over by the Argentine Meteorological Department) by similar permanent observatories on Bouvet Island, the Crozets, and Kerguelen. The same paper says that the cruise of the *Norwegia* towards Enderby Land has had to be postponed, as the damage the vessel received off Bouvet Island cannot be repaired in time for the present Antarctic summer. The *Norwegia* found that the Falkland Island seal (*Phoca Falklandica*) still breeds on Bouvet Island, though it was practically exterminated in its original haunts by the sealers of a hundred years ago.

We have recently received from the Section of Geodesy of the International Union for Geodesy and Geophysics several issues (Nos. 8, 10-13) of its organ (nominally issued quarterly), the *Bulletin Géodésique*, for the years 1925–1927. They represent a considerable and very useful addition to the literature of international interest to workers in the subject. They contain papers, mainly printed in French, on theoretical and instrumental questions, reports on work executed or projected in the various parts of the world, biographical notices and bibliographies, and a chronicle of current events relating to the science. Among the principal general topics dealt with in the issues named are questions connected with an international ellipsoid of reference; the centre of gravity and the moments of inertia of the oceans; the mean density of the earth; errors in high-precision levelling; and an international inquiry (with answers to a questionnaire) on the trustworthiness of invar wires and tapes.

The annual report of the Smithsonian Institution of Washington for the year ending June 30, 1926, which has recently been issued, is presumably the last of the long series of these volumes to bear the name of the late Dr. C. D. Walcott. We have already referred to the presentation of this report (Nature, April 2, 1927, p. 505) and it will be sufficient to direct attention to the valuable general appendix, which, as usual, accompanies the published report. This appendix consists of no less than thirty-one articles, some of them reprints of recent papers and others original; among those of general interest we may mention the papers by Dr. J. H. Jeans on the new outlook in cosmogony, Dr. C. G. Abbot on the influence of the sun's rays on plants and animals, M. Lucien Rudaux on conditions on the moon and the planets, Prof. R. A. Millikan on cosmic rays, Prof. E. Newton Harvey on 'cold' light, Dr. Arthur D. Little on carbon, Dr. John M. Coulter on the history of organic evolution, Dr. L. O. Howard on the control of injurious insects by parasites, and obituary notices of the late Dr. W. Bateson, by Prof. T. H. Morgan, and of Prof. Kamerlingh Onnes, by Dr. F. A. Freeth, the latter being reprinted from Nature.

The Ministry of Agriculture and Fisheries has just published a small volume on "Poisonous Plants of the Farm," by H. C. Long (*Miscellaneous Publications, No. 57*, London: H.M. Stationery Office. 2s. net). Though the number of wild plants which are seriously poisonous is perhaps small compared with the total number of species included in the British flora, yet there are many of very common occurrence which may occasionally cause serious losses to farm stock, and also illness and death to human beings, particularly children. In cases where poisonous plants occur in quantity, they may be unavoidably harvested, and later given to stock, or they may be eaten in the green state in the open fields or along the hedgerows. There are also numerous cultivated plants and trees which are poisonous and often responsible for trouble with live stock. Sometimes the effect is merely irritant, sometimes it is poisonous. Mr. Long deals with a large number of species, and the toxicology of each is discussed in a simple way. The book is written in non-technical language, is well illustrated by many full-page illustrations, and should be widely welcomed by farmers and those engaged in agricultural instruction.

The estimates for Civil Services (Class IV., Education, Science, and Art) for the year ending Mar. 31, 1929, include the sum of £225,085 for scientific investigation, etc., and £1,579,400 for Universities and Colleges, Great Britain, and Intermediate Education, Wales.

A very large earthquake was recorded at Kew Observatory on Mar. 22 at 4 hr. 29 min. 17 sec.,

G.M.T. The epicentre is estimated to have been 5780 miles away, and was probably near the Pacific Coast of Mexico. This disturbance was the most violent shock which has been recorded at Kew since the great Chinese earthquake of May 22 of last year.

THE last meeting of the one hundred and twenty-sixth session of the Royal Philosophical Society of Glasgow was held on Mar. 21. Prof. Graham Kerr, in vacating the president's chair which he had occupied for three years, reviewed the work of the session, and intimated that as great interest in the Society had been shown by women by reading papers and by attending the meetings, it had been agreed that their interest should be recognised by welcoming women to full membership. The following officers were then elected: *President*, Mr. George A. Mitchell; *Vice-Presidents*, Prof. Peter Bennett and Dr. Henry L. G. Leask; *Hon. Treasurer*, Sir John Mann; *Hon. Librarian*, Dr. James Knight; *Hon. Secretary*, Dr. Charles R. Gibson; *Hon. Auditors*, Mr. Alex. Murdoch and Mr. David A. Richmond; *Acting Secretary*, Dr. James M. Macaulay.

AT the annual general meeting of the Ray Society, held on Mar. 22, the following officers were re-elected: *President*, Prof. W. C. McIntosh; *Treasurer*, Sir Sidney F. Harmer; *Secretary*, Dr. W. T. Calman. Mr. J. Spedan Lewis was elected a vice-president, and Mr. D. J. Scourfield and Mr. A. W. Sheppard were elected new members of council. It was announced that the first volume of Dr. T. A. Stephenson's "Monograph of the British Sea-Anemones" would shortly be issued to subscribers for 1927. The year 1927 being the tercentenary of the birth of John Ray, the Council has accepted the offer of Dr. R. T. Gunther to prepare, as a commemorative volume, a series of unpublished letters of Ray which are preserved in the Bodleian Library and in the British Museum. This volume is in the press and, together with the third and final volume of Messrs. Soar and Williamson's "British Hydracarina," will form the issue for 1928.

AT the annual general meeting of the Institute of Chemistry, held on Mar. 1, the Meldola Medal for 1927 was presented to Dr. J. H. Quastel, fellow of Trinity College, Cambridge. In making the presentation, Mr. E. R. Bolton, vice-president of the Institute, said that Dr. Quastel has advanced the knowledge of reduction-oxidation systems following on the pioneer work which resulted in the discovery of glutathione by Sir Frederick Gowland Hopkins, and has introduced new methods into the study of living cells as represented by bacteria. He has also thrown some light, for the first time, on the mechanism of the activation of molecules by a living organism. It will be recalled that the Meldola Medal is presented by the Society of Maccabæans in commemoration of Prof. Raphael Meldola, president of the Institute of Chemistry (1912–15) and of the Society of Maccabæans (1911–15), and is awarded for meritorious work in chemistry during the year.

THE ninety-sixth annual meeting of the British Medical Association will be held at Cardiff on July 20–28, under the presidency of Sir Ewen Maclean, who will deliver his address on the evening of July 24. The annual exhibition of surgical appliances, foods, drugs, and books will be open on July 23–27. A pathological museum is also being arranged by Drs. J. B. Duguid and J. Mills, Department of Pathology and Bacteriology, Welsh National School of Medicine, The Parade, Cardiff. The following presidents of sections are announced in the provisional programme: Sir Thomas Lewis (*Medicine*), Prof. A. W. Sheen (*Surgery*), Dr. T. Watts Eden (*Obstetrics and Gynæcology*), Prof. E. H. Kettle (*Pathology and Bacteriology*), Dr. E. Goodall (*Mental Diseases and Neurology*), Sir John Lynn-Thomas (*Orthopædics*), Dr. A. Howell (*Diseases of Children*), Mr. F. P. S. Cresswell (*Ophthalmology*), Dr. D. R. Paterson (*Laryngology and Otology*), Dr. H. M. Davies (*Tuberculosis*), Dr. O. L. Rhys (*Radiology and Physio-Therapeutics*), Dr. E. C. Williams (*Preventive Medicine*), Mr. R. M. F. Picken (*Public Health*), Dr. W. E. Thomas (*Medical Sociology*), Dr. Philip H. Manson-Bahr (*Tropical Medicine*), Mr. Walter G. Spencer (*History of Medicine*), Dr. W. Langdon Brown (*Therapeutics and Pharmacology*), Sir Robert Bolam (*Dermatology*). The honorary local general secretary for the meeting is Dr. G. I. Strachan, 20 Windsor Place, Cardiff.

THE Ministry of Health has published the Seventh Report of the Advisory Committee on the Welfare of the Blind, 1926–27. The returns show that there were 46,822 blind persons in England and Wales in 1927. Much information is given on the education and employment of the blind, their distribution in administrative districts and by age periods, their earnings, grants for their welfare, etc.

Bulletin No. 59 (1927) of the National Research Council, Washington, contains in five papers the report of a committee on chemiluminescence. The facts and theories of this extensive subject are conveniently summarised in the report, and are discussed from various points of view ranging from the purely physical to the biological. The members of the committee and authors of the papers are E. Q. Adams, A. D. Garrison, A. H. Pfund, and H. S. Taylor, under the chairmanship of E. N. Harvey.

The new volume of *Ergebnisse der exakten Naturwissenschaften* (No. 6), published by Julius Springer, Berlin (price 24 gold marks), contains articles on the structure and development of stars, by Prof. Vogt; on the sources of stellar energy, by Prof. Freundlich; on photometry, by Prof. Brodhun; on ferromagnetism, by Dr. Steinhaus; on the optical determination of the heats of dissociation of gases, by Dr. Sponer; on adsorption, by Dr. Cassel; on the equation of state for solids, by Dr. Braunbeck; on the theory of strong electrolytes, by Dr. Orthmann; on active hydrogen, by Dr. Boenhoffer; on the element rhenium, by Drs. I. Tacke and W. Noddack; and on photographic methods of measurement, by Mr. P. Seliger. Most of the sections have a bibliography of other literature dealing with the same subject, and the volume includes in addition the index for the present and five preceding issues.

A CATALOGUE of nearly 400 second-hand works, mainly on natural history subjects, but some on historical medicine and on mechanical arts, has just been circulated by Mr. J. H. Knowles, 92 Solon Road, S.W.2.

THE industrial uses of sand are numerous and varied. Those interested will welcome a new edition of the trade catalogue of sands, which include certain clays, flint, and other non-metallic minerals, issued by Mr. A. L. Curtis and obtainable from him (price 1s.) at Westmoor Laboratory, Chatteris.

AN important catalogue of some 1500 works relating to Australia, Tasmania, New Zealand, and the Islands of the Pacific Ocean has been received from Messrs. Francis Edwards, Ltd., 83 High Street, Marylebone, W.1. Included are many rare volumes, and a series of original water-colour drawings of Sydney and its Harbour, by Conrad Martens.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—Two junior assistants under the Safety in Mines Research Board, for research, respectively, in connexion with colliery wire ropes research, and on materials and structures used for the support of underground workings—The Under Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (April 7). A temporary demonstrator in pharmacy, and an assistant lecturer in preparing, combing, and spinning, and yarn manufacture, at the Bradford Technical College—The Director of Education, Town Hall, Bradford (April 11). A secretary to the Institution of Municipal and County Engineers—The Secretary, Institution of Municipal and County Engineers, 92 Victoria Street, S.W.1 (April 11). A professor of anatomy in the University of Lucknow—The Registrar, The University, Lucknow, India (April 23). A professor of engineering in the University College of South Wales and Monmouthshire—The Registrar, University College, Cardiff (April 28). A lecturer in geography at Birkbeck College—The Secretary, Birkbeck College, Breams Buildings, Fetter Lane, E.C.4 (May 1). A senior lecturer in zoology in the University of the Witwatersrand, Johannesburg—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (May 4). A lecturer in mathematics at Armstrong College—The Registrar, Armstrong College, Newcastle-upon-Tyne (May 5). A senior entomologist for noxious weeds investigation, a senior entomologist for noxious insects investigation, and a senior entomologist at Canberra for advice and technical assistance in various branches of investigation and to take charge of the museum. Each post under the Entomological Section of the Australian Council of Scientific and Industrial Research—F. L. McDougall, Esq., Australia House, Strand, W.C.2 (May 31). A professor of therapeutics, pharmacology, and materia medica, at University College, Galway—The Secretary, University College, Galway (June 15). A research chemist for work in connexion with fastness tests for dyed materials—The Secretary, Colour Supervisory Committee, British Research Association for the Woollen and Worsted Industries, Torridon, Headingly, Leeds. A lecturer in estate management subjects at the Royal Agricultural College, Cirencester — The Principal.

Our Astronomical Column.

COMETS.—M. Giacobini, who is already known as the discoverer of twelve comets, including two short-period ones, but whose name has not appeared in the list of discoverers since 1907, reports a new comet of the eleventh magnitude, the position of which on Mar. 17, at 22 h. 14 m. U.T., was R.A. 5 h. 50 m.; N. Decl. 14° 35′; rapid motion southward. It would appear that the discovery was made by photography, and that the image was not noticed for some days. It is to be feared that there may be some difficulty in locating the object, without more definite knowledge of its motion.

The following is the latest position to hand of Reinmuth's Comet (1928*a*), made at Babelsberg by G. Struve :

Mar. 19 d. 22 h. 19 m. 24 s. U.T., R.A. (1928·0) 9 h. 18 m. 28·60 s., N. Decl. 23° 35′ 5·5″.

Prof. A. O. Leuschner suggests the possible identity of this comet with that of Taylor (1916 I). There are considerable difficulties in accepting this, but it must be remembered that Taylor's comet divided into two portions, like that of Biela. This brings a measure of uncertainty into the forecasts of its motion. Mr. F. R. Cripps found next October as the probable date of perihelion of Taylor's comet (*B.A.A. Handbook*, 1928).

OSCILLATIONS IN THE PERIOD OF BETA LYRÆ.—Miss M. A. Blagg contributed papers on this star to the *Mon. Not. Roy. Ast. Soc.*, vols. 84 and 85 (1924 and 1925). These announced the detection of a long-period fluctuation in the time of minimum, taking more than nine years to complete its cycle. She contributes a further paper on the subject to the January number of *Monthly Notices*, in which she utilises additional material derived from observations by Rev. J. G. Hagen, Mr. E. F. Sawyer, and several members of the Variable Star Section of the B.A.A. The result confirms her previous conclusions, with slight alterations in the numerical values. Her formula for principal minimum is $2398590{\cdot}57 + 12{\cdot}908006\,E + 0{\cdot}000003914\,E^2$. On this is superposed a B wave given by $2407136{\cdot}12 + 6{\cdot}584\,E + 0{\cdot}00000308\,E^2$. It will be noticed that the period of this wave is nearly, but not exactly, half that of the main wave, and that both periods are increasing, as shown by the terms in E^2.

Allusion is made in the paper to a research by S. Tcherny in *Ast. Nach.* of May last, in which he finds by theory a fluctuation of 3439·543 days, which is within 3 days of Miss Blagg's period. His suggestion is that rotation is not quite synchronous with revolution, which produces a gradual change in the presentment at minimum. The research is a hopeful one for finding out more about the exact circumstances of this interesting star. Now that the phenomenon is known, observations can be made more systematic than before. They were sometimes missing at critical stages.

Research Items.

EXCAVATIONS AT THE HIPPODROME, CONSTANTINOPLE.—Mr. S. Casson in *Discovery* for March surveys the progress which has been made in the excavation of the Hippodrome at Constantinople in the two seasons since work was first begun. His task was complicated by the fact that the dimensions of the building were entirely unknown, and estimates by experts of its extent varied by hundreds of feet. All that was left visible were the three monuments down the centre, one of them the bronze serpent column which celebrated the Greek victory over the Persians at Platæa in 479 B.C., and was brought from Delphi by Constantine. It is interesting to note that an examination of these three monuments, of which two, the Column of Constantine Porphyrogenitus and the Serpent Column proved to have been used as fountains, revealed that the spina or dividing wall, which, it had been held, must run down the centre of the Hippodrome and upon which the monuments were supposed to stand, had no existence. In the Sphendone, the substructure at the end of the building, which was originally used for storing apparatus and animals for the games, were found twenty-five chambers, each opening out of a wide corridor which ran the length of the building. These in later and more troubled time were converted into cisterns for storing the water-supply, a purpose for which part is still used. The excavations here made it possible to determine the width of the building as 117·5 metres. Trial excavations to determine the length, brought to light a building which is probably the Baths of Zeuxippos. The total length was found to be 480 metres. A Turkish wall composed almost entirely of marble fragments from the Hippodrome furnished material from which it has been possible to reconstruct a general idea of what the Hippodrome looked like.

MILK PASTEURISATION AND THE TUBERCLE BACILLUS.—Many investigations have been made on the thermal death point of the tubercle bacillus in milk, but owing to the difficulty of obtaining satisfactory samples of naturally infected milk, a large proportion of the experiments have been carried out with artificially infected milk. Mr. L. J. Meanwell has recently conducted a research into the effect of pasteurisation in destroying the tubercle bacillus in naturally infected milk. It was found that a temperature of 62·8° C. (145° F.) acting for 30 minutes does not invariably kill the tubercle bacillus, though in most cases it is effective (*Jour. Hyg.*, vol. 26, p. 392; 1927). The temperature and time are those commonly employed in pasteurisation, but the apparatus used consisted of a vessel containing only about 1000 c.c. of milk, heated in a water-bath, and we still seem to lack experimental information of the efficiency of a *commercial* pasteurising plant for destroying the tubercle bacillus in naturally infected milk.

WEST AFRICAN MYRIAPODA.—Ralph V. Chamberlin has described the Chilopoda and Diplopoda collected by the American Museum of Natural History Congo Expedition (*Bull. Am. Mus. Nat. Hist.*, 57, pp. 177-249; 1927). The west African Diplopod fauna is rich and varied and largely a distinct and peculiar one. As was to be expected, it proves to have little in common with the north African fauna, and it is also now certain that it has little similarity to the fauna of east and south Africa. With the exception of five species of widespread chilopods, no species are common to east and west Africa, and many of the west African genera are likewise peculiar, such as all those constituting the family Prepodesmidæ as well as many other polydesmoids and certain spirostreptoids. Noteworthy is the apparently complete lack in the west African fauna of any representatives of the Oniscomorpha, members of which are common in south Africa as well as in Asia and Australia.

HYBRIDS BETWEEN SPECIES OF UNIO.—When, two years ago, A. S. Kennard, A. E. Salisbury, and B. B. Woodward published (*Proc. Malac. Soc. Lond.*, vol. 16) the first part of their monograph on the "British Post-Pliocene Unionidæ," they described a form of Unio which in their opinion could only be a hybrid between *Unio pictorum* (Linn.) and *U. tumidus*, Retzius. All that was then known was that the specimen was British and had been in the possession of the well-known dealer, W. Rich. Since then the non-marine portion of the late P. B. Mason's collection has passed into the hands of A. S. Kennard and proved to contain a series of similar Unios coming from Repton Park, Derbyshire (*Proc. Malac. Soc. Lond.*, vol. 17), and since Mason was shown to have been in correspondence with Rich, there is no doubt as to the identity of the locality of the first described specimen. The interesting point is that whereas the two species are frequently found dwelling together, no case of hybridisation has hitherto been recorded. Out of the 89 specimens of Unio from Repton Park, 31 being normal *U. pictorum* and 25 normal, with 14 malformed *U. tumidus*, there were 19 hybrids. These last, whilst showing individually a mixture of the characters of the two parent species, could not be sorted out into classes, or analysed into Mendelian factors. The authors tabulate the varying combinations of characters in 15 of the examples and figure both these and the normal forms very fully on thirteen photographic plates, which they were enabled to do (in this as in the first part) by aid from the Government Publication Grant administered by the Royal Society. In an appendix, H. H. Bloomer describes the present condition of the locality. In both parts of their monograph the authors make an important departure in employing the internal characters of the shell instead of relying, as usually the case with other writers, on the extremely variable external form for purposes of distinction, whilst at the same time stressing the value of the umbonal ridges.

PRODUCTION OF POLYPLOID PLANTS.—The Solanum chimæras of Winkler, produced by cross-grafting, are well known. Some of these gave rise to tetraploid forms, but the latter were rare—only three among several thousand. Mr. C. A. Jorgensen (*Jour. of Genetics*, vol. 19, No. 2) has now found that the grafting is unnecessary and that tetraploid and occasional triploid shoots will appear when plants of various Solanum species are simply decapitated and allowed to regenerate. He points out the not infrequent occurrence of binucleate tissue cells in plants and attributes the origin of tetraploid shoots to the fusion of the two nuclei in such cells during mitosis, a process which he calls endo-duplication. Haploid *Solanum nigrum* has also been obtained by pollinating it with *S. luteum*. The sperms from the foreign pollen tubes enter the egg cell and there disintegrate, while the egg develops parthenogenetically. Apparently the number of chromosomes is usually doubled later in the embryo, for 28 diploid and 7 haploid plants of *S. nigrum* were obtained in this way, and a single true hybrid with *S. luteum*. The various heteroploid forms obtained are compared with each other morphologically, many of the differ-

ences, *e.g.*, in flower size, leaf-shape, and pollen grains, corresponding to those already known in polyploid Œnotheras and Daturas. Some of the work was done in conjunction with Mr. M. B. Crane. It is interesting that in the haploid *S. nigrum*, which has 36 chromosomes, these show some pairing in meiosis, such as occurs in triploid hybrids. This suggests that the hexaploid *S. nigrum* may have arisen as a hybrid between a diploid and a tetraploid species, which afterwards doubled its chromosomes.

SHORE LINE TOPOGRAPHY.—A striking phenomenon on the shores of many of the English lakes is the line of large boulders ranged along the water's edge with a remarkable uniformity of line. Their position has been explained as that of the heavy part of the detritus rolling down the slopes to the lake, which stops with the reduction of gradient on the beach. But in a lecture to the Royal Geographical Society on the shore topography of the English lakes on Mar. 12, Mr. T. Hay amplified this explanation, which he has found untenable in those lakes which have gentle slopes around them. A striking example is the western side of Ullswater between Glencoin and Gowbarrow. The boulders are clearly of glacial origin and are the remnants of a moraine of which the lighter materials have been carried away by wave action. Thus they are the rocky skeleton of a vanished strip of hillside, and so are regularly arranged on the beach. Another type of shore lake to which Mr. Hay directed attention is marked by rounded protuberances of boulder clay projecting into the water like delta fronts. They are, however, not deltaic in origin, but are due to the cutting action of the waves on stretches of boulder clay that have not been subjected to excavation by running water. At the mouths of streams, except where deltas grow, the coast lines tend to show great landward bites as the waves have an easier task in excavation.

SURVEY OF ST. KILDA.—Mr. J. Mathieson, who, with Mr. A. M. Cockburn, spent five months on St. Kilda last year while engaged in a survey of the island, has received the great compliment of having his work accepted by the officials of the Ordnance Survey, who have published his map of the main island and neighbouring islets as a sheet of the 6 in. to 1 mile map. The sheet shows as an inset the village and landing-place on the scale of 1/2500. Copies of the map are being distributed with the issue of the *Scottish Geographical Magazine* for Mar. 15, which contains an article by Mr. Mathieson on the group, accompanied by notes on the geology by Mr. A. M. Cockburn, the flora by Mr. John Gladstone, and the birds by Mr. Seton Gordon. The article is illustrated by a very fine series of photographs, those showing the magnificent cliffs of the island being particularly impressive. It gives an authoritative account of all the objects of interest in the group, and includes notes on the inhabitants, who now number 48 in all. Though the island is often visited during the summer season and has been the subject of various investigations, it has never before been surveyed accurately and in detail. It will be a source of general satisfaction in Scotland that this long-delayed survey has now been carried out entirely by unassisted individual effort, and yet with a care which has received official recognition and acceptance. The publication of Mr. Mathieson's photographs and description also add greatly to the value and interest of the map.

GEOLOGY OF BRITISH GUIANA.—A valuable contribution to our knowledge of the country north and south of the famous Kaieteur Falls has been made by Smith Bracewell in his "Report on the Preliminary Geological Survey of the Potaro-Ireng District of British Guiana" (*B.G. Combined Court*, No. 21/1927). The falls have a vertical drop of 740 feet at the head of a sixteen-mile gorge cut in the great scarp of the Kaieteur Sedimentary Series. The latter consists of shale, conglomerate, and sandstone, and lithologically the series can be matched with similar Brazilian beds ranging in age from Devonian to Triassic. In the absence of fossils no closer comparison is possible. The remarkable association of diamond-bearing alluvium with the edge of the scarp suggests that the diamonds are probably derived from the Kaieteur conglomerate. The whole region of the plateau is injected with thick sills and dykes of gabbros, norites, and dolerites which resemble the post-Triassic intrusions of Brazil. It has been thought that these may have been in some way responsible for the diamonds, but the associations of the latter do not support this view. They do, however, seem to have contributed to the gold resources of the district, for auriferous aplites occur which are specially rich near contacts with the later basic rocks. Below the escarpment the basement rocks, like those of the Brazilian shield, include a great variety of gneisses and schists and granites. Highly folded sedimentary formations trending north and south also occur. Economically, the study of the country justifies increased optimism as regards the mineral resources and their successful exploitation.

A WORK-METER.—Messrs. Lewenz and Wilkinson, Ltd., of 25 Victoria Street, S.W.1, have sent us a pamphlet describing their 'work-meter.' This instrument is an electrical recording mechanism which registers continuously by means of a 'time-space' graph the performance of any machine to which it is connected. The chart shows at any moment whether the machine is working at full output or not, while the complete chart enables the production efficiency of the machine to be computed. In this way an accurate record can be obtained of the working of every machine in the factory, and thus the engineer can control the speeds so as to get the maximum economy.

THE ESTIMATION OF FIREDAMP.—The most convenient method for the estimation of firedamp in coal mines is still the observance of the 'cap' which it produces on the flame of a safety-lamp. Different types of lamp show different heights of cap for the same amount of firedamp, and hence it is necessary to issue a series of pictorial reproductions of the flame-caps to be expected with any given type. Existing methods of obtaining these pictures have proved unsatisfactory and a new process is described in *Paper No. 37* of the Safety in Mines Research Board (London: H.M. Stationery Office). This method is photographic, the prints finally obtained being dyed a deep blue. The paper contains a number of reproductions of such photographs.

RARE EARTH MATERIALS AND ELEMENT No. 72.—Since zirconium and thorium are closely related to element No. 72 (hafnium or celtium) and are frequently found in rare earth materials, it would seem probable that element No. 72 should also be present in these minerals. W. B. Holton and B. S. Hopkins have therefore examined the most soluble fractions of fractional crystallisations of materials of the yttrium group by X-ray analysis. These fractions contained most of the thorium and zirconium, but it was found that the concentration of element No. 72 was not greater than 1 part in 1000. Various rare earth materials, including gadolinite from Norway, were

also investigated by photographing their arc spectra, but only in one case were indications of the presence of hafnium found.

THE SEPARATION OF OIL FROM CONDENSATION WATER BY ELECTROLYSIS.—Most of the oil which is used for the lubrication of steam pistons and gearing is atomised and carried away in the waste steam. This causes a milky emulsion, which is very stable, to form on the condensed water. Even after standing a long time the separation of the oil from the water is very imperfect. Were it not for this, it would be equal in quality to distilled water, and would be most useful for manufacturing purposes as well as for feeding the boiler. Mechanical oil separators are only moderately successful, and when the condensed water is used for the boiler, appreciable quantities of oil pass into it. With hard water this combines with the boiler scale to form a solid mass which settles on the walls of the boilers and leads to overheating of the plates. In *Helios* for Jan. 29, Fritz Hoyer describes how electrolysis has been successfully employed to purify condensed water. A direct electric current passes through the water, collects the oil in foamy flakes, destroying the emulsion, and so renders filtration possible. The consumption of energy is about one kilowatt hour for five cubic metres of water. The apparatus is automatic, no special attendance being required.

POZZOLANAS.—*Bulletin No. 2* of the Building Research Station of the Department of Scientific and Industrial Research (London: H.M. Stationery Office) deals with the subject of pozzolanas. A pozzolana is a substance which is mixed with lime mortar in addition to, or in partial substitution for, sand, in order to increase the strength of the mortar. To achieve this, the pozzolana must be capable of combining with hydrated lime in the presence of moisture to form insoluble compounds which act as cements. The use of such substances was the so-called secret of the old Roman builders, and Vitruvius mentions the use of volcanic ash for this purpose. Other suitable natural materials are trass, a volcanic rock found in Germany, and various forms of diatomaceous earth (such as kieselguhr) or 'celite' as it is termed in the United States. Artificial pozzolanas are also employed, the more important being burnt clay, granulated slag, certain clinkers, and spent oil shale. The pozzolana reacts with the lime to form insoluble silicates and aluminates and hence pozzolanic mixtures can set under water, and in the absence of carbon dioxide, the presence of which is essential for the hardening of ordinary mortars. Such mixtures are also more resistant to sea water and acid, but the time required for effective setting varies enormously according to the nature and degree of fineness of the pozzolana.

NITROGEN FIXATION.—Prof. G. Senn, of Basle, has published a very useful review of the work on which our present knowledge of the assimilation of atmospheric nitrogen by lower plants is based (*Biol. Reviews*, vol. 3, No. 1, 1928, and also in *Verh. d. Schweiz. Naturf. Gesell.*, Jahresversammlung 108, 1927). One merit of the work is that it takes account of several continental researches not often cited in British lists of references on the subject. Besides the well-known free-living and symbiotic bacteria which fix free nitrogen, attention is directed to several species of fungi which perform the same function. The number of known forms of these nitrogen-fixing fungi has been increased by the work of some of Dr. Senn's pupils. Some controversial points regarding the energy relations of nitrogen fixation emerge from this paper. From the data of Ternetz and others, nitrogen fixation is regarded as a function requiring free energy, which can be procured by the respiration of large quantities of carbohydrates. Recently, the energy relations of nitrogen fixation have been carefully worked out by Dean Burk, and his results are published in a paper not noted by the present author (see *Jour. Gen. Physiol.*, vol. 10, No. 4). Burk finds that fixation of nitrogen even with liberation of energy will take place if either oxygen or hydrogen or other substances, the standard free energies of which are close to zero, are involved in the formation of either nitrates, ammonia, or other compounds. It is pointed out that there are two, and only two, general conditions where nitrogen fixation can require energy. These are, first, if nitrogen reacts with some compound like water with an already high negative free energy of formation and where negligible oxidation of nitrogen takes place; secondly, if the metabolism of the plant is not carried on at the concentrations where the process would yield free energy.

THE PRESSURES PRODUCED BY ELECTRIC ARCS IN CLOSED VESSELS.—A paper (No. 39) by G. Allsop and R. V. Wheeler, published by the Safety of Mines Research Board (London: H.M. Stationery Office), describes the results of experiments on the pressures produced by arcing in closed vessels during switching operations. When a disruptive electric discharge occurs, a pressure wave or pressure pulse is undoubtedly produced. But as disruptive discharges in air at voltages less than 350 are impossible, it was of importance to find out whether the arcs formed when breaking the circuit necessarily produced a pressure wave. In the first set of experiments the enclosure had a volume of 10·8 cub. in., the supply voltages varied from 220 to 260, and the currents from 12 to 136 amperes. The mean power expended in the arc varied from 0·38 to 5·88 kilowatts, and its duration from 0·4 to 0·6 of a second. The pressure in pounds per square inch increased fairly regularly with the power from about 1 to 12. Experiments with a voltage of 570 and with alternating voltages were also made. The results show that with voltages up to 250 and currents up to 200 amperes, no pressure wave could be detected. With 1350 amperes at 575 volts, no pressure wave was detected by a manometer situated six inches from the arc. Dangerous pressures are only produced when the arcing is prolonged. For example, a ¾-in. arc lasting for half a second gave rise to a pressure of 140 lb. per square inch. It is also clearly shown by the experiments that when alternating currents are used, the arcing effects are much less severe. Dangers from rise of pressure as the result of arcing are much greater with direct than with alternating currents.

THE NATURE OF ACTIVE NITROGEN.—Further information concerning the nature of active nitrogen and obtained by a study of the synthesis of ammonia from the elements is described by B. Lewis in the *Journal of the American Chemical Society* for January. It can be shown that the formation of ammonia from mixtures of unactivated nitrogen and atomic hydrogen, activated nitrogen *molecules* and atomic hydrogen, or active nitrogen and unactivated hydrogen, involves more than two successive and selective collisions. With *atomic* nitrogen and atomic hydrogen only two collisions would be required: $N + H = NH$; $NH + H_2 = NH_3$. The results obtained appear to show that ammonia is formed only when active nitrogen and atomic hydrogen are mixed, and, with the assumption that no tri-atomic hydrogen is present, it is inferred that active nitrogen contains atomic nitrogen.

Vitamin B.

ALTHOUGH our knowledge of the constitution and nature of vitamin D is greater than our knowledge of the chemical composition of the other accessory factors, recent work suggests that it will not be long before it has advanced to a comparable stage. Progress has been particularly striking in the case of vitamin B, and has followed two lines: the physiological function of this compound in the animal economy has been investigated by a number of observers, whilst at the same time much information has been obtained as to its chemical nature and properties.

In this connexion the most important recent development is the confirmation of suggestive previous researches, which indicated that the substance which we call 'vitamin B,' consists of at least two compounds with different chemical properties and different physiological functions. In this point vitamin B is following the example set by vitamin A, and although at first sight this splitting of a compound of unknown chemical constitution into two similarly unknown bodies may seem to hamper further advances, yet the opposite is probably more nearly true, at any rate if we may take the differentiation of vitamin D from vitamin A, followed by the early recognition of the sterol nature of the former, as an example of what may be expected to occur in the future in the case of vitamin B.

Our present knowledge indicates that deficiency of vitamin B in the diet is associated with human beriberi and pellagra and avian polyneuritis: the latter disease is usually held to be the equivalent of human beriberi. The association of pellagra with deficiency of vitamin B has only recently been conclusively demonstrated by Goldberger and his co-workers. How a deficiency of the vitamin produces symptoms is not known, although many suggestions, based on experimental work, have been made. Recent investigations into its physiology have included both a direct attack on the problem and also an examination of its relationship to the three chief classes of foodstuffs, the proteins, fats, and carbohydrates, in the diet.

J. C. Drummond and G. F. Marrian (*Biochem. Jour.*, vol. 20, p. 1229; 1926), after a scrutiny of the literature, found that the only definite function attributed to vitamin B was that of stimulating tissue oxidations, based on a decrease in oxidative power of the body in conditions of vitamin deficiency. In a series of experiments the authors investigated this alleged function and definitely demonstrated that vitamin B bears no relationship to tissue oxidations. Thus muscles obtained from pigeons or rats suffering from vitamin B deficiency, decolorised methylene blue under anærobic conditions to the same extent as the equivalent muscles from normal birds or animals: and the oxygen consumption of pigeon breast muscle or liver was the same, whether the tissue had been obtained from normal birds or from those suffering from polyneuritis. The oxygen consumption of rats kept on a complete diet was compared with that of animals kept on a vitamin B deficient diet, and no difference between the two was detected until the rats in the latter group were almost moribund: for these experiments the animals were lightly anæsthetised with amytal to eliminate variations in the oxygen consumption due to movements and placed in a modified form of the closed-circuit type of apparatus for estimating the respiratory exchange.

Now the early symptoms of vitamin B deficiency in the animals used by Drummond and Marrian are loss of appetite, constipation, and lassitude: the last stage of lowered body temperature, laboured respirations, inco-ordination of the hind limbs and convulsions only lasts about twenty-four hours, and the fall in oxygen consumption is only observed when the body temperature has fallen below 33° C: if the animal is warmed up, the body temperature and the oxygen consumption return towards their usual level, with a temporary improvement in the animal's condition. These effects, however, are not peculiar to vitamin B deficiency itself, but occur in animals starved completely of food or kept undernourished on a complete diet, the fall in body temperature and oxygen consumption occurring as above as a terminal event.

The conditions of starvation and vitamin B deficiency also produce similar effects on the blood sugar, which is raised from 0·082 per cent. to 0·125 per cent. during the earlier stages of the experiment but falls to 0·02-0·03 per cent. with the fall in body temperature. From these experiments the authors conclude that the relationship between vitamin B and appetite is the most important factor in producing the results observed, and that oxidation processes are normal in vitamin B deficiency: the majority of the symptoms are due simply to starvation, following the loss of appetite. That the oxidation processes of the body are normal in vitamin B deficiency, except when starvation enters into the picture, has also been shown by B. A. Lavrov and S. M. Matsko (*Jour. de Biol. et de Méd. Experiment*, No. 9, p. 71; 1926).

Since pigeons have so often been used for experimental work on vitamin B, Drummond, working with S. K. Kon, has investigated the relationship of the symptoms of vitamin B deficiency to those of simple undernutrition in these birds also (*Biochem. Jour.*, vol. 21, p. 632; 1927). Each bird on the vitamin-deficient diet was controlled by another, which was only given to eat as much food as the former had consumed during the previous twenty-four hours, but was provided daily also with a liberal supply of vitamin B: in this way it was hoped to differentiate between the symptoms due to vitamin B deficiency and those due to simple undernutrition.

Of all the various symptoms observed by Drummond and Kon in these experiments, only the loss of appetite and the nervous symptoms appeared to be specifically caused by absence of vitamin B from the diet. Nervous symptoms appeared in 79 per cent. of the birds within a month, and in 47 per cent. a temporary spontaneous improvement was noted (Kon, *ibid.* p. 834): in these experiments the birds were kept on a synthetic diet of the type used in experiments with rats: on a polished rice diet, 60 per cent. developed symptoms, which were speedily followed by death, no remissions being observed. The failure of appetite is associated with delay in the emptying of the crop: if forcibly fed, the crop still fails to empty normally, and the major portion of the food is vomited, so that the birds obtain no more nourishment than if left to feed themselves. The authors offer as explanation of the temporary improvement of the symptoms in so many birds on a synthetic diet, the suggestion that the convulsions in some way liberate vitamin B from the tissues and so make it available to subserve its function in nutrition.

The cause of the nervous symptoms is obscure: the organic lesion can only be slight, since injection of a preparation containing the vitamin will restore a pigeon to a normal condition in a few hours. The characteristic head retraction in this bird bears some resemblance to the forced movements or attitudes which can be obtained by stimulation of the labyrinth or its central connexions, but the nervous symptoms occur in birds in which the labyrinth has been

destroyed (L. A. Tscherkes and T. M. Kuperman, *Jour. Biol. et Med. Exper.*, No. 8, p. 13; 1926). Nervous lesions demonstrable histologically have been described in both birds and rats. In the fowl, P. G. Culley (*Quart. Jour. Exp. Physiol.*, vol. 17, p. 65; 1927) has found that the myelin sheath of the affected nerves shows irregular swelling and fragmentation, but that the axis cylinder is not affected until polyneuritic symptoms appear: the changes resemble those occurring after section of a nerve, except that the alteration in the axis cylinder is considerably delayed. In the rat, H. H. Woollard (*Jour. Anat.*, vol. 61, p. 283; 1927) has only found lesions in the nerve-endings, both sensory and motor, of the voluntary muscles and in the intramuscular nerve fibres: they take the form of swelling of the nerve endings and fragmentation of the myelin in the sheaths of the nerve fibres, but the nerve axons remain intact. Similar, but less generalised, lesions occur in animals starved for a few days, and they can still be found even if vitamin B has been administered during the period of starvation. No lesions were observed in any other parts of the nervous system, central or peripheral.

It appears, then, that the lesions observed cannot be directly the cause of the symptoms, since they are too extensive to be abolished in a few hours, but they probably lead to a change in the axis cylinders or nerve-endings not demonstrable by present histological technique, which can be prevented or cured by administering the vitamin: the position is, however, rendered obscure by the fact that similar gross lesions are observed in starvation, and it is possible that starvation rather than vitamin B deficiency *per se* is the primary cause of both lesions and symptoms, the appearance of the latter, however, depending on the length of time the animal can live on the deficient diet, as compared with the short duration of a complete starvation experiment.

The actual amount of the vitamin required in the diet depends both on the diet and on the physiological condition of the animal. Thus Gladys A. Hartwell has shown that the rat requires about four times more vitamin B in the diet when rearing young than for growth or reproduction (*Biochem. Jour.*, vol. 19, p. 1074; 1925), whilst Drummond and Plimmer and their co-workers have demonstrated a relationship between the amounts of some of the other constituents of the diet and the vitamin B, which must be adhered to if optimal conditions for growth and maintenance are to be obtained (J. C. Drummond with Vera Reader, *ibid.*, vol. 20, p. 1256; 1926: and with A. Hassan, vol. 21, p. 653; 1927: R. H. A. Plimmer, J. L. Rosedale, and W. H. Raymond, *ibid.*, vol. 21, p. 913).

It is well known that the onset of symptoms of polyneuritis in birds is earlier in those which consume more of the deficient diet, and in those kept on a diet consisting chiefly of corbohydrates, whilst the onset is latest when the chief constituent of the diet is fat. Using young chicks or ducks, and, in the case of the carbohydrate diets, pigeons and rats also, Plimmer and his associates have succeeded in demonstrating a definite dependence of the vitamin B content of the diet upon the amounts of the other three chief constituents present if maximal growth and health are to be obtained.

The plan of the experiments was to feed diets consisting chiefly of protein, fat, or carbohydrate, together with salts and vitamins, and vary the relationship of the vitamin B to the main dietary constituent until satisfactory growth was obtained. The authors found that the ratio of dried yeast (as source of vitamin B) to the total calories in the diet was a constant and varied from 1 : 40 in the case of the chick, for a predominantly fat or carbohydrate diet, to 1 : 80 in the pigeon and 1 : 160 in the rat. Young animals require more than adults. The authors advance the suggestion that vitamin B is a constituent of the nucleus of every cell (perhaps a pyrimidine or purine compound), and thus the amount required depends on the total metabolism of the animal.

Drummond, working with rats, has observed that the ratio between the protein content and the yeast extract of the diet must be in the neighbourhood of 5, if growth is to be normal: with ratios of 18, growth was poor. He was unable to trace any relationship between the calories or the carbohydrate of the diet and the vitamin B content, thus failing to confirm the conclusions to which Plimmer was led by his experiments. The diet used by the latter for his rats contained no less than 94 per cent. of white flour, 5 per cent. fishmeal and 1 per cent. cod-liver oil completing it together with varying amounts of yeast extract: in none of Drummond's diets was the starch, as source of carbohydrate, higher than 70 per cent., nor did the protein content, in these experiments, caseinogen, fall below 20 per cent.: cod-liver oil, salts, lemon juice were also added, together with varying amounts of yeast extract, whilst fat sometimes replaced starch to increase the caloric value of the ration: in these differences between the diets used may lie the explanation of the somewhat different conclusions of the two observers.

That vitamin B really consists of two separate substances has been suggested by a number of different observations, but only recently has this differentiation become an established fact. Harriette Chick and Margaret H. Roscoe (*Biochem. Jour.*, vol. 21, p. 698; 1927) describe the two factors as the 'antineuritic,' which prevents polyneuritis in birds and paralysis in rats, and the 'pellagra-preventive' (of Goldberger), which prevents pellagra in rats, both together forming the water soluble vitamin B and both being necessary for normal growth. In a review of the literature, the authors point out that the two factors show certain differences in distribution; *e.g.* the antineuritic predominates in wheat embryo, but the antipellagrous in milk, meat, green leaves, etc., and that the antineuritic is more easily destroyed by a temperature of 120° C. and is more soluble in certain organic solvents such as alcohol, acetone, or benzene. In their experiments, the authors have confirmed the work of Goldberger and his associates on this subject.

The experiments were carried out on rats maintained on a synthetic diet: various preparations of yeast and wheat embryo were used as sources of the vitamins. On the basal diet alone, the animals died in a few weeks, usually without developing any symptoms: administration of dried yeast then permitted of growth and prevented death: if the yeast were first autoclaved, the animals died just as on the basal diet alone: if an alcoholic extract of yeast were given, the animals lived for some time, but without growth, and ultimately developed the symptoms of pellagra, characterised by ophthalmia, loss of fur, and dermatitis of the ears, paws, and neck. This condition could be cured, and at the same time growth restored, by the administration of autoclaved yeast. It is thus clear that the alcoholic extract of yeast contains the antineuritic factor, and the autoclaved yeast only the antipellagrous: growth occurs only when both are present together. The authors also confirmed the observation that wheat embryo contains mainly the antineuritic factor.

Hassan and Drummond have obtained similar results in their experiments (*loc. cit.*); thus rats kept on a high protein, low yeast, diet failed to grow satisfactorily until additional autoclaved yeast was added to the diet: but if only autoclaved yeast was used,

growth again failed to occur, but could be produced by the administration of small amounts of an alcoholic extract of yeast. The balancing of the protein in the diet appeared to be the function of the thermostable factor.

With this differentiation of vitamin B into two parts, greater knowledge of the chemistry of this vitamin should be soon obtained. Some light is thrown on the chemical nature and properties of the antineuritic factor by recent work by H. W. Kinnersley and R. A. Peters (*Biochem. Jour.*, vol. 21, p. 777; 1927, and by U. Suzuki and Y. Sahashi in Japan (*Scientific Papers, Inst. Physic. and Chem. Res.*, vol. 4, p. 295; 1926, and vol. 5, p. 191; 1927). Kinnersley and Peters have purified their yeast extract ('torulin') until only 0·15-0·3 mgm. per day is necessary to cure polyneuritis in pigeons.

The methods of extraction and purification used are briefly as follows: Yeast autolysed for three days at room temperature is extracted twice with boiling water: the combined filtrates are treated with neutral lead acetate, the precipitate removed and the filtrate treated with baryta. On filtration, a crystal clear yellow fluid is obtained containing 6000 doses of torulin from 14 lb. yeast. The barium is removed as sulphate and the filtrate treated with acid mercuric sulphate: after removal of the precipitate the reaction is adjusted to *p*H 7·0 and purified 'Norite' charcoal added. The charcoal adsorbs the torulin, which can be removed from it by extraction with hot 0·1 *N* hydrochloric acid, or with acid alcohol. About 60 per cent. of the torulin contained in the baryta filtrate is recovered. For prolonged feeding experiments, it is advisable to omit the mercuric sulphate stage: the solution can be cleared by 'Norite' charcoal, provided the *p*H is at 2·5, since at this reaction the torulin is not adsorbed, but remains in solution. Further purification may be affected by a prolonged alcohol fractionation, following removal of any traces of metals with hydrogen sulphide.

The purified material contains 15-25 per cent. nitrogen: it is soluble in absolute ethyl alcohol, but is not adsorbed on 'Norite' charcoal, like the impurer preparations, so that adsorption must be a property conferred on the torulin by some accompanying impurity. The Pauly reaction becomes less intense as the material is purified. The authors identify torulin with the thermolabile growth factor and consider that it is probably the same as the anti-beriberi vitamin. In view of the work previously discussed, the opinion that the antineuritic, antiberiberi, and thermolabile growth factors are the same substance appears to be justified at present, although future work may show the necessity of differentiating between them.

The Japanese workers have obtained a substance, which they call 'Oryzanin,' from rice-bran or yeast, which cures polyneuritis in pigeons in doses of about 5 mgm. The material was obtained from an alcoholic solution of rice-bran, by precipitating impurities with lead acetate and the active material with phosphotungstic acid, followed by silver nitrate. When boiled with dilute acids, the substance was split into glucose, choline, nicotinic and 2·6-dioxychinolin carboxylic acids. The latter has been found to have a stimulating effect upon the growth of yeast, whilst a closely related compound, 2·6-dioxychinolin hydrochloride, in doses of about 7·5 mgm. daily, injected intramuscularly, cures the polyneuritis of pigeons, but has no influence on their weight. The authors consider that these compounds are closely related to the active principles contained in rice-bran: caution must be exercised, however, in accepting this conclusion, since the substances isolated might be contaminated with minute traces of a very highly active compound, in the same way as the activity of irradiated cholesterol has been shown to be due to contamination with small amounts of ergosterol, the latter only being converted into vitamin D on irradiation.

The work reviewed above offers hope that the designation 'vitamin B' will soon have to be discarded in favour of the proper names of well-defined chemical compounds, and that their isolation will be followed by their synthesis in the laboratory.

Biology of the Gulf of Mannar.

THE recent *Bulletin* of the Madras Government Museum, edited by the Superintendent (The Littoral Fauna of Krusadai Island in the Gulf of Mannar. New Series. Natural History Section, vol. 1, No. 1. 1927. P. 196. Madras: Government Press. 8 rupees), is the first issue of a new series of Madras Government publications on the natural history of animals and plants, as distinct from a general section dealing with archæology, anthropology, and allied subjects. The treatment of the subject in this number is one intermediate between a textbook and a specialist's monograph. Descriptions of many common species of invertebrate animals found on Krusadai Island in the Gulf of Mannar and in neighbouring localities are given. The classification followed is either that of the "Oxford Zoology" or of the "Cambridge Natural History." A new genus is described, Pseudocaprellina, in the suborder Caprellidea. There are two appendices, the first on the vertebrate fauna and the second on the flora of the island.

The various authors, among whom Dr. F. H. Gravely and Dr. B. Sundara Raj are prominent, have adopted a useful system of describing the common species, of which no up-to-date account exists within the reach of the Indian student. They have illustrated their papers well and given good lists of literature under each group. This publication will be valuable to students not only as a preliminary guide to the fauna and flora of the Island, but also as a stimulus to collecting and to subsequent research in the biological world of India.

The southern side and the eastern part of the northern side of the Krusadai Island are entirely sandy; the western part of the northern shore is very muddy and fringed with mangroves. A salt marsh, bounded on its southern and eastern sides by high sand dunes, extends from the northern shore across the whole width of the island, a little to the east of the middle. Tolerably fresh water can be obtained from shallow pits dug in the sand. Swarms of anopheline larvæ have been found, but no mosquitoes have been seen in September or in April-May.

From this island there is an easy approach to collecting grounds in Shingle Island, Kutikāl Point on Rāmēswaram Island, Pāmban Channel, and Rāmēswaram. Shingle Island gives ample opportunities for observing corals in their natural surroundings; Kutikāl Point is a good place for collecting medusæ and other pelagic forms; the Pāmban Channel is extraordinarily rich in hydroids, polyzoa, ascidians; and Rāmēswaram is interesting, as its fauna is very different from anything yet found in the immediate neighbourhood. With such surroundings and the prospects of the establishment of a Marine Biological Station in Krusadai Island, there is every hope that much information of interest on tropical marine life will be forthcoming in the near future.

University and Educational Intelligence.

EDINBURGH.—Dr. A. E. Cameron, professor of zoology and entomology in the University of Saskatchewan, has been appointed lecturer in medical entomology in the Department of Zoology as from Oct. 1 next.

LIVERPOOL.—The University will celebrate the twenty-fifth anniversary of its Charter on May 10 and 11, when honorary degrees, including the following, will be conferred:—D.Litt.: Lord Crawford and Balcarres, Chancellor of the University of Manchester, for eminent services to art, literature, and education; Prof. T. Percy Nunn, professor of education in the University of London and principal of the London Day Training College, for distinguished contributions to philosophy and education. D.Sc.: Prof. J. E. Littlewood, Rouse Ball professor of mathematics in the University of Cambridge, for distinguished contributions to mathematical science; Prof. Robert Robinson, professor of organic chemistry in the University of Manchester, for eminence as an organic chemist. LL.D.: Mr. William M. Childs, Vice-Chancellor of the University of Reading, for eminent services to university education in England; the Right Hon. H. A. L. Fisher, Warden of New College, Oxford, for his distinction in scholarship and his services to education in England; Prof. J. W. Gregory, professor of geology in the University of Glasgow, for distinguished services to geology, geography, and exploration. D.Eng.: Prof. J. A. Fleming, emeritus professor of electrical engineering at University College, London, for distinguished services in the advance and application of electrical science.

LONDON.—As from the beginning of the session 1928–29, in place of the existing Department of Philosophy and Psychology at University College, a Department of Philosophy and a Department of Psychology have been instituted. Prof. C. E. Spearman, now Grote professor of philosophy of mind and logic, will be head of the Department of Psychology, his title being changed to professor of psychology in the University of London.

The title of assistant professor of mechanical engineering at University College has been conferred on Mr. B. J. Lloyd-Evans.

The following doctorates have been conferred: D.Sc. in Anatomy on Mr. W. E. Le Gros Clark, University professor of anatomy at St. Bartholomew's Hospital Medical College, for a thesis entitled "On the Anatomy of the Pentailed Treeshrew (*Ptilocercus Lowii*)"; D.Sc. in Biochemistry on Mr. F. W. Fox (Imperial College—Royal College of Science), for a thesis entitled "Some Studies in Sterol Metabolism"; D.Sc. in Chemistry on Mr. R. W. E. B. Harman (University College), for a thesis entitled "Aqueous Solutions of Sodium Silicates"; D.Sc. in Mathematics on Mr. R. G. Cooke (University and East London Colleges), for a thesis entitled (1) "On the Theory of Schlömilch Series," (2) "Gibbs's Phenomenon in Fourier-Bessel Series and Integrals," (3) "The Inversion Formulæ of Hardy and Titchmarsh"; D.Sc. in Statistics on Mr. John Wishart (University College), for a thesis entitled "1. On the Approximate Quadrature of Certain Skew Curves, with an Account of the Researches of Thomas Bayes. 2. The Generalised Product Moment Distribution in Samples from a Normal Multivariate Population."

The Petrie Medal for distinguished work in archæology has been awarded to Sir Aurel Stein.

OXFORD.—The outgoing Senior Proctor, Mr. E. Ll. Woodward, of All Souls', in the customary oration delivered on the expiry of his year of office, took occasion to remark on the scanty attendance at "the very centre of our self-governing society, the Congregation of the University." The younger masters, as he truly said, are rare visitors to this assembly. A remedy might be found if a time were allowed for questions. Speaking of the spaces in the Parks taken up by the rightful claims of the new sciences, he suggested that by way of compensation a new garden and plantations might be laid out in the University's land on the other side of the Cherwell.

ST. ANDREWS.—Dr. J. C. Earl has been appointed to the chair of organic chemistry, pure and applied, in the University of Sydney, in succession to Prof. Kenner. Dr. Earl, who has lectured on organic chemistry in the University since 1922, has conducted investigations on fibrous materials, essential oils, and other products of Australian origin.

AN interesting exhibition was held at the Battersea Polytechnic on Friday and Saturday, Mar. 23 and 24, when the institutes concerned with continued education in the Battersea and Wandsworth areas held a combined exhibition, showing the work done by their students and the facilities offered for such work. The exhibition was opened by Lord Riddell, and the chair was taken by Mr. Alexander Glegg, vice-chairman of the governing body of the Polytechnic. In a short address, Lord Riddell referred to the increasing importance of technical education as related to industry, and the vital need for the nation as a whole to realise that success and happiness can be achieved only by hard and regular work. After the inaugural meeting, the guests spent a considerable time in going round the various exhibits, and were not slow in expressing their astonishment at the nature and scope of the instruction obtainable in the various institutes of the district. The whole of the Polytechnic was open for inspection, and the work shown included engineering, woodwork, building construction, chemistry, physics, hygiene and physiology, art and crafts, domestic science, elocution and dramatics, music, physical training, and many other branches of education. A pleasing phase of the exhibition was the keen interest shown by the many hundreds of young people of both sexes who attended.

INDUSTRIAL Education in 1924–1926 is dealt with in a *Bulletin*, No. 29 of 1927, of the United States Bureau of Education, which will be read with interest in Great Britain in connexion with the Emmott Committee's report, recently published, on the relationships of technical education to other forms of education and to industry. Among other outstanding features of education in America are mentioned: a growing tendency to discriminate more effectively between manual arts courses and vocational courses, with a growing recognition of the former as a part of general education; marked increase in the number of schools offering some form of apprenticeship work, occupational information courses and systematic vocational guidance; increase in the use of the kinematograph and other visual aids in industrial schools; development of itinerant teachers' courses in manual arts and agricultural engineering in rural districts; rapid increase of a new type of organisation, known as the general shop, for teaching elementary work in a number of more or less related activities, such as wood-work, electrical plant, automobile repairing, forging, machine shop, and mechanical drawing; continued change in the emphasis of instruction in manual arts courses from skill in the use of tools and machinery to general elementary, fundamental, manipulative abilities.

Calendar of Customs and Festivals.

April 1.

All Fools' Day.—The custom of sending anyone on a fruitless errand and consequently exposing them to ridicule, sometimes erroneously stated to be confined to England, though it occurs also in Continental countries, especially in France, Germany, and Sweden, has been variously explained as a survival of Roman festivals on which special licence prevailed, as a memory of the mockery of Christ by the Jews, or even as a memorial of the bootless errand of the first dove sent from the Ark by Noah. An etymology of 1656 explains the French phrase for April Fool—*poisson d'Avril*—as a corruption of Passion, connecting it with the manner in which Christ was sent from authority to authority before the crucifixion. The custom may be connected with the festival of the vernal equinox in the Celtic year, and it has been compared to the festival of that date in India which is traced to the ancient Persian calendar.

Palm Sunday.—The carrying of boughs in procession in church in commemoration of our Lord's entry into Jerusalem was one of the ceremonies specially exempt from the liturgical reforms of Henry VIII., although it was intermitted under Edward VI., and always abhorred by the stricter Protestants on account of its 'superstitious' character. This was due not only to the practice of hallowing the palms, but also to a number of beliefs and practices, many more probably popular than ecclesiastical in origin. In Roman Catholic countries and in England before the Reformation, box was the usual substitute for the palm. In the Domesday survey, a supply of box twigs on Palm Sunday was a condition of tenure of one of the Shropshire farms. Later, willow branches with their catkins, which are usually in flower, have generally been used, and the willow in bud is still called 'palm' in popular diction.

The palm used on Palm Sunday had special virtues. Barnabe Googe, in describing the procession of the wooden figure on a wooden ass, speaks of the people throwing branches before and on both the figure and the ass on its way to, and in, the church, which they then snatched up because of their special virtue. The use of the ashes of the previous year's palm on Ash Wednesday has already been mentioned. The custom of roasting eggs in the palm ashes was condemned in the Protestant Church. It was a belief of more than popular currency that the ashes were a sovereign remedy for disease, especially ague and worms. Roman Catholics carried small crosses made of palm in their purses, and at Little Colan, Cornwall, on Palm Sunday crosses of palm were thrown into Lady Nant's well and an offering made to the priest. If the crosses sank it betokened the death of the inquirer before the year was out.

Among the English peasantry, Palm Sunday was made an occasion for rejoicing, not only in the cutting and bringing in of the palms during the week before the actual day, but also on the day itself. At Kimpton in Hertfordshire it was an ancient custom to eat figs on this day, which was known as Fig Sunday, and to keep wassail, and there are several records beside that of Barnabe Googe, that after the Church procession boys sang and collected money, bread, and eggs from the people in the town or neighbourhood. Its possible connexion or confusion with an agricultural festival is shown by the fact that Mothering Sunday in Wales was celebrated on Palm Sunday.

April 5.

Maundy Thursday.—The day for the distribution of royal alms at Westminster, which in earlier days took the form not only of a dole but also of the washing of the feet of a number of poor persons by the reigning monarch, and sometimes of poor women also by his consort. In number originally 13, they were afterwards made to correspond with the years of the king's reign or of his life, as is first recorded of King John. In the earliest records of the custom, it was performed by the head of a monastery, the number of people equalling the number of monks. It is not confined to England, but is a custom of the Roman Catholic and the Greek Church, the ceremony being performed by the Pope and the reigning monarchs of the respective countries.

Shere Thursday, an alternative name, probably refers to its character as one of the days of special solemnity in Holy Week, Shere being a mis-spelling of *Chare*, from Old German *Char*, although there is an explanation of some antiquity that on this day the hair and beard were cut to mark the end of Lent and as a preparation for the Easter festival.

In the Highlands of Scotland, if the stock of seaweed used as manure obtained by this day was still inadequate, a pot of porridge prepared with butter and other rich ingredients was taken to the shore and a portion poured into the sea from each headland with incantations.

April 6.

Good Friday, or God's Friday.—Certain special observances were enjoined upon the king as head of the State. He crept to the cross, which was laid upon a carpet, and kissed it. It was also the custom for him on this day to hallow a number of the rings called 'cramp rings'—a remedy for fits.

Cakes or small loaves of bread baked on Good Friday morning had certain special virtues. They were not intended to be eaten, but were put by until the next year. Fragments grated into water were sovereign remedies for certain ailments. The custom of marking this bread with a cross has been derived from the custom of the Greeks and Romans of marking their bread with crosses and intersecting lines. In the north of England a pudding containing leaves of the passion dock (*Polygonum bistorta*) was an indispensable dish.

In the Isle of Man and in the Highlands there was a special taboo on the use of iron on this day. In the Isle of Man no iron must be put in the fire; in the latter locality no iron was to enter the ground, and if a burial had to take place on this day, the grave was opened the day before and the earth replaced over the corpse with a wooden shovel.

According to an observer in about the year 1810, the sailors of South African and Portuguese ships in the London docks hanged a clothed wooden figure of Judas Iscariot to the rigging. On their return from church they lowered it to the deck, and dipped it in the dock three times. It was then beaten by all members of the crew until no clothes remained on its back.

April 7.

Easter Eve.—On this day the paschal taper was lighted with flint and steel. In various parts of England, boys played games with hard-boiled eggs as balls and marched in procession with torches. In Ireland the day was made an occasion for feasting, and at 12 o'clock at night Lent was driven out with clapping of hands and shouts. Before dawn, everyone went out to see the sun dance in honour of the Resurrection. All clothes should be new for Easter, to ensure good luck.

Societies and Academies.

LONDON.

Geological Society, Mar. 7.—**Hilda K. Cargill, L. Hawkes, and Julia A. Ledeboer**: The major intrusions of south-east Iceland. The main plutonic intrusions into the Tertiary plateau-basalts of Iceland were discovered some forty-five years ago in the south-east of the island, but little is known of their field-relations or petrology; the present paper summarises the results obtained on summer visits to the more accessible localities. The outcrops are scattered; the largest one (the Slaufrudal Stock) is elongate in plan, and its area covers $1\frac{1}{2} \times 4\frac{1}{2}$ miles. The relationship of intrusives to country-rocks is a discordant one, the intrusions being stocks with steep-sided walls and domed roofs (not laccoliths as formerly suggested). The elongation of the stocks is parallel to the strike of the regional dykes, and intrusion clearly took place under, and was facilitated by, crustal tension. All intrusions are multiple: the common association is that of gabbro and granophyre. A horizontal layered structure of granite and granophyre is visible in the Slaufrudal stock, which seems to have grown by the injection of successive sills with intermittent subsidence of the replaced block. The rocks belong to the calc-alkaline suite, and comprise in the order of differentiation gabbro-peridotite, gabbro, diorite, granodiorite, granophyre, granite, quartz-vein. Eight new analyses are given. The suite, with the addition of granodiorite, is similar to that of the main plutonic intrusions of Tertiary age in Scotland. Comment is made on the absence of alkaline types in a region of 'Atlantic' tectonics. In the whole Icelandic area intermediate rocks are relatively unimportant in bulk, the extrusives are dominantly basic, and the intrusives dominantly acid: this may be related to the superior mobility of the basic magma. The absence of a sedimentary 'floor' in Iceland is noted, and it is suggested that the preservation of the Iceland-Faeroes remnant is due to the intrusion beneath it of an acid magma.

Society of Public Analysts, Mar. 7.—**T. P. Hilditch**: Composition of the fatty acids present as glycerides in elasmobranch oils. Whereas normal marine animal oils contain 30-40 per cent. of acids of the C_{20} and C_{22} groups, the fatty acids of shark-liver oils are of relatively low unsaturation. Apparently there is some connexion between the deficiency of these highly unsaturated acids and the presence of large amounts of the highly unsaturated squalene.—**R. T. Thomson**: Behaviour of indicators in the titration of ammonia, sodium and calcium phosphates, the methylamines, puridine bases, and boric acid. In commercial analysis, for ammonia and the methylamines methyl orange is the most satisfactory, and Congo Red for pyridine bases. Methyl orange is also to be preferred as an indicator for boric acid in quantities not exceeding 0·2 gm.—**H. R. Jensen**: Cacao tannin. As tannin is probably a principal cause of astringency in chocolate, the cinchonine method has been applied to the determination of tannin in cacao. The cinchonine tannate precipitate was found to contain 4·4 per cent. of nitrogen, which is similar to the 4·3 per cent. found in the hop and tea tannin compounds. The water-soluble tannin content of eleven samples of fully roasted cacao nibs ranged from 5·2 to 6·3 per cent.

Royal Meteorological Society, Mar. 21.—**H. W. Newton**: The sun's cycle of activity (Symons Memorial Lecture). The cycle of activity through which the sun passes in a period of about 11 years is shown by various solar phenomena. There is the well-known variation in the number of sunspots and in the concomitant phenomena of bright calcium and hydrogen flocculi at higher levels. Above these is the region of prominences and dark hydrogen markings which show only a partial relation to the spot zones. The extended and outermost envelope of the sun—the corona—also undergoes a cyclical change. The cause of this 11-year period, though seemingly within the sun, is not known, and phase and amplitude of a cycle ahead cannot be predicted with accuracy. Sunspots are probably vortical in origin and are the centres of strong magnetic fields, the polarities of which, when similar spots are compared, have been found to be opposite in successive 11-year cycles. A theory dealing with the sun's general circulation and that of spots in particular has been advanced by V. Bjerknes. Measures of the solar-constant and of the sun's ultra-violet radiation indicate a change with the solar cycle. A similar variation in the reception of radio signals is also suspected. The occurrence of terrestrial magnetic storms and the corresponding state of the sun is briefly considered.

CAMBRIDGE.

Philosophical Society, Feb. 27.—**J. A. Gaunt**: A theory of Hartree's atomic fields. The equations used by Dr. Hartree in calculating atomic fields are compared by means of perturbation theory with the exact equation for an atom with many electrons. Many of the correction terms cancel out.—**F. Hurn Constable**: (1) On the present position of the theory of centres of activity in heterogeneous catalysis. A critical discussion, with evidence from the oxidation of active centres on iron, leads to the conclusion that the energy store in the active centres is not greatly in excess of that possessed by the regular arrangement of atoms in the surface. The theory seems adequate as so far developed to explain the facts of catalysis, though the quantitative development is somewhat tentative. (2) A method of generalising the law of mass action for heterogeneous surface reactions. To the conditions of reaction in homogeneous systems is added yet another condition, the adsorption of the reactants on the centres of activity of the surface. The surface is treated as if it were homogeneous, reaction taking place as if only those centres on which the heat of activation is smallest, were responsible for chemical change. The general equation is worked out in terms of the rate of bombardment and the mean lives of the molecules on the surface. It is incidentally shown that the same areas associated with the forward reaction must inevitably catalyse the backward reaction. The general solution is impracticable, so the special cases of irreversible synthesis and decomposition are considered.—**A. F. Crossley**: Operational solution of some problems in viscous fluid motion. The solutions are given of some two-dimensional problems: (i) on the motion which arises when a lamina of unlimited extent moves in its own plane in a viscous fluid, either infinite or confined between parallel plane boundaries; (ii) on the motion of a viscous fluid contained in a circular cylinder rotating about its axis.—**R. W. Ditchburn**: The photo-electric threshold and the heat of dissociation of the potassium molecule. The energy of dissociation of the potassium molecule is considered to be $0{\cdot}50 \pm 0{\cdot}01$ volts. The wave-length of the photo-electric threshold is 2555 A. ± 25 A. The mechanism of the photo-ionisation process is discussed in connexion with the recent work of Franck and his colleagues.

DUBLIN.

Royal Dublin Society, Feb. 21.—**Rev. H. C. Browne**: Stereoscopic notes. The utility of stereoscopic photography is generally reduced by the lack of uniformity

of commercial apparatus. If full advantage is to be taken of stereoscopic principles, the stereoscope used must be designed to suit the camera. The adoption of definite, recognised standards is therefore desirable.—**J. H. J. Poole**: The measurement of the current flowing through a photo-electric cell by means of a neon lamp (*v.* NATURE, Feb. 25, p. 281).

Royal Irish Academy, Feb. 27.—**S. Young**: The boiling points of the normal paraffins at different pressures. The boiling points of the normal paraffins from methane to octane have been determined by various observers over a wide range of pressure, generally up to the critical point, and from nonane to nonadecane at a few pressures up to 760 mm.; and those of many of the higher homologues up to pentatriacosane, $C_{35}H_{72}$, at 15 mm. or a few pressures up to 25 or 30 mm. Three methods of calculation are employed: (1) The quite general formula $\Delta = A/T^B\sqrt{T}$ gives the approximate difference between the boiling points of any two consecutive homologues at any pressure. In this formula $\log A = 1{\cdot}92251 + 0{\cdot}026187 \log p + 0{\cdot}013987 (\log p)^2 + 0{\cdot}0013374 (\log p)^3$, and $B = 0{\cdot}01676 - 0{\cdot}000795 \log p$. (2) At any given pressure the boiling points of the normal paraffins may be calculated with fair accuracy by the formula $\log T = a + b \log n + c(\log n)^2 [+ d(\log n)^3]$, where n is the number of carbon atoms in the molecule. The fourth constant d was only required at the three lowest pressures for the complete series from CH_4 to $C_{35}H_{72}$. (3) In this method each paraffin is compared with one of them, hexane, taken as a standard, at a series of pressures the same for both. The equation is of the form $1/T'_B = 1/T'_A[a + bT'_A + cT'^2_A]$, where A represents hexane and B the other paraffin.

EDINBURGH.

Royal Society, Feb. 20.—**E. B. Bailey**: Schist geology: Braemar, Glen Clunie, and Glen Shee. The Ben Eagach schist outcrop of Caenlochan Glen continues by Glen Shee to Glen Clunie. It there comes into contact with Blair Atholl limestones: (1) at Newbigging cottage owing to faulting, and (2) southwest of Morrone owing to sliding. Differences of rock character at Glens Clunie and Caenlochan are attributed to metamorphism. The structure of the district includes refolded recumbent folds and slides.—**H. H. Read**: The Highland schists of Middle Deeside and East Glen Muick. The Highland schists of these areas are divided into three groups which are correlated with the Pitlochry schists, Loch Tay limestone and Ben Lui schists of Perthshire. There is no discontinuity of outcrop between Perthshire and Aberdeenshire, and structures in the two areas are continued on the equivalent horizons. The Deeside schists lie, in a northerly pitching anticline, far above a culmination recognised in Tarfside.—**C. Norman Kemp**: The X-ray examination of coal sections. The X-ray examination of coal has hitherto for the most part been carried out on comparatively small and irregular pieces. The special methods of sawing developed at H.M. Fuel Research Station for the production of coal sections having smooth, flat, and parallel surfaces are described. The resulting slices, of a thickness of about 1 cm., and measuring sometimes 20 cm. by 15 cm., were subjected to radiographic examination. Comparisons within and between radiographs acquire a new degree of precision, and, in marked contrast with former results, the negatives are so sharp that moderate degrees of enlargement may be employed for the study of finer structural details.—**Edward Henderson**: An X-ray examination of saturated dicarboxylic acids and amides of the fatty acid series. Additional members of the series of normal saturated dicarboxylic acids have been investigated and the results are in agreement with the conclusions already arrived at (*J.C.S.*, **129**, 2633; 1926). A number of mono- and di-alkyl malonic acids have been studied. Successive reflection planes are separated by the length of one molecule. The series of fatty acid amides resembles closely the series of fatty acids.—**W. L. Ferrar**: Generalised derivatives and integrals. The various definitions of D^nf, n not a positive integer, are considered. Pincherle's operator is a representation of the analytic function given by Riemann's definition. Limiting processes applied to Δ^nf lead to Liouville's, and not Riemann's, definition.

LEEDS.

Philosophical and Literary Society, Feb. 21.—**C. A. Ford**: Discontinuous fluid motion past an elliptic barrier.—**R. Stoneley**: A Rayleigh wave problem. The propagation of waves of the Rayleigh type is examined for a compressible elastic solid of finite depth, with one surface fixed. The wave-velocity depends on the wave-length, and may have any value greater than that of a simple Rayleigh wave in the medium. The wave-velocity equation is also deduced as a limiting case of Rayleigh waves in a surface layer.—**H. Jones** and **R. Whiddington**: Note on the energy losses of electrons passing through hydrogen. A brief introductory account of experiments using a photographic method in which radiation quantum losses are observed using 100 volt electrons in hydrogen at low pressure. The view is taken that the hydrogen molecule and H_3 are mainly concerned.—**R. Whiddington**: Some experiments with electrons passing through fine slits. Certain highly complicated energy changes have been observed when electrons of about 100 volts energy are passed in a good vacuum through a fine slit. The apparent occurrence of energies in excess of the greatest expected are due probably to an inherent instrumental effect.—**S. R. Pike**: The physical conditions in new stars. The corrections required to reduce the visual to the bolometric magnitudes of stars have been calculated for surface temperatures between 20,000° A. and 120,000° A., and are applied to show that the increase in brightness of a nova cannot be due to temperature changes alone, but must involve a large increase in radius. For Nova Aquilæ the rate of expansion of the photosphere can be found approximately, and it exceeds the parabolic velocity. Consideration of the degree of ionisation of the resultant expanding shell of gas yields information about its density, and about the temperature of the central star at various times.—**E. C. Stoner**: On the distribution of electrons among atomic levels. A number of unjustifiable applications have been made of a scheme previously put forward for the distribution of electrons among atomic levels. The classification of electrons in n, k groups is discussed and the spectroscopic significance of X-ray levels is considered. Electrons cannot be subdivided into grouplets specified by n, k, j values appropriate for X-ray levels.—**E. Percival** and **H. Whitehead**: Observations on the ova and oviposition of some Ephemeroptera and Plecoptera. The ova and oviposition of seven species of Plecoptera and four species of Ephemeroptera are described. The eggs of Perlodes and Perla are modified for attachment to the substratum. Three groups of eggs are to be separated, (*a*) those carried by the female, before oviposition, in masses held by a water-soluble cement, (*b*) those eggs held together by a water absorbent cement which is not soluble, (*c*) those which are attached directly to the substratum by the female,

which creeps down into the water. An attempt is made to correlate the behaviour in water of some eggs with that of sand grains.—**R. G. S. Hudson**: (1) The Lower Carboniferous corals: *Cravenia rhytoides* and *Cravenia tela*, gen. et spp. n. Among the Rugose corals of the Lower Viséan of the Central Province, there are various small cornute forms with a complex Clisiophyllid central column and a simple Caninoid septal area. In development these forms show early specialisation in a particular structure which later became the characteristic feature of the dominant Rugose corals of the Upper Viséan. (2) The Lower Carboniferous corals: development of *Lithostrotion cyathophylloides*, Vaughan. The structure of this species shows that it is not a Lithostrotion but a Cyathophyllid coral which has a Clisiophyllid trend, and in its late growth stages possesses a medial plate and arched tabellæ, thus approximating to the structure of Clisiophyllum.—**F. C. Stewart**: The maintenance of semi-permeability in the plant cell during leaching experiments. Leaching phenomena applied to living tissues do not afford a means of ascertaining the chemical nature of substances in the cell walls or limiting protoplasmic surface of plant cells. Protracted leaching experiments indicate that such treatment does not necessarily result in loss of semi-permeability. This is not in accordance with the view that leaching involves removal of those substances responsible for the permeability properties of living cells.

PARIS.

Academy of Sciences, Feb. 20.—**Gabriel Bertrand** and **L. Silberstein**: The proportions of barium contained in arable soil. The method of determining barium in soil is given in detail. The proportions found range from 0·008 per cent. to 0·17 per cent.—**Louis Roy**: The general equations of elastic surfaces.—**J. Le Bel**: A cyclic system connected with harmonic surfaces.—**B. Hostinsky**: Complement to the note on the probabilities relative to repeated transformations.—**R. Gosse**: The equations $s = qf(x,y,z,p)$.—**R. Wavre**: The permanent rotations of a heterogeneous fluid mass and geodesy.—**Seth B. Nicholson** and **Nicolas B. Perrakis**: The constitution of the solar atmosphere. It has been proved that a large number of known elements are absent from the solar atmosphere, and an attempt is made to see if these absences are accidental or depend on reasons connected with atomic structure. The solar atmosphere contains neither extremely stable elements, such as the rare gases, nor specially unstable elements, such as the radioactive bodies. The absences, apparent or real, occur periodically as the atomic number increases. The total, or almost total, absence of the heavy elements is difficult to explain.—**H. Deslandres**: Remarks on the preceding communication.—**Louis Kahn**: A conformal chart utilisable as an orthodromic chart for long routes.—**Winter**: Vibrating spaces.—**Mlle. Paule Collet** and **Francis Birch**: The magnetic moments of the cupric ion. The usual moment of the cupric ion is ten magnetons, but in one case nine magnetons were found.—**B. Cabrera**: Internuclear reactions.—**Henri Moureu**: The tautomerism of the α-diketones. Constitution of the two forms of methylbenzylglyoxal. One of the isomerides of methylbenzylglyoxal is a true α-diketone: the other has the keto-enolic form, $C_6H_5 . CH : C(OH) . CO . CH_3$.—**A. Demay**: The upper elements of the Cévenol tectonic complex, the Pilat and Laval strata, in the Pyfara face and in the Saint-Marcel synclinal.—**Conrad Kilian**: The presence of the Silurian to the east and south of Ahaggar.—**E. Bruet**: The conditions of formation and of conservation of the upper Pliocene of the Aujon valley.—**A. Guilliermond**: Remarks on the phylogeny of the Ascomycetes.—**Michel-Durand**: The physiological rôle of the pyrogallic tannins.—**Y. Volmar** and **A. Jermstad**: The essential oil of *Salvia Sclarea*. The results of a detailed physical and chemical examination of the essential oil of sage.—**D. Chouchak**: The presence of glycuronic acid in wines made from diseased or mouldy grapes. Wines produced from healthy grapes contain only traces of glycuronic acid: the determination of this acid in wine serves as a measure of the care taken with the grapes before fermentation.—**Georges Truffaut** and **N. Bezssonoff**: The usefulness of natural and soluble phosphates measured by a bacteriological method, and the effect on higher plants.—**Tsen-Cheng**: The histopathological modifications proved in the potato (*Solanum tuberosum*) attacked by degenerescence.—**A. Jullien**: The transformation of the blood cells of the cuttle fish (*Sepia off.*) in the course of aseptic inflammatory reactions.—**L. Mercier**: Contribution to the study of the loss of the power of flight in *Carnus hemapterus*.—**C. Dawydoff**: The embryology of the Protonemerta.—**Mme. Hélène Sorg-Matter**: The quantitative law of the minimum nitrogen consumption of the homœotherms: intraspecific validity.—**Angel Establier y Costa** and **Charles Kayser**: Analysis of the mechanism of hyperallantoinuria observed after the puncture of the fourth ventricle.—**Mme. M. Phisalix** and **F. Pasteur**: The action of ultra-violet light on the venom of *Vipera aspis*.—**Bordier**: The heat disengaged by diathermal d'Arsonvalisation with sponge electrodes: important disadvantages of these electrodes. Flexible metallic electrodes are preferable to sponges for making contact with the patient.—**Jean Saidman**: An automatic test for the sensibility of the skin.—**Barrien** and **Nemours-Auguste**: The technique and the results of the treatment of angina pectoris by radiotherapy. The treatment is absolutely without danger, provided care is taken to shield the thyroid gland. Out of seven cases there were five cures and one marked improvement.—**S. Metalnicov** and **V. Chorine**: Bacterial diseases in the larvæ of the maize moth, *Pyrausta nubilalis*.—**F. Picard**: The factors of geographical distribution of *Plasmodium vivax* and *Plasmodium præcox*.

VIENNA.

Academy of Sciences, Jan. 12.—**K. Beaucourt**: Condensation products of furfurol with acid amides.—**H. Mäe**: Sudden transitions of temperature in the Baltic. North or south winds blowing along the length of the Gulf of Bothnia induce a vertical circulation, bringing cold bottom water to the surface.—**W. Blabensteiner**: The application of the ash picture for the determination of barks used in pharmacy.—**C. A. Bobies**: Quartz gravel in the marine sediments of the eastern Triesting.—**H. Pettersson**: The disintegration of carbon (3). Graphite was bombarded with α-particles of reduced range from polonium. These cease to liberate H-particles of observable range from carbon at a reduced range which lies between 1 and 2 cm. of air. Apparently a higher minimum energy of the α-particle is required for disintegrating carbon than for aluminium.—**K. Menger**: A theorem of topology. Notes on the theory of dimensions. (1) A proposition supplementing the definition of dimensions, (2) weak n-dimensional spaces, (3) n-dimensional growths.—**K. Czapla**: Ash pictures of technically useful barks. Barks useful in tanning can be recognised in test sections. The ash products were examined microscopically for crystals and use made of micro-chemical staining reagents.—**R. Wagner**: Anisophylly and partial inflorescences in *Salvia sclarea*.

Official Publications Received.

BRITISH.

Proceedings of the Fourteenth Indian Science Congress, Lahore 1927. (Second Circuit.) Pp. xxiv+884. (Calcutta: Asiatic Society of Bengal.)

Australasian Association for the Advancement of Science (Australia and New Zealand). Programme, Hobart Meeting, January 1928. Pp. 29. Handbook to Tasmania: prepared for the Members of the Australasian Association for the Advancement of Science on the Occasion of its Meeting in Hobart, January 1928. Pp. ii+185+17 plates. 3s. (Sydney, N.S.W.)

Metropolitan Boroughs of Wandsworth and Battersea. Guide to the Exhibition of Continued Education, Friday and Saturday, March 23rd and 24th, 1928. Pp. 40. (London: Battersea Polytechnic.) 2d.

Memoirs of the Asiatic Society of Bengal. Vol. 9, No. 4: Geographic and Oceanographic Research in Indian Waters. By Lieut.-Col. R. B. Seymour Sewell. Part iv: The Temperature and Salinity of the Coastal Water of the Andaman Sea. Pp. 131-206. (Calcutta.) 2.13 rupees.

Transactions of the Geological Society of South Africa. Vol. 30, January to December 1927. Pp. iv+144+7 plates. 42s. Proceedings of the Geological Society of South Africa: containing the Minutes of Meetings and the Discussions on Papers read during 1927. To accompany Vol. 30 of the Transactions, January-December 1927. Pp. iii+xlviii. (Johannesburg.)

British Research Association for the Woollen and Worsted Industries. Annual Report, 1927-28. Pp. 40. (Leeds.)

Annals of the Natal Museum. Edited by Dr. Ernest Warren. Vol. 6, Part 1, March. Pp. 169+11 plates. (London: Adlard and Son, Ltd.) 17s. net.

FOREIGN.

Observations and Investigations made at the Blue Hill Meteorological Observatory in the Year 1927 under the direction of Prof. Alexander McAdie. Pp. 86+21 plates. (Cambridge, Mass.)

Transactions of the Astronomical Observatory of Yale University. Vol. 6, Parts 1 and 2: Tables for Weights and Probable Errors, by Frank Schlesinger; The Parallaxes of Fifty-eight Stars, by Frank Schlesinger, Frances Allen, and others. Pp. 32. Vol. 6, Part 3: The Stellar Case of the Problem of Three Bodies. By Paul Slavenas. Pp. 33-43. (New Haven, Conn.)

Publikationer fra det Danske Meteorologiske Institut. Aarbøger. Isforholdene i der Arktiske Have (The State of the Ice in the Arctic Seas) 1927. Pp. 15+5 maps. (København: G. E. C. Gad.)

Annuaire de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique, 1928. 94e année. Pp. 92+68+3 planches. (Bruxelles: Maurice Lamertin.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et procès-verbaux des Réunions. Vol. 46: Contribution aux appareils et aux méthodes destinés aux recherches océanographiques pratiquées à bord d'un navire en marche. Par J. Habert. Pp. 50+1 planche. (Copenhague: Andr. Fred. Høst et fils.)

Koninklijk Nederlandsch Meteorologisch Instituut. No. 106a: Ergebnisse aerologischer Beobachtungen. 14, 1925. Pp. iv+41. 2.50 fl. No. 108: Seismische Registrierungen in De Bilt. 12, 1924. Pp. ix+54. 1.00 fl. No. 110: Oceanographische en Meteorologische Waarnemingen in der Atlantischen Oceaan, Juni, Juli, Augustus, (1870-1922). Kaarten. Pp. 16+24 kaarten. 7.50 fl. (Utrecht: Kemink en Zoon.)

CATALOGUES.

Bibliographie des livres français de médecine et de sciences, 1919-1928. Pp. xlviii+166. (Paris: Masson et Cie.)

Early English Books from the Huth, the Hoe, the Britwell and other famous Libraries. (Catalogue No. 19). Pp. 208. (Newcastle-on-Tyne: William H. Robinson.)

Diary of Societies.

FRIDAY, MARCH 30.

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts), at 11 A.M.—Lt.-Col. V. C. Richmond: Some Modern Developments in Rigid Airship Construction.—G. S. Baker and J. L. Kent: Experiments on the Propulsion of a Single-Screw Ship Model.—At 3.—W. G. A. Perring: The Vortex Theory of Propellers and its Application to the Wake Conditions existing behind a Ship.—J. Tutin: Cavitation.—J. L. Taylor: Statistical Analysis of Voyage Abstracts.

DIESEL ENGINE USERS' ASSOCIATION (at Caxton Hall, Westminster), at 3.—D. Brownlie: Liquid Fuel from Coal.

INSTITUTION OF LOCOMOTIVE ENGINEERS (Manchester Centre) (at College of Technology, Manchester), at 7.—W. G. Smith: Some Features of the Mechanical and Electrical Equipment of the Port of Manchester.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—J. L. Hodgson and others: Discussion on The Problem of Utilising the Earth's Internal Heat.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Students' Section) (at Lighting Service Bureau, Newcastle-upon-Tyne), at 7.15.—Annual General Meeting.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—C. F. Adams: Locomotive Maintenance.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—A. G. Davis: The Geology of the Clapham-Morden Railway Extension.—Miss Helen M. Muir-Wood: A New Brachiopod, *Discinisca ferrovia*, from the Woolwich Beds.—E. M. Venables: The London Clay of Bognor.

INSTITUTE OF METALS (Sheffield Local Section) (in Non-Ferrous Section, Applied Science Department, Sheffield University), at 7.30.—Dr. W. H. Hatfield: Non-Ferrous Metals in relation to Ferrous Metallurgy.

INSTITUTION OF WELDING ENGINEERS (at Caxton Hall, Westminster), at 7.30.—W. Steele: Bronze Welding.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Ernest Rutherford: Radioactive Atoms and their Structure.

SATURDAY, MARCH 31.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Transformation of Matter (IV.).

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students' Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—B. E. Houle: The Installation of a Booster Fan.

MONDAY, APRIL 2.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—A. H. Forbes: Science in the Book of Ecclesiastes.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 6.—R. W. A. Brewer: Air Cooled Radial Engines.

INSTITUTION OF AUTOMOBILE ENGINEERS (Western Centre) (at Merchant Venturers' Technical College, Bristol), at 6.45.—J. N. Tait: Mixture Distribution in Multi-Cylinder Engines.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Dr. H. Muthesius: Modern German Architecture.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—C. D. Adams: The English Beet Sugar Industry.

SURVEYORS' INSTITUTION (at Institution of Civil Engineers), at 8.—C. Dampier-Whetham: Agricultural Depression: its Causes and Possible Cures.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—A. C. Hardy: The Work of the R.R.S. *Discovery* in the Falkland Islands Dependencies.

SOCIETY OF CHEMICAL INDUSTRY (Yorkshire Section) (at Leeds).—Annual General Meeting.

TUESDAY, APRIL 3.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Dr. A. Wade: The Oil Well and Later Developments at Hardstoft, Derbyshire.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Miss E. M. Brown: Exhibition of a Fluke (*Microcotyle alcedinis*) from the Gills of the Sea-Bream *Pagellus centrodontus*.—C. R. S. Pitman: (1) Notes on a Young Pangolin captured in January 1928; (2) Nkosi Island and its Sitatunga.—Dr. R. Gurney: Some Copepoda from Tanganyika collected by Mr. S. R. B. Pask.—Cambridge Suez Canal Expedition Reports:—(a) Prof. A. Palombi: Report of Turbellaria.—(b) Dr. A. Schellenberg: Report on the Amphipoda.—(c) F. A. Potts: Report on the Sedentary Polychæta.

INSTITUTION OF CIVIL ENGINEERS, at 6.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—Annual General Meeting.—H. B. Poynder: Some Practical Considerations in the Design of Automatic Equipments for Heavy Traction Substations.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—F. H. Evans: Westminster Abbey.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.45.—E. A. Watson: The Electrical Characteristics of Spark Gap and Sparking Plug.

ROYAL SOCIETY OF MEDICINE (Orthopædics Section), at 8.30.—Dr. C. Scudder: The Treatment of Recent Fractures by Operation.

INSTITUTION OF MECHANICAL ENGINEERS (Swansea Branch).—G. A. V. Russell: Reversing Blooming Mill Practice.

WEDNESDAY, APRIL 4.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. G. W. Tyrrell: The Analcite-Syenites and Associated Rocks of Ayrshire.—Dr. J. Parkinson: The Pleistocene History of Western Buchivacoa (Venezuela).—A. Tindall Hopwood: *Gyrinodon quassus*, a New Genus and Species of Toxodont from Western Buchivacoa (Venezuela).

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Gas Light and Coke Company, Watson House, Nine Elms, S.W.8), at 5.30.—J. G. Clark: Demonstrations of Method of Assessing the Radiant Efficiency of Gas Fires.—Methods of Examining Materials of all Kinds used in Gas Supply.—Testing of Gas Fittings for Soundness, Weight, and Quality.—The Testing of Wrought Iron Fittings for Soundness and Quality.—Methods of Ventilating Gas Appliances and of dealing with Adverse Winds.—Methods used for Instructing the Various Sections of the Staff of the Gas Sales Department.—The Use of Special Flues for Use with Gas Fires, etc.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Prof. E. V. Appleton: The Study of Signal Fading (The Work of the Radio Research Station at Peterborough).

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.—D. S. Munro: Modern Electric Wiring, particularly as applied to Small Houses.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—J. Evans and T. E. Wallis: Coffee Parchment as an Adulterant of Bran and Sharps.—W. B. Adam: Determination of the Colour-producing Constituents of the Cacao Bean.—Dr. A. T. Etheridge: Determination of Vanadium in Steel.—S. G. Clarke: Colorimetric Determination of Antimony and its Separation from Tin.—Dr. A. Riad: Determination of Carbon Dioxide in Soils.

ROYAL MICROSCOPICAL SOCIETY (Biological Section).

PUBLIC LECTURES.

MONDAY, APRIL 2.

GRESHAM COLLEGE, at 6.—G. P. Bailey: Modern Science and Daily Life: Summary and Some Outstanding Problems.

WEDNESDAY, APRIL 4.

MEDICAL SCHOOL, LEEDS, at 3.30.—Prof. G. E. Gask: Radium in the Treatment of Malignant Disease.

SATURDAY, APRIL 7, 1928.

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Team Work.

WE welcome the appearance of another report of the Committee of the Privy Council for Scientific and Industrial Research, that for the year 1926–27, which will doubtless be received as an encouraging document in progressive political circles. For one thing, it represents the credit side of a balance sheet on the debit side of which there stands an item of some £450,000 of public money. In these days of necessary economy—and of even more necessary judgment in its incidence—a recital of the kind of goods that an outlay of half a million pounds will buy in the scientific market is an education by itself. For another, it gives some indication of the dimensions of the quarry in view. The Department performs the dual function of taking a part in assuring a supply of trained and experienced research workers, capable of applying themselves in their respective spheres to the solution of problems confronting British industry, and of instituting and co-ordinating the researches themselves for the benefit of the community.

It is, of course, unfashionable, almost indecent, to scoff at research in this twentieth century; the devotion and skill of the pioneers may have been taken for granted, but there have at least been enough of the more spectacular kind of successes in one branch or another not only to attract the popular attention, but also to awake a genuine concern for the vigorous prosecution of scientific researches with a view either to the amelioration of the conditions of life or to ultimate commercialisation. What is not so fully realised is the enormous amount of untiring, expensive, fundamental team work which must precede the successful completion or application of a discovery; the amount of minute and often apparently inconsequent detail which must be accumulated in order to fashion a single signpost of progress. The ten per cent. of inspiration in genius is readily acclaimed, but the ninety per cent. of perspiration is little appreciated, because undisclosed in the ordinary non-technical report. The labours of the less prominent members of the research community, moreover, although normally receiving due recognition at the hands of those who afterwards make use of them, are often more in the nature of fuel for the furnace than the heat itself.

Our contention, however, is not that the prizes are unequal, or even that the opportunities are equal, but merely that every honest contribution to the advance of our knowledge, provided it is accurately reported and adequately indexed,

possesses a potential relative value which may far exceed its actual intrinsic value. In particular, the major problems of national concern lend themselves to organised team-work, and the Department of Scientific and Industrial Research, together with the laboratories and associations working under its ægis on co-operative lines, are effectively and unobtrusively 'delivering the goods.' The backing of the State puts selected investigators in the position of being able to spend both energy and money on an exploration of the foundations of industry to an extent which would be impossible were the rise of a superstructure the immediate and sole concern. Thus there is a solidity, as well as a catholicity, about the work done under such auspices.

Another important aspect of the Department's activities is the part which it takes, in conjunction with the universities, in making it possible for specially promising students to devote themselves to the preparation for and the practice of a career of research. It is recognised that such support is a means—possibly only a temporary means—and not an end; it is not of the nature and quality of a prize, but rather of an insurance. As we consider that, despite the enormous advances of the past decade, Great Britain has scarcely left the threshold of the scientific development of industry, we realise how necessary a policy this is. The premium costs but five per cent. of the expenditure.

Much thought has been devoted to the question of the propriety of giving or continuing maintenance grants to students. It is satisfactory to find that inquiry shows the number of cases in which the award proves unjustified to be negligible; it is equally satisfactory to find that, even in the chemical profession, where there is a superfluity of aspirants, 66 per cent. of the former recipients are now employed in research in industry, in Government laboratories, or in the universities. It seems clear that the policy of the Department in this respect, although it may require some modification from time to time to meet the changing aspect of industrial and scientific affairs, has proved both economic and fruitful; it is evident that some such opportunity for training in the application of academic knowledge and of academic methods in the industrial arena, whether it be carried out under public or private direction, is an essential link in the chain.

Probably the weakest link is here, in the use which we make of scientific knowledge, scientific potentialities, and particularly of scientific method. We hear much of the lack of appreciation of industrial conditions evidenced by young university graduates, of their unpractical equipment and the like, but too little of the new directions in which the methodical, critical, analytical, and finally synthetic processes of thought and of action in which they have been trained can be brought to bear on the difficulties and the opportunities of the work-a-day world. This application is by no means an automatic process, and the Advisory Council emphasises its significance. Britain, it declares, is not behind others in purely scientific work; what she lacks is the application of scientific discoveries, and above all of scientific method, to industry. It is to such organisations as the research associations that we look specially to hold fast to both partners, and to make their co-operation both possible and profitable. "New industries," says the Report, "may spring up from individual discoveries and by individual effort, but as a new industry grows or merges into a staple industry it will depend more and more on co-operative effort for its health and progress. In this co-operative effort, which is needed to preserve and develop our great industries, the scientific man must take his share; he must be concerned with the necessity for improvement in detail no less than with more spectacular endeavours to strike out into new paths."

These considerations bring us fairly and squarely in view of the main business of the Department, namely, to accumulate, either by assembly or direct inquiry, scientific results of a character suitable for immediate application in support of industry, and to lay sure foundations for its further development. No one who knows anything about the subject nowadays disputes the contention that organised research is, broadly speaking, a paying proposition, although there may be a considerable lag between the expenditure and its profitable return. Individual researches may, and often do, lead to no practical advantage, whereas others realise a handsome profit out of all proportion to the cost; in consequence, only the larger industrial concerns can support capital charges adequate to ensure a profitable proportion of commercially successful results of major dimensions, whilst the smallest firms can share in the rewards of such investigation by supporting the work on a co-operative basis. There are twenty-four such associations, and the majority are in receipt of financial assistance from the Department. It is surprising, however, to find that the Research Association of British Motor and Allied Manufacturers receives so little support from the now prosperous industry — substantially less than an amount

represented by sixpence per motor vehicle produced annually by the industry—as to render it ineligible for a grant from public moneys. We cannot claim to know all that is necessary for maintaining a world-wide supremacy in this direction, so that it would appear that we are more afraid of our competitors at home than abroad. If this is in fact the case, or if the attitude of the industry is determined by some other reason, our hopes for the future must rest entirely on the experimental work which individual firms are able to carry out. This work, of course, is a very long way from being inconsiderable.

The existence of a National Research Council in Canada, a Commonwealth Council for Scientific and Industrial Research in Australia, a Department of Scientific and Industrial Research in New Zealand, and technical boards in South Africa and India, is one of the most encouraging premonitions of a reawakening Empire prosperity. Team work on a national scale can scarcely fail to be as productive of results as team work on an individual basis. The Empire Marketing Board rightly advises us to spend our money in such a way as to keep as much as possible "in the family"; the duty is also laid upon us as members of that family to advise one another concerning the use of our diverse opportunities in the common weal, and to explore our heritage in concert with a view to the efficient exploitation of the family estates. In such a case not only wealth, but also better health and greater happiness are unlikely to be denied us.

The Electronic Theory of Valency.

The Electronic Theory of Valency. By Dr. Nevil Vincent Sidgwick. Pp. xii + 310. (Oxford: Clarendon Press; London: Oxford University Press, 1927.) 15*s.* net.

WHEN the electronic structure of matter had been demonstrated, and the electrons in the atom had been not only counted but also classified by means of spectroscopic data, it was inevitable that attempts should be made to correlate the new data in reference to atomic structure with the commonplace facts of chemistry. In the case of metallic salts, which have been shown by X-ray analysis to be ionised completely even in the solid state, the application of physical data has been comparatively easy, since the attractive forces in an aggregate of ions can be calculated, and the principal unknown quantity is the compressibility or deformability of the ion. This can be expressed as a repulsion varying inversely as the *n*th power of the distance, the value of *n* being about 9 for crystals of the sodium chloride type, in which each ion is surrounded by *six* atoms of opposite sign; in crystals of the cæsium chloride type, however, where the envelope includes *eight* ions of opposite sign, the value of *n* is greater, whilst the *four* ion envelopes of the zinc sulphide type require a smaller index. These simple considerations are complicated by the mutual polarisation of the ions, which introduces another independent constant in the calculations; but, by assigning an arbitrary value to this constant, it has been possible in a considerable number of cases to calculate, by means of data derived from independent sources, the physico-chemical properties (*e.g.* the heat of sublimation, and the molecular volume) of crystalline compounds of this type.

On the other hand, when atoms are united into molecules by means of 'bonds,' the problem at once passes beyond the present scope of physical calculations, since the nature of these bonds cannot yet be defined in terms of known physical quantities. An interesting situation has thus been created. On one hand, physicists have yielded only too readily to the temptation to ignore these inconvenient linkages, and have assigned ionic structures to compounds in which the chemical evidence points clearly to the existence of molecules, held together by real bonds. Thus, since water at 25° contains only one ion-pair for each 500,000,000 molecules (and this proportion decreases as the temperature falls), chemists will view with profound scepticism the suggestion that ice is ionised to the extent of 100 per cent. and contains no molecules at all; and they may even regard this suggestion as a *reductio ad absurdum* of the physical method of attacking chemical problems. On the other hand, when once the electrical structure of the *atom* has been accepted, chemists cannot avoid making mental pictures of the electrical structure of *molecules*; and these pictures have a definite value even when they cannot be reduced to precise physical forms.

Thus, although the idea of 'shared electrons' as an explanation of the chemical bond was introduced by Sir J. J. Thomson before the nucleus atom was invented, we are indebted to Prof. G. N. Lewis for exploiting the general proposition that it takes two of these shared electrons to make a bond; and this general proposition is now so firmly established that physicists may look upon it as a chemical fact for which a physical explanation must ultimately be devised, although at present we do not know in what way a pair of electrons can come

under the control of two atomic nuclei, or why a binuclear orbit should be occupied by two electrons.

Dr. Sidgwick's book is an attempt to review the ordinary facts of chemistry in the light of the electronic structure of matter. It differs from previous books on the same subject, mainly in that attention is paid to the classification of the electrons into groups and sub-groups having a common principal or subsidiary quantum number. The most characteristic feature of the book is therefore a tentative classification of the *shared* electrons of chemical compounds, on the lines of the well-established spectroscopic classification of the *unshared* electrons of free atoms and ions. Such a classification must be mainly speculative, since it has at present no clear physical basis ; but it may nevertheless prove to be of real value as an essential stage in the development of a combined attack by chemists and physicists on a problem which is of vital interest to both. In particular, the interpretation of chemical facts in terms of a purely empirical electronic theory of valency (and theories of valency have always been empirical) may be the only way in which the overwhelming array of chemical facts can be collected and masticated with the view of ultimate digestion. Thus, a very elementary static theory enabled Prof. G. N. Lewis to demonstrate the dual character of chemical affinity (typified by the *transfer* and the *sharing* of electrons) which the earlier chemical theories of valency had persistently sought to unify, and thus made it possible to harmonise the antagonistic valency theories of van 't Hoff and Werner.

This dual classification of *single bonds*, which is still the most important contribution made to chemistry by the electronic theory of matter, leads logically to the conception of polar, non-polar, and semi-polar *double bonds*, and a corresponding series of *triple bonds*, and in this form appears to cover all the main facts of chemical combination. It therefore seems likely to provide a permanent basis for all future theories of valency, with perhaps a grudging admission of a limited number of exceptions.

The most important of these possible exceptions are the *one-electron bonds* which Sugden has used as a means of maintaining Lewis's octet rule in compounds where groups of 12 electrons would otherwise be called for to represent the six 2-electron bonds of a 6-co-ordination compound. Sugden's very large group of exceptions, however, is narrowed down by Dr. Sidgwick to a few conspicuously unstable compounds, comparable with the 1-electron system, H_2^+, which can be detected in high vacua by means of the mass spectrograph. Dr. Sidgwick therefore admits the existence of 1-electron bonds amongst the unstable hydrides of boron ; but even these exceptions to the general rule are only made necessary by the assumption that, since spectroscopic evidence proves that a large amount of energy is required to remove the *K*-electrons from an atom of elementary boron, the sharing of these electrons with a second atom of boron in the molecule of a boron hydride is impracticable. This assumption is open to question, since the balance of energy required can at present only be set down as the difference of a large known quantity and a similar unknown quantity, which may perhaps also be large.

The *three-electron bonds*, used in Thomson's formula for benzene, represent another type of exception, which appeals strongly to many chemists as supplying a physical basis for certain theories of residual affinity ; but, since the parachor of benzene is in harmony with Kekulé's formula, it is doubtful how far even this very attractive exception is justified when the static condition of chemical molecules is under consideration, as contrasted with the possible existence of transient 'activated' forms.

Dr. Sidgwick's own principal contribution to the electronic theory of valency has been in connexion with the 'co-ordination compounds' which formed the subject of his presidential address to Section B (Chemistry) at the Leeds meeting of the British Association. These compounds were (and still are) widely known as 'molecular compounds,' *i.e.*, as compounds formed by the union of integral molecules, instead of free atoms. The rules and many of the facts of co-ordination, culminating in the development of a new type of optical activity, were discovered by Werner ; but they were associated with a confused (although definitely dual) conception of valency, which he would have been the first to clarify if he had lived to read G. N. Lewis's (1916) paper on "The Atom and the Molecule." These molecular compounds do not obey the ordinary rules of valency, although they conform to the rules of co-ordination. They were first brought into the general scheme of the electronic theory of valency in 1919, when Langmuir suggested that, in the platinum ammonia compounds, such as $PtCl_4$, $4NH_3$, the "NH_3 radicals are held directly to the platinum, each sharing a pair of electrons," so that "all these compounds should be looked upon as typical primary valence compounds," that is, as compounds in which a quadrivalent atom of nitrogen is united to the metal by two shared

valency-electrons. In 1921 he applied the same ideas to the metallic carbonyls, $Ni(CO)_4$, $Fe(CO)_5$, $Mo(CO)_6$, which can be regarded as molecular compounds of carbon monoxide with a metal; he therefore assigned to these compounds valency formulæ, which have recently received a remarkable vindication from the discovery of chromium carbonyl, $Cr(CO)_6$, by Prof. Job in the laboratories of the Sorbonne.

Langmuir's suggestion that co-ordination depends on the sharing of a pair of electrons, derived wholly from one of the components, has been adopted by Sidgwick as the fundamental feature of the theory of co-ordination with which his name is now sometimes associated. In order to illustrate that theory, he suggests that the union of ammonia with a metallic chloride may be compared with the action of ammonia on methyl iodide,

$$[CH_3I] + NH_3 = [CH_3 . NH_3]^+I^-,$$

since in each case the molecule of ammonia can only enter the inner sphere of affinity by displacing an atom of halogen from it in the form of a halide ion. The process of co-ordination therefore involves: (i) *the formation of a real bond* between the molecules or ions that are undergoing co-ordination, just as a bond of the ordinary kind is formed between carbon and nitrogen when methyl iodide and ammonia unite to form methylamine hydriodide; and (ii) *the transfer of an electron* from one atom to another, just as (in the same interaction) the nitrogen of the ammonia gives an electron to the iodine of the methyl iodide, and thereby acquires a positive charge to balance the negative charge of the iodide ion.

Whilst, however, Dr. Sidgwick has done much to clarify our conception of co-ordination, and to bring it into line with other forms of chemical combination, he is doing a real disservice by attempting to extend the use of the word to include not only all the main types of molecular compounds to which it is commonly applied, but also a large proportion of the oxidation products known to chemistry. For this extension there does not appear to be any warrant in current literature, since the burning of carbon monoxide to carbon dioxide, the electrolytic oxidation of potassium chloride to potassium chlorate or perchlorate, and the conversion of a sulphide to a sulphone, all lie outside the scope of existing definitions of co-ordination; and only ambiguity and confusion can result from an attempt to alter the meaning of so well-established a term. None of these oxidation products is in fact a co-ordination compound in the generally accepted meaning of the term, and the only analogy is found in the fact that, when an atom of oxygen is added to a chloride ion (or indeed to any system carrying a complete octet or shell of electrons), the two shared electrons which provide the bond of the oxide are both derived from the complete octet, whilst the half-molecule of oxygen contributes only a sextet to the final system.

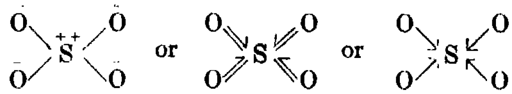
If these two electrons are shared equally by the two atoms which they unite, the oxidation must be accompanied (as I pointed out in 1923) by the development of a negative charge on the oxygen and a positive charge on the other element, exactly as in the process of co-ordination. The atoms are then united, on one hand by a non-polar bond or co-valence, and on the other hand by an ionic linkage or electrovalence, similar to that which unites the sodium and chloride ions in common salt or the ammonium and chloride ions in sal-ammoniac,

e.g. $NMe_3 + O \longrightarrow \overset{+}{N}Me_3 - \overset{-}{O}$ (compare $\overset{+}{N}H_4 + \overset{-}{Cl}$).

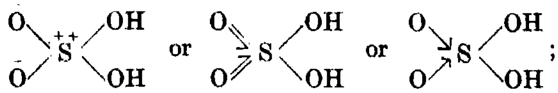
This dual linkage, which was first described as a 'mixed' double bond, is described by Sugden as a 'semi-polar' double bond; but Sidgwick now proposes to call it a 'co-ordinate link.' This name is again unfortunate, since the transfer of an electron, which accompanies the process of co-ordination, may either create a charge on the atoms of a neutral molecule, as in the formation of an ammoniate, or may get rid of it, as in the formation of a platinichloride, $2\overset{+}{K}\overset{-}{Cl} + PtCl_4 = \overset{++}{K_2}[PtCl_6]^{--}$, where the chlorine atoms in the product are regarded as neutral (just as in CCl_4), since the electric changes which they formerly carried have been transferred to the metal. In the product, therefore, Sidgwick's own theory indicates that the co-ordination compound is held together by ordinary non-polar bonds, which are abnormal only in that the anion carries a negative charge. Since one of the two main groups of co-ordination compounds does not contain the type of union which it is proposed to describe as the 'co-ordinate link,' this new term appears to break down, not only by covering too much ground when including the oxides, but also by covering too little ground in excluding the co-ordination compounds of ionised salts.

Finally, reference may be made to the symbol which Dr. Sidgwick uses to represent the 'mixed' or 'semi-polar' bond, or the 'co-ordinate link' of his own nomenclature. Since a single arrow has been used extensively by Robinson and others to represent a process of 'electron drift' in a single bond, there is a real risk of confusion in Dr. Sidgwick's use of this same symbol to represent a

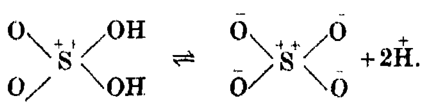
homopolar single bond on which an electrovalence has been superposed, as in the oxide $\overset{+}{N}Me_3 - \overset{-}{O}$, especially as Robinson's electron drift would ultimately have the effect of *breaking* or ionising the homopolar bond, whilst the electron transfer represented by Dr. Sidgwick's symbol has the converse effect of *making* a bond between two molecules or ions which were previously quite free from one another. In this respect, Sidgwick's symbol is definitely inferior to the symbol $\rightleftharpoons$ introduced by me in 1922, which Sugden has used so extensively for this purpose. Both symbols are, however, inferior to the alternative (which is expressed by Sir Joseph Thomson's phrase 'intermolecular ionisation') of showing by means of plus and minus signs the charges on the individual atoms, or (more accurately) the relationship between the nuclear charge of the atom and the number of its quantum orbits which are occupied by electrons. Thus we may write the sulphate ion as:



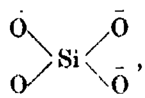
and sulphuric acid as



but the first of these symbols is the only one which shows that there is no direct change in the single bonds between sulphur and hydroxyl when sulphuric acid is ionised



In the same way, the analogous formula for the orthosilicate ion,



, is the only one which shows that the negatively charged oxygen cannot form a true 'semi-polar' bond with the silicon atom, since this atom is neutral and no longer carries a surplus positive charge.

Whilst a large part of Dr. Sidgwick's book is necessarily concerned with co-ordination and its various applications, the other forms of chemical combination are also adequately discussed. Thus the physical evidence for the nuclear atom, with its quantised electron orbits, forms the subject of two preliminary chapters; and the nature of the chemical evidence which led Main Smith to anticipate Stoner in re-arranging the quantum groups in the periodic classification of the elements is indicated much more clearly than in Smith's own book. General rules are also given whereby the author not only proposes to distinguish the physical properties of an ionised salt from those of a non-ionised compound, but also claims to be able to distinguish a covalent compound from a chelate co-ordination compound. In many cases these distinctions can be made with some confidence, as in the case of mercurous iodide, where the colour of the compound agrees with the X-ray analysis of the crystals in showing that the compound is not a mere aggragate of univalent ions, $\overset{+}{Hg}\overset{-}{I}$, but must consist of covalent molecules, probably of the structure I.Hg.Hg.I. In other cases, however, the evidence is much less clear and the conclusions arrived at are less certain. Thus, in the rather difficult case of tellurium, the diagnosis appears to be based on a somewhat incomplete study of the symptoms, and will almost certainly have to be reconsidered as further knowledge becomes available.

The possibility that drastic revision of some of these preliminary conclusions may be called for does not, however, destroy their value, since, if they succeed in provoking further experimental work, they will have fulfilled one of the principal functions of a theory. At the same time, the reader would be well advised not to let the attractiveness of the picture obscure the tenderness of many of the threads of the canvas on which it is painted, since the author does not always emphasise sufficiently the reservations underlying his statements. If, however, when the author writes "it has been proved" the reader will mentally substitute the more accurate phrase "it has been suggested," and if when he writes "this must be due" the reader will read "this is generally believed to be due," no great harm will be done by the rather over-confident way in which the author's very fascinating views are put forward. There is also a risk that injustice may be done to earlier workers, owing to the fact that the origin of the views adopted by the author is not always indicated clearly. In particular, the section on the "Electronic Interpretation of Co-ordination" does not contain any reference to the paper, published in 1919, in which Langmuir anticipated the essential postulates of the theory of co-ordination advanced by the author in 1923. In the same way, the sections on the co-ordination of hydrogen might be strengthened by including a reference to the very clear statements on this subject which were made by Pfeiffer so long ago as 1913, and by Dimroth in 1921.

The last chapter of the book is devoted to a preliminary survey of the families of elements which make up the periodic table, with the view of finding an electronic interpretation of the chemical data, based on the known structure of the atoms and the known behaviour of the valency electrons. This survey is intended to foreshadow the contents of a new volume, in which these problems can be discussed more fully; but the value of that volume, when it appears, may be enhanced considerably by the fact that the author has been bold enough to put his first impressions into print, perhaps with the expectation that they may form a target for constructive criticisms.

Since the work of interpreting chemistry by means of physics may be one of the main tasks of the next decade, Dr. Sidgwick's book will be welcomed by workers in both branches of science, and all the more so from the attractive form in which it is presented. It is not an easy book to read, but (with one exception) the chapters are short, averaging less than 20 pages, so that they can be studied, one unit at a time, without undue effort; and the publishers have done their share in contributing to the pleasure of reading the book.

T. M. LOWRY.

Phosphatic Fertilisers.

Phosphoric Acid, Phosphates, and Phosphatic Fertilisers. By Wm. H. Waggaman. Assisted by Henry W. Easterwood. (American Chemical Society Monograph Series.) Pp. 370. (New York: The Chemical Catalog Co., Inc., 1927.) 7.50 dollars.

THIS book is the thirty-fourth publication of the American Chemical Society Monograph Series, the purpose of which is to present to chemists as a whole the collected information on a chosen subject in a readable form and to show the problems that still await investigation. Exceedingly numerous are the references to the literature, and these will be of the greatest value to those readers who wish to pursue the subject still further.

Ever since the value of artificial fertilisers in agriculture was established, phosphoric acid has been considered mainly in this connexion. While in the past this essential plant food was given in the form of superphosphate, basic slags, rock phosphates, guano, and bones, only the first three of these are now available to any extent as fertilisers. The reserves of guano are becoming exhausted and the supplies are consequently limited. Bones are of importance in other industries. The ideal phosphatic fertiliser should combine good 'availability' with cheapness and be at the same time a high-grade product, for freightage has to be taken into account.

Judging the three fertilisers now in use by these standards, the water-soluble phosphate has the greatest possibilities, for by development and improvement of methods of manufacture the grade can be increased and price reduced. Basic slags are the by-product from steel works and of comparatively little value to the makers; the chances of improving their agricultural value are very remote. With regard to rock phosphates, though both high-grade and attractive in price, they are slower in action. Of recent years they have undoubtedly been used to a larger extent, but this would appear to be due to the fact that price and proximity of supply—they are well distributed over the world, so freightage is reduced—are important factors. Even now, however, the world consumption of superphosphate is greater than that of either rock phosphate or basic slag. Thus if any advance—which is long overdue—can be made in the phosphate industry similar to that which has taken place in the manufacture of nitrogenous fertilisers, the future would seem to be with the water-soluble phosphates. This is a topic of much general interest. In consequence, Messrs. Waggaman and Easterwood's book should be valuable to many, for in the main it deals with this subject. In addition, the growing importance of phosphoric acid in other industries is shown very convincingly. Of the relative merits of the phosphatic fertilisers now in use it has little to say, for there is still much controversy on the subject. Nevertheless, information on that matter from one so well qualified as Waggaman would have been welcome.

The book as a whole describes (1) the importance of phosphoric acid in bio-chemical and industrial processes, and (2) the sources and types of raw phosphatic material available, (3) methods for converting these into commercial products, (4) the economic production of phosphoric acid. Part I. is a general outline, but its value is greatly enhanced by the numerous references to the literature; an expansion of this part, the inclusion of references to some of the more recent work, and omission of the section on elemental phosphorus and its compounds would have been preferable. The sources and types of raw phosphate material, their conversion into fertilisers, etc., are treated in considerable detail,

and to those in any way connected with this trade it should be valuable. With regard to basic slags, their agricultural value in Great Britain and Ireland, at least, is not in full agreement with the results, taken from 1911 experiments, quoted in this book. Of the economic production of phosphoric acid the authors have much to say. The senior author has taken an active part in the development of the pyrolytic process and other problems, so that the conclusion that phosphoric acid will be a serious rival to other inorganic acid comes from a very authoritative source.

"Phosphoric Acid, Phosphates, and Phosphatic Fertilisers" fulfils admirably the purpose of this series, giving a clear and full account of the subject, especially the industrial side. The authors' views on the future development are supported by a veritable mass of data, while the numerous illustrations make the book attractive.

Geography and Anthropology.

Environment and Race: a Study of the Evolution, Migration, Settlement, and Status of the Races of Man. By Dr. Griffith Taylor. Pp. xv + 354 + 6 plates. (London: Oxford University Press, 1927.) 21*s.* net.

THE racial history of man cannot be elucidated by the physical anthropologist alone. The most that he can do is to describe the physical characters of large or small groups of men, recent and extinct, and to indicate their inter-relationships. The historian, or collector of legendary history, may throw some light upon past movements of the population, and the contemporary observer can record what movements are in progress or took place in the immediate past. The biologist, using that term in its widest sense, may make suggestions as to the factors of evolution, physiological, psychological, and others; as to the phenomena of miscegenation, heredity; and various other influences and processes.

Some of these aspects of anthropology are conditioned by the physical environment of a given people, but even an environmental study does not suffice, since it is necessary to understand the former geographical and climatic conditions which were operative upon the ancestors of that people. We know that practically all peoples have been subjected not only to an environment different from that in which they now live, but also that their environment continually varied, land was raised or submerged, and there were major and minor fluctuations of climate. Also, it is necessary to know the relief of the land, the rainfall, and other data, in order to learn what areas were favourable for human existence, those that served as corridors and those that acted as barriers, and so facilitated or inhibited human movements.

These studies are the province of the geographer, and although partial studies of this kind have been made, which have been published in various books and journals (some of which are likely to escape the notice of anthropologists), they have never previously been assembled in a single book; thus a general survey of the world on these lines has been beyond the scope of the anthropologist. If only for this effort, anthropologists owe a great debt to Prof. Griffith Taylor for his "Environment and Race." In considerations of this kind, a time scale is necessary, and it is mainly to the geologist that anthropologists must turn, and our author, naturally, has not neglected this aspect. Although culture has nothing to do with race, we do find that certain languages, customs, ideas, and objects have a particular range in space, and doubtless some of them were restricted in their origin to a definite group of people; here the linguist, the sociologist, and the technologist come to our aid; the subject of fossil technology, or archæology, for example, is invaluable in tracing the movements of ancient cultures; but the diffusion of cultures in some cases may to a large extent be independent of racial migrations, a fact which the author seems to have overlooked.

For the past and present setting of the stage for mankind, Prof. Griffith Taylor provides a most admirable survey. Within the compass of a small book it was obviously impossible for him to go into that detail which a student of a given area might require, but the broad lines here sketched out will prove an invaluable preliminary to more intensive research—it may here be noted that the loess belt of Europe has been overlooked, though it formed an important migration route.

The book is an amplification of suggestive articles that have appeared in the *American Geographical Review*, 1919, 1921, 1922. The thesis is maintained that man originated in central Asia and thence Neanderthal (with which Proto-Australian, *e.g.* Talgai, etc., are associated), Negrito, Australoid, Negroid, Iberian, Nordic, early and late Alpine (*i.e.* Mongolian) stocks debouched in this order and passed, but not necessarily all of them, along the corridors of the peninsulas of central Asia—Europe, Africa, Australia, and America; the earlier propulsive forces being the climatic thrusts of the four main ice ages. This theory presupposes that increase in

the cephalic index (C.I.) took place only in the centre of Asia, and though it is worked out with ingenuity it is unlikely to receive the support of anthropologists.

The argument is based on averages, and does not take into account the considerable fluctuations that occur in the groups. Thus the Lower Negroes, "Peoples of Guinea and Upper Nile," are credited with a C.I. of 71 (parallel with the South Melanesians and New Guineans); the Wolofs of Senegal are said to have a C.I. "as low as 69," but Struck gives it as 74·3; and the author credits the Higher Negroes, "Bantu-speaking Negroids," with a C.I. of 73 (parallel with the Australians). B. Struck has prepared a well-documented "Karte des Kopfindex" of central Africa (*Z. f. E.*, **54**; 1922), from which it is evident that the averages of peoples of Guinea and the Upper Nile Valley vary from 71 to 75, few being 71 or less, but also in the former region there are numerous peoples with average C.I. of 75-79, while in the Cameruns and Congo basin average indices of 77 to 81 are common, with patches of above 81. According to Griffith Taylor's scheme, these Negroes should be Hamites, Semites, Aryans, and early Alpines; but we are told that the "vast central and southern block of negroes has not been greatly affected by recent mixture" (p. 106). A similar objection applies to other areas.

From Appendix B, it is evident that the author still adheres to his previously published opinion that various customs, etc., characterise definite zones of cephalic indices. In 1921 he said, "the couvade occurs in the Hamitic-Iberian zone [C.I. 76-78] *and nowhere else*," but the Carib C.I. of 80·9 and the Arawak of 83 are hard to reconcile with this generalisation, and other cultural distributions are equally open to question. It is doubtful whether any ethnologist will accept this theory of zonal cultures. A new feature is the introduction of 'ethnographs,' in which certain physical characters are combined to form a hexagon, the proportions of which vary according to race. The book is illustrated by a number of racial types, and especially useful is the large number of distribution maps and block-diagrams.

The book concludes with valuable discussions on "the white race in the Australian environment" and "the control of the potential white settlement of the world by environment." In these sections Prof. Griffith Taylor speaks with authority based on solid facts, and they should be carefully studied by prospective emigrants and also by politicians.

A. C. Haddon.

Our Bookshelf.

Rules for Compositors and Readers at the University Press, Oxford. By Horace Hart. The English spellings revised by Sir James A. H. Murray and Dr. Henry Bradley. Twenty-eighth edition. Pp. 135. (London: Oxford University Press, 1928.) 2*s*. net.

This little book was not originally intended for publication. When it was begun the intention was simply to make a guide for compositors and readers at the Clarendon Press. But copies were also given to those who were interested, and, later, applications for copies were received from persons who had no absolute claim to be supplied gratuitously. Many such requests came from Home, Colonial, and Indian Government officials. That is a recommendation in itself, and the recommendation is heightened when we learn that, later, it became known that copies were on sale in London. Clearly there was no alternative but to publish the book for the benefit of all those who are interested in the technicalities of typography; and there can be no doubt that it confers great benefits not only on those engaged in the art of printing, but also on those whose business it is to write.

The book includes, of course, the ubiquitous (but none the less necessary) guide to proof correction. But there is also an alphabetical list of alternative and difficult spellings; there is a list of spellings for use in medical works, divided into words with, and words without, hyphens; there are rules for setting up French, German, and Greek works; there is advice on the question of spacing—a matter which is ordinarily full of annoyance for both printer and author; special signs and symbols are made clear; and sufficient attention is paid to the use of punctuation, O and Oh, a and an, to save much impending irritation. It is not possible here to indicate the full scope of the book. It is a work of reference, and, as such, may be expected to be a mine of *easily accessible* information; that expectation is certainly fulfilled.

The American Annual of Photography, 1928. Vol. 42. Edited by Frank R. Fraprie and E. J. Wall. Pp. 224 + 68. (Boston, Mass.: American Photographic Publishing Co.; London: B. T. Batsford, Ltd., 1928.) Paper, 7*s*. 6*d*.; cloth, 10*s*.

This annual has several distinguishing features. The "Practical Digest of the Year's Work in Photography," by Mr. Wall, is a readable and discriminative article with occasional valuable criticisms. The formulæ of developers, etc., are all tabulated on the same unit, and each table, which includes those of a like kind, has the average formula appended to it. There are more than ninety pictorial illustrations, and an article directing attention to their characteristics by Mr. Fraprie.

Of the sixteen other articles, the one of outstanding interest is on "Photography through the Microscope," by E. P. Wightman and A. P. H.

Trivelli. The authors not only describe modern developments in photomicrography, such as the use of ultra-violet light, modern methods of dark-ground illumination, and the application of the 'motion picture camera' to certain types of microscopic moving subjects, but also they give illustrations that are very little if at all inferior to the original photographs. Examples of the use of the ultra-microscope include pictures of *Pleurosigma angulatum*, collodion and gold films, a partial mirror of gold, normal blood platelets, soap crystals, and the germ of yellow fever. Those taken by means of ultra-violet radiations show remarkably fine definition, bearing in mind how difficult it is to find the focus in this method, and they clearly demonstrate the increased resolving power of the shorter wave-lengths. The kinematographic photomicrographs show the gradual development of silver bromide grains, the growth of silver sulphide specks on the surface of fused silver bromide, the absorption of water by a crystal of salt in butter, and the formation of colloidal bismuth and its subsequent coagulation. These and several other photomicrographs, of both high and low power, were supplied by experts in the various branches of work represented.

God is Love. Can this be True? An Old Man's Meditations. By Dr. James M. Wilson. (Affirmations: God in the Modern World.) Pp. 31. (London: Ernest Benn, Ltd., 1928.) 1*s*. net.

Religion is closely concerned not merely with the problem of the existence of God, but also with the even more pressing problem of His character. God might exist, and yet not be the kind of being man could worship. Canon Wilson clearly realises that the God of biological science scarcely resembles the God of Love whom we read of in the New Testament. How are we to reconcile these opposites?

Canon Wilson's method is to evacuate his God of transcendence and personality, and to present Him as purely immanent Spirit, in the conscious possession of which Spirit men may find sonship with God. This solution, while emphasising the, to religion, indispensable consciousness of union with God, has its dangers too. Indeed, what solution has not? If we divest God of transcendence and personality, the God of biology may wear a more tolerable aspect, since the sufferings He imposes are His own, and since (if He is impersonal) He does not really know what He is doing. But what we gain in one way, we lose in another; for the God of religion, divested of transcendence and personality, seems no longer worshipful. Personality is a supreme value, and whatever falls short of it seems unworthy of worship. As for the immanent God, the God within us, if we begin by worshiping *Him*, shall we not end by worshipping ourselves?

We may, however, be grateful to Canon Wilson for approaching this most difficult subject in a spirit of candour and deep religious faith.

J. C. Hardwick.

Archimedes: or The Future of Physics. By L. L. Whyte. (To-day and To-morrow Series.) Pp. 96. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., n.d.) 2*s*. 6*d*. net.

This little book appears at an opportune moment. It is generally acknowledged that the accepted principles of theoretical mechanics break down at the boundary of the atom, and some new system will have to be devised which will make the internal structure of atoms amenable to mathematical treatment. The main issue of the crisis is the subject of the controversy between Einstein and Eddington on one hand and Bergson and Whitehead on the other. The author tries to fathom the meaning of this modern duel and to forecast the manner in which it will be eventually settled. He directs attention to the fact that the laws formulated by Einstein deal with reversible phenomena. Real processes in Nature, on the other hand, are irreversible. "It may be that the reason why we cannot interpret atomic behaviour in terms of particle motions is that electrical and radiational processes are essentially irreversible. Particle motion and wave propagation—the two ideas on which all modern theories of matter are based—are both represented by mathematical expressions which are essentially reversible, since time enters only through the square of 'dt'. If the quantum processes should prove irreversible, we have already found a reason why the old conceptions of particles and waves must be inadequate."

The author draws a suggestive analogy between radiation and life processes, both of which are essentially irreversible.

La géométrie non euclidienne. Par Prof. P. Barbarin. Troisième édition suivie de notes sur la géométrie non euclidienne dans ses rapports avec la physique mathématique, par Prof. A. Buhl. (Collection Scientia, No. 15.) Pp. 176+7 planches. (Paris: Gauthier-Villars et Cie, 1928.) 15 francs.

An interesting and brightly written introduction to non-Euclidean geometry, with an appendix of notes dealing with its relations to the theory of relativity. There are plenty of references and several plates, including portraits of the heroes of the subject, Bolyai, Lobatschewsky, Riemann, and a fascinating picture of Beltrami's pseudosphere. It is an extremely good half-crown's worth.

Les bases de la géométrie et de la physique: l'invariance de l'espace euclidien. Par Clément Laurès. Pp. iii+125. (Paris: Albert Blanchard, 1928.) 15 francs.

The author claims to have proved Euclid's postulate of parallels and to have pointed out the errors and contradictions of Lobatschewsky. The book is an attack on non-Euclidean geometry and the theory of relativity, which M. Laurès describes respectively as "une des plus stupides inventions du XIXᵉ siècle," and "une autre stupidité, fille aînée de la première."

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Production and Application of High Voltages in the Laboratory.

THE importance of the application of high voltages to vacuum tubes is self-evident. Its possibilities in connexion with radioactivity have been emphasised lately by Sir Ernest Rutherford.[1] For the last two years we have been occupied in developing a laboratory method for the production of high voltages in a form suitable for application to vacuum tubes. Our problem divided itself into two parts: (*a*) The production of high voltages; (*b*) their application to vacuum tubes.

(*a*) The method for producing high voltages is based on old and well-known principles. A condenser of the order of 0·5 microfarad is charged to a potential of the order of 50,000 volts and suddenly discharged through a small inductance and a spark gap. The inductance is coupled to a resonance coil of the type usually referred to as a Tesla or Thomson coil. It was immediately obvious that very high potentials can be obtained with moderate means. Our coils were wound on pyrex tubing 3 inches in diameter and 36 inches long. The number of turns was in the neighbourhood of 7000.

The main difficulties to overcome were the insulation of the ends of the coil and of the turns from each other. We found ordinary transformer oil to be capable of insulating coils for 3,000,000 volts at atmospheric pressure, and for more than 5,000,000 volts at 500 pounds per square inch. No extraordinary precautions as to purity of the oil or otherwise were used, and do not seem to be necessary for these voltages. Spherical caps were mounted in the usual manner on the ends of the coil. By using the coil on half wave-length, the gradient at the caps corresponded to one-half of the total voltage. The coils were subjected to rough vacuum impregnation perhaps as a matter of prejudice. Our limitation at 5,000,000 volts was in the insulation between turns with this particular length of coil. Ordinary No. 40 silk enamel covered wire was used. The ends and the electrical efficiency are capable of giving considerably higher voltages with the present arrangement. Since 5,000,000 volts, when applied to doubly charged helium atoms, or particularly to α-particles, and still more to multiply charged ions (stripped atoms), should be capable of giving particles with energy much in excess of the swiftest α-particles so far observed, we temporarily transferred our efforts about a year ago to the problem of applying voltages of this order to vacua.

The method of measuring the voltages may be described as a capacity potentiometer. The apparatus consisted in an insulated metal 'pick-up' ball suitably placed in the field of the coil and connected to one terminal of a 10-inch sphere gap, the other terminal of which was earthed. By a preliminary calibration at the same frequency, the ratio of the coil potential to the pick-up potential was determined at low voltages on the latter (about 100 volts). This calibration involved a study of the voltage distribution along the coil, the details of which we will report later. A knowledge of this distribution made it possible to infer the voltage across the whole coil by measuring the voltage across a small section, thus eliminating capacity effects of the measuring instrument. We took care to ascertain experimentally the effect of the distance between the two balls of the gap. These calibrations have been performed under various conditions with entirely different set-ups, giving always consistent values for the voltage obtainable with a given input.

We have also performed rough calibrations in which the Tesla coil voltage was measured directly by means of a sphere gap and simultaneously by the capacity potentiometer. Due care has been taken in this case to reduce the effect of the leads to the direct gap on the potentiometer.

The order of magnitude of the voltage has also been ascertained by measuring the field strength at a distance by means of a cathode-ray oscillograph and applications of electrostatics.

The doubts which might be raised as to the correctness of our sphere-gap measurement seem to be two: The truthfulness of the sphere gap and the absence of conductivity in the oil. Our frequencies being of the order of 100,000 per second, the correctness of the sphere gap is proved by the work of Peek.[2] The extrapolation applied to the capacity potentiometer from low to high voltages we have tested in various ways. Thus the position of the pick-up was varied, giving always consistent results. The spark-over between turns on especially tested wire always leads to higher voltages than those measured. The voltage measured is proportional to the voltage applied to the primary circuit. At the same time, the direct effect of the primary circuit on the pick-up is negligible.

(*b*) After trying discharge tubes of ordinary design, it became obvious that limitations somewhat similar to those experienced at low frequencies apply to high-frequency voltages as well. The application of more than 400,000 volts in an ordinary way appears to be difficult, apparently due to the fact that methods of completely outgassing an entire electrode (including the part close to the glass) have not yet been devised. However, we found it quite possible to apply several times the above voltage to a vacuum without electrodes inside the tube, making use, therefore, of the fact that our voltages alternate at high frequency. In this arrangement we have a 9-inch, well-baked and evacuated bulb placed, using approximately 1 mm. spacings between the end of the Tesla coil and an earthed plate. Fluorescence of long duration is caused on the sides of the bulb, but no volume discharge takes place and the bulb does not puncture. An ionisation gauge on a side tube does not give any difficulty. If the pressure in the bulb is raised, a bolt strikes through 2 inches of oil and makes a large hole in the bulb.

The question of the power available in a Tesla coil is of some importance. Experimental tests show that coils of our usual design with a given power input have their voltage reduced by a factor of 2 if a 16-megohm leak is connected across the terminals. If the coil is used on a 60-cycle synchronous gap, and if the energy dissipation only during 10^{-5} sec. for each spark is considered, the power which may be drawn from a coil operating at 5×10^6 volts is readily seen to be at least of the order of 1 kilowatt.

Even with one discharge a second considered as taking place effectively in producing high-voltage particles for 10^{-5} sec., *i.e.* for $\frac{1}{10}$ of a cycle, a number of electrons equivalent to 10 gm. of radium could be supplied by the Tesla coil without overstepping its electrical power limitations. On the same basis, a

[1] E. Rutherford, NATURE, 120, p. 809; Dec. 3, 1927.

[2] F. W. Peek, jun., *Jour. Franklin Inst.*, 197, p. 1; 1924.

gap operated on 60-cycle current giving 120 sparks a second would enable the Tesla coil to deliver the equivalent of 2 lb. of radium.

It is clear that the outside electrode method of using vacuum tubes does not make it possible to use all of this power. However, a transfer of 2×10^{11} electrons would not puncture the glass. Estimates show that very considerable radium equivalents can be obtained even by the method of external electrodes.

G. BREIT.
M. A. TUVE.

Department of Terrestrial Magnetism,
Carnegie Institution of Washington,
Washington, D.C., Feb. 25.

An Optical Paradox.

SURELY there is nothing peculiarly 'optical' in the 'paradox' to which Mr. Smith refers in NATURE of Feb. 25. In respect of most measurable properties (for example, length and mass) systems can be arranged in a series such that each member, though indistinguishable from its immediate neighbours, is distinguishable from those more remote. In other words, the relations usually termed 'equality' in measurement are not transitive; though $A = B$, $B = C$, it does not follow that $A = C$.

That is a fact; paradox can enter only in describing it. Mr. Smith's description appears paradoxical, because the term 'identical' that he employs usually implies transitiveness. To determine whether a relation is transitive, at least three members of its field must be compared; accordingly, if 'identical' means a transitive relation, none of his comparisons, each involving two sensations only, can establish identity. It is *not* a 'quibble' to say that two sensations, A and B, indistinguishable when compared directly, are not identical; for they may be distinguished by the classes, C_A and C_B, consisting of sensations from which they are respectively indistinguishable. C_A and C_B always contain common members; but in general they are not coextensive, and each contains members foreign to the other. A and B are truly identical only if C_A and C_B are coextensive, and A is indistinguishable, not only from B, but also from every sensation indistinguishable from B.

In theory these considerations may be 'widely ignored,' but in practice they are not. Poincaré's suggestion that the theory of errors of measurement and of the adjustment of observations should be based on them has not been widely adopted. But, as I have tried to show in Chaps. xvi. and xvii. of my "Physics," it leads to practical rules for dealing with these matters closely resembling those in general use, which are more often based on the futilities of the Gaussian Gospel. Whenever we recognise the possibility of errors and take steps to avoid them, we are in effect giving full weight to Mr. Smith's considerations. Nobody experienced in photometry would actually compare lamps through a simple unidirectional chain such as he describes.

NORMAN R. CAMPBELL.

A PARADOX, resembling that which Mr. T. Smith describes in NATURE of Feb. 25, p. 281, was stated by G. F. Stout in his "Manual of Psychology" (1915), pp. 303 to 304, for senations in general.

For a particular sensation, that of weight lifted, the paradox was abolished by the experiments of F. M. Urban (*Archiv für gesamte Psychol.*, 5, 15, 16), for they showed that the threshold was not the definite thing that Mr. Smith assumes it to be, but that when one stimulus was kept fixed, the probability of the observer making the decision 'equal' varied with the other stimulus in a gradual manner.

Is the optical threshold unlike that for weight?

LEWIS F. RICHARDSON.

Westminster Training College,
Horseferry Road, S.W.1,
Feb. 29.

DR. CAMPBELL seeks to demolish the paradox by applying to sensations an argument constructed to take account of the variability of our measurements of the properties, believed to be constant, of external objects. Besides differing in other important respects, the two applications are unlike in that the presence of errors in our measurements is readily demonstrable by intercomparison, whereas the view that indistinguishable sensations are not in fact equal sensations is an arbitrary assumption which it would be difficult to support by direct evidence. This view is perhaps derived from the wish that it were permissible to regard visual sensation and light stimulus as definite single-valued functions of one another.

Now there may be occasions when it is convenient to postulate an idealised system of sensations bearing such a relation to a series of stimuli; but the concept is essentially theoretical, and must not be confused with the sensations of experimental photometry. Experimentally, sensation denotes an impression individual to the observer, an impression, moreover, of so fleeting a nature that group intercomparison is impossible. The observer's verdict on his sensations at any given moment is the only one that matters: if he says that two sensations are indistinguishable, we ought either to accept that statement as final or bring forward evidence to justify our distinguishing between them.

I am inclined to think that the physicist has been handicapped in considering the photometric problem by his expectation of a close correspondence between sensation and stimulus. It is characteristic of the way in which he has grown accustomed to regard his experiments that he should, without question, ascribe the sensation he associates with the left side of the field solely to the lamp on his left, and to the lamp on his right the sensation he associates with the right side of the field. I have little doubt that he habitually presses too far the view that sensations may be isolated. In photometry, particularly when the two parts of the field are nearly or exactly matched, we ought to regard the sensation as a function of both the stimuli. On this view the argument of the paradox fails, not because the two sensations in a single observation differ, but because we are not justified in isolating the two halves of the system from one another or in assuming an unvarying connexion between the radiation on the unaltered side of the system and the sensation in the part of the field we link with it.

More generally the principle to which I wish to direct attention is that every sensation is a function of all the stimuli. The principle is illustrated by the fact that the introduction of peripheral illumination may enable us to discriminate between sensations when differentiation was previously impossible. Dr. Campbell would perhaps explain this result by saying that the introduction of the additional illumination in effect constitutes the replacement of the old comparator by a better one. That view is, I think, legitimate, but it is not consistent with the assumption of an unvarying connexion between stimulus and sensation.

T. SMITH.

The Soil 'Stratometer': A Method for the Examination of Deep-lying Soil.

In alluvial soils there are frequently large variations of soil texture, especially in a vertical direction. With deep-rooting crops like cotton, the soil at depths of more than two metres may be directly important to the plant, quite apart from its indirect importance by influencing drainage, or infiltration under irrigation. The study of such deep soil by soil-boring and sampling has certain limitations, while its complete disturbance by digging large holes is even more objectionable and tedious.

Some infertile areas of the Botanical Section Farm at Giza were being examined for the presence of 'pans' when it was noticed that the mechanical resistance of the soil varied greatly, whether such resistance was felt by a Frænkel borer or by the use of the digging tool. From this observation was developed a simple instrument which has been entitled a 'stratometer,' whereby the variable hardness of soil along vertical lines can be found, giving results somewhat analogous to the records of variability on the surface, in a horizontal plane, which have been made at Rothamsted with dynamometers attached to ploughs (B. A. Keen, Nature, Dec. 19, 1925, p. 905).

The present note is intended to put the actual method on record. Detailed studies of Egyptian soils by this method are being continued, and will be published later.

The method consists merely in driving a rod into the soil by repeated application of a uniform impact blow, as in pile-driving. The error which would otherwise be caused by increased friction on the sides of the rod as the depth increased is avoided almost entirely by the use of an enlargement like a spear-head at the point of the rod; this head is detachable to save trouble in removing the rod from hard soils, the head being left below and a new one fitted to the rod. The uniform impact blow is conveniently applied by a perforated weight through which the rod passes loosely; this weight rests and strikes on an anvil-stop clamped firmly to the rod, while the height through which the weight drops on to this anvil is fixed by a stop above it, also clamped to the rod.

The distance through which the rod descends at each blow is measured in any convenient way; a simple method is to fasten a tape just behind the head and to mark on the tape after each blow at the point where the tape passes through a zero level, indicated by a spiked plate driven into the surface soil with a hole through which the rod and tape both pass.

The tape-records may be afterwards computed and plotted in various ways, but usually it is convenient to show the hardness of successive strata, between 10 cm. or 20 cm. intervals, in terms of the energy required (*i.e.* number of blows) to traverse such intervals. The whole apparatus is very simple, can be made by any blacksmith, and a single set of observations down to two metres takes about ten minutes to make with two operators at work.

As an illustration of the information thus obtainable, the case of a 'pan' may be cited. The cotton plants in one corner of a field were stunted during mid-summer, recovering later. An exposure was made and showed that their roots found difficulty in penetrating a layer at 30-60 cm. deep. Less than 15 metres away they were quite healthy. Soil water-content samples showed the hard layer to be impermeable to water also. The digging of pits showed an exactly similar distribution of clay above and sand below in both spots, the hardness and impermeability of the lower edge of the clay in the panned spot not being obvious except to the feel of the tools used in boring or digging. On applying the stratometer the difference was most strikingly revealed as a four- to five-fold difference in maximum hardness (Fig. 1).

If the stratometer impinges on a stone this is readily indicated by the sound as the blow is given, and the *sudden* and persistent resistance to the rod.

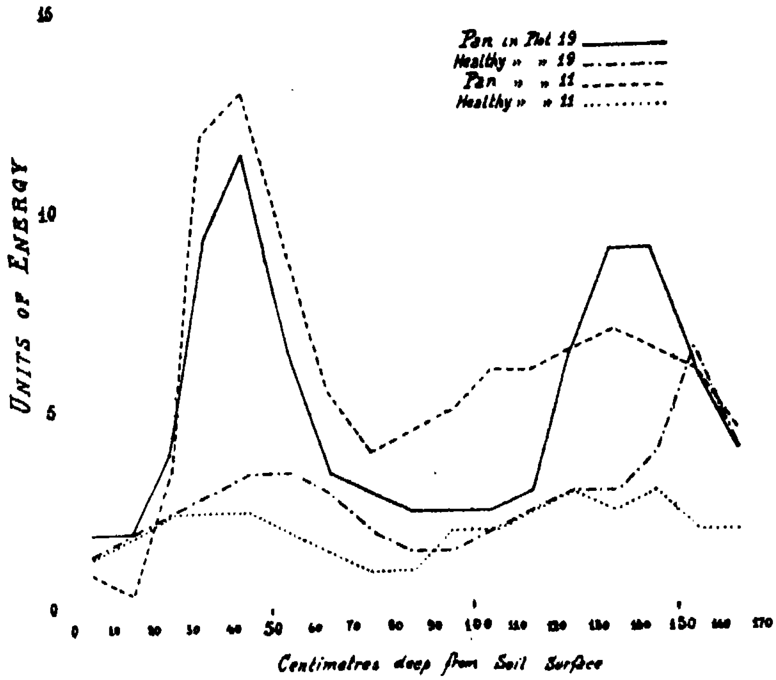


Fig. 1.—Graph of stratometer records.

The design of the rod for depths exceeding two metres needs care in order to avoid loss of energy by undue vibration, and the relation between water-content and hardness of soil is an obvious source of variability when comparisons over an interval of time are required. These are being investigated in conjunction with the direct employment of the stratometer for detailed survey of the deep soil and subsoil on particular areas.

Mohᴰ. Zaghloul.

Ministry of Agriculture,
Botanical Section,
Giza, Cairo.

The Nitrogen Afterglow.

The phenomena connected with active nitrogen and its afterglow have recently received a great deal of attention. A view almost generally accepted now is that the afterglow is due to the recombination of nitrogen atoms produced in the discharge. Though it has not been possible hitherto to determine thermochemically the heat of dissociation of molecular nitrogen, a value a little above the equivalent of 11 volts has been found for it from the characteristics of its band spectrum. On the recombination of two atoms taking place to form a molecule this amount

of energy may be transferred to a second molecule, and it is just sufficient to excite the afterglow bands. This view, it may be stated, is based on the assumption that the initial states giving rise to the first positive group of bands are the same as the final states involved in the production of the second and fourth positive group. The vibrational levels seem to be identical; the rotational levels have not yet been analysed.

What appeared to be a confirmation of this hypothesis was the discovery that foreign vapours such as those of mercury, zinc, etc., when mixed with active nitrogen, emitted radiations that required for their production electronic excitation not greater than the equivalent of 10 volts.

A closer examination of the spectra thus excited shows, however, that the intensity distribution obtained is not what one might expect to get from an energy transfer corresponding to that of 10 or 11 volts. With the spectrum of mercury, the rate of decrease of intensity in passing to the higher members of the series involved is much greater for excitation by active nitrogen than is obtained with a low voltage arc run at 10 or 11 volts in this vapour. Similarly, the intensities of the lines produced under excitation by active nitrogen in thallium vapour correspond closely with those obtained when the thallium lines are produced under excitation by the metastable atoms of mercury, which have an energy corresponding to about 5 volts.[1]

Tl.	$(2^2P_2 - {}^2S_1)$		$(2^2P_1 - {}^2S_1)$			$(2^2P - 3^2D)$			$(2^2P - 4^2D)$		
	5351,	3230	3776,	2580,	2826	3529,	3519,	2768	2022,	2018,	2380
In arc	10	10	10	8	8	8	10	10	6	10	8
In afterglow		6	2	1	0	4	10	3	0	3	–
In mercury		5	3	1	–	0		2	1	–	–

At the low pressures at which the nitrogen afterglow is studied, luminescence produced by chemical reactions is strong (formation of alkali halides, explosion of mercury compounds), so that it is not impossible that chemi-luminescence plays a rôle in producing the spectra excited by active nitrogen. It is well known that nitrides of metals, some of them explosive ones, accumulate in the discharge tubes used for the afterglow. With these considerations in mind, we recently decided to investigate the probability, by the use of active nitrogen, of causing an inert gas to emit its characteristic radiations. In such a case chemical changes would, of course, be excluded. If the view expressed above be valid, xenon with an ionisation potential of about 11 volts ought to emit its complete spectrum when mixed with active nitrogen. With the use of krypton the low level spectral lines should be obtained. These inert gases were therefore introduced into the discharge tube, and the spectrum of the light from the afterglow was photographed by means of a quartz spectrograph of high light power specially built in the laboratory for this purpose.

In the first series of experiments a mixture of krypton and xenon prepared in the laboratory was used and an excess of nitrogen was added. In the spectrograms obtained the afterglow bands were present, but no spectral lines due to the inert gases were recorded.

When, however, a drop of mercury was introduced into the tube and the spectrum of the afterglow again photographed, it was found that the mercury lines came out strongly on the plate in addition to the nitrogen afterglow bands. Very short exposures were required to bring out these mercury lines.

In a second series of experiments, very pure xenon was added to the nitrogen until the mixture was about half and half of each gas.

When an electrical discharge was passed through this mixture, the xenon lines showed up strongly in the spectrum of the light from the discharge, and the first positive nitrogen bands were almost completely suppressed. With this mixture the afterglow obtained was intense, but no xenon spectral lines were obtained on the spectrograms even when an exposure of twelve hours duration was made.

An experiment was performed to see if xenon radiation of wave-length λ8819 A., which is known to be strongly weakened when sent through excited xenon (J. C. McLennan and R. Ruedy, *Trans. of Royal Society of Canada*, vol. 32, p. 15; 1928), was absorbed by the xenon present in the nitrogen when the latter was showing a strong afterglow. No change could be detected, however, in the intensity of the xenon radiation sent through the glowing gas.

It would appear, then, that no xenon atoms were present in the gas in the metastable state ($^3P_2$ or S_0) that is known to be involved in the absorption of the wave-length λ8819 A. It is evident, therefore, that active nitrogen is not an agent that can cause xenon atoms to pass from the ordinary into the metastable state. The energy of the latter, it may be stated, is the equivalent of about 8·4 volts. It is interesting to recall that when, for example, zinc vapour is present in active nitrogen, spectral lines corresponding to 8·4 volts excitation are readily obtained. What happens with zinc vapour is obtainable with the vapour of any metal with which nitrogen can enter into chemical combination. The conclusion seems to be justified that chemi-luminescence plays a rôle in phenomena associated with active nitrogen.

J. C. McLennan.
Richard Ruedy.
J. M. Anderson.

The Physical Laboratory,
University of Toronto,
Toronto, Feb. 9.

[1] *Jour. Opt. Soc. Am.*, 14, p. 17; 1927. *Zeit. f. Physik*, 29, p. 345; 1924.

Prices of Periodical Scientific Publications.

In view of Dr. Baini Prashad's letter on this subject in Nature of Mar. 31, perhaps the following information with regard to physiological and biochemical periodicals may be useful.

The statistics in the list below show that the total cost per annum of seven of the most important German physiological and biochemical journals is between three and four times as much as that of seven leading English ones, and also that the same German journals cost considerably more than do the more important physiological journals *of all the other countries together*. These figures, like those of Dr. Baini Prashad, are for the year 1927.

1. British.

	Vols. per year.	Price per year.		
Biochemical Journal (Biochemical Society)	1	£3	0	0
British Journal of Experimental Biology (Company of Biologists, Ltd.)	1	2	0	0
Heart (Shaw and Sons)	c. 1	1	17	6
Journal of Physiology (Physiological Society)	2	2	10	0
Physiological Abstracts (Physiological Society)	1	2	2	0
Proceedings of the Royal Society, B.	1½	1	10	0
Quarterly Journal of Experimental Physiology (Griffin and Co.)	2	3	12	0
	9½	£16	11	6

2. AMERICAN.

	Vols. per year.	Price per year.
American Journal of Physiology (American Physiological Society)	4	£7 4 0
Journal of Biological Chemistry (American Society of Biological Chemists)	4	6 0 0
Journal of General Physiology (Rockefeller Institute for Medical Research)	2	2 15 0
Physiological Reviews (American Physiological Society)	1	1 12 6
	11	£17 11 6

3. GERMAN.

Berichte ü. d. ges. Physiologie (Springer)	4½	£13 10 0
Biochemische Zeitschrift (Springer)	12	17 8 0
Ergebnisse der Physiologie (Bergmann)	1	4 12 6
Jahresbericht ü. d. ges. Physiologie (Bergmann and Springer)	1	4 18 0
Pflüger's Archiv f. d. ges. Physiologie (Springer)	3	9 12 0
Zeitschrift für Biologie (Lehmann)	1½	3 0 0
Zeitschrift für physiologische Chemie (de Gruyter)	10½	8 8 0
	33½	£61 8 6

4. OTHER EUROPEAN.

Annales de Physiologie (Doin)	1	£1 7 6
Archives italiennes de Biologie (Trade)	1	2 2 0
Archives internat. de Physiologie (Vaillant-Carmanne)	2	2 5 6
Archives néerlandaises de Physiologie (Société hollandaise des Sciences)	1	1 12 0
Archivio di Fisiologia (Niccolai)	1	2 2 0
Bulletin de la Société de Chimie biologique	1	c. 0 15 0
Journal de Physiologie (Masson)	1	1 5 0
Scandinavisches Archiv f. Physiologie (de Gruyter of Berlin)	3	3 3 0
	11	£14 12 0

The enormous output at present both in England and in Germany—still more so in America—renders it imperative that all published results should be as concise as possible, so that the research worker may be able to keep abreast of the material. One great difference between the British and German journals is that the former are edited far more rigorously than the latter. If the Germans followed our example in this respect, it is probable that they would be able to reduce their published biochemical matter by one-half.

If the Englishman finds the cost of German periodicals excessive, still more must the German physiologist himself find it so. When this matter was brought up at the International Physiological Congress at Stockholm the year before last, the suggestion was there made that the German physiologists should do their own printing: the Deutsche Physiologische Gesellschaft might well be utilised for this purpose, in the same way as the Deutsche Chemische Gesellschaft is used by the German chemists, thereby rendering German chemistry available to all at a very low price.

The only other remedy left for Great Britain is to discontinue subscriptions to the more expensive German journals. Dr. Prashad suggests that the Royal Society and similar bodies should take the matter up in the interest of workers. I am informed that the Council of the Royal Society at a recent meeting actually decided to discontinue a number of these journals, mostly published by Springer, and including Pflüger's *Archiv*, and the *Zeitschrift für Anatomie und Entwicklungsgeschichte*, thereby saving just under £100 a year, and setting an example which might well be followed by other societies and institutions, both in Great Britain and in the United States.

WILFRID BONSER.

Medical Sciences Library,
University College, London, W.C.1.

Woods and Wireless.

THE splendid paper read by Mr. Barfield at the meeting of the Institution of Electrical Engineers on Dec. 7 last, and referred to in NATURE of Dec. 30, 1927, p. 967, throws light upon the hitherto obscure mechanism of the damping by trees on the propagation of radio waves. In fact, every tree acts as a B.C.L., absorbing part of the energy falling upon the antenna, and re-radiating the rest.

May I lay stress upon the fact that a tree cannot possibly be regarded as a pure resistance, except when

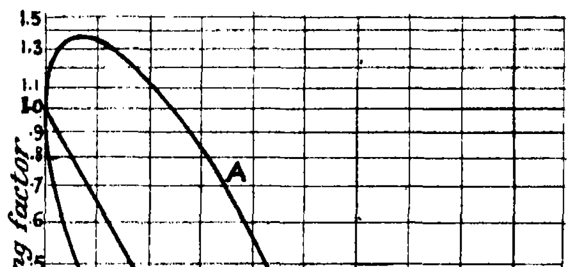


FIG. 1.

emission takes place on the resonant frequency of the tree. As, generally, the natural wave-length of the tree is shorter than the wave-length of the broadcasting transmitter, its action is that of a condenser with big losses. Translating to the language of Prof. Sommerfeld's beautiful solution, this means that the 'numerical distance' is not a positive real number, but a complex one. Writing his α^2 in the form $2\alpha^2 = q\,(\cos b + i \sin b)$, we get, approximately, $q = 2\pi r/2c\lambda^2\sigma$, $\tan b = (\epsilon + 1)/2c\lambda\sigma$, the symbols having their usual meaning, and with σ in E.M.U., ϵ in E.S.U.

The computation of the damping is in this general case a trifle more tedious than when the soil is a pure conductance, but surely pays for the trouble taken. In the special case when $\cos b = \sin b = 1/\sqrt{2}$, *i.e.* the capacity effect just as great as the conductivity effect, we have the damping curve *A* drawn in full in the accompanying diagram (Fig. 1); for comparison the trivial case of $\cos b = 1$, $\sin b = 0$ is also shown (B).

The former curve explains the very remarkable feature, first revealed by Mr. Barfield himself on the Daventry station, and amply confirmed by Mr. Lemoine on the Swedish stations at Karlsborg and Motala, namely, that the damping is *negative* for the first 20 or 30 kilometres. This is nothing but a feint on the part of the woods, which soon revenge themselves by an almost catastrophal damping farther away. It is a happy coincidence on certain wave-lengths that, in day-time, reflection sets in at the right moment to reinforce the vanishing direct ray. The same effect ought also to be shown by great expanses of fresh water, for example, the very pure water of Lakes Wetter and Wæner in Sweden, where the conductivity seems to be of the order 10^{-14} E.M.U.

The third curve drawn (C) is a by-product from the computations obtained by reversing the sign of *b*. This should be equivalent to introducing an inductive load, not improbably exerted by trees on waves shorter than their fundamental, thus explaining the very rapid decay of such waves when early entering a wood.

As the composite damping on the longer broadcasting wave-lengths is shown to be inversely proportional to something between the first and the second power of the wave-length, the Washington Conference of 1927 has seriously hampered the attempts to build up a broadcasting service in densely wooded and sparsely inhabited countries such as Sweden, by forbidding the use for this purpose of waves longer than 1850 m. No doubt this clause will be amended in the near future. In Sweden 'wood' means nothing less than some 40,000 trees per square kilometre!

It seems not improbable that a thorough investigation of the properties of various wave-lengths might result in better knowledge, and consequently better legislation.

Bruno Rolf.

Meteorological Bureau,
Stockholm, Feb. 23.

A Dogfish without Pelvic Girdle or Fins.

A specimen of *Scyllium canicula* was noted, amongst a number of dogfish received from Plymouth, in which the pelvic fins were entirely absent and the sex was consequently indeterminate externally.

This naturally raised the question as to whether the pelvic girdle was normally developed. Subsequent dissection showed that there was no trace of the girdle. The dissection also showed that the animal was a fully mature male with the internal urinogenital organs normally developed, but, correlated with the absence of pelvic fins, there was no trace of claspers.

The urinogenital papilla was situated somewhat nearer the vent than is usually the case.

Abdominal pores were present on each side of the cloaca, but they did not open internally to the cœlom.

E. M. Sheppard.
J. H. Lloyd.

University College,
Cardiff.

Functional Differences between Left and Right Splanchnic Nerves.

Stimulation of the peripheral end of the divided right splanchnic nerve in the abdominal cavity has revealed several marked differences in the resultant effect upon the blood-pressure from the well-known results obtained by similar stimulation of the left nerve. If the right nerve be stimulated by successive stimuli of sufficient strength at frequent intervals, a rapid exhaustion of the nerve occurs. Using a rapidly interrupted current with the secondary coil 10 cm. from the primary and 2-volt accumulator, it is found that there is a rapid diminution in the pressor response, and after about four or five stimulations no further rise of blood-pressure can be elicited with the same strength of current.

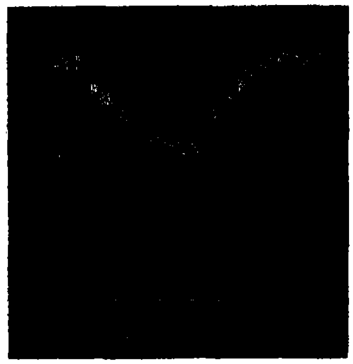


Fig. 1.—Mechanical stimulation of the peripheral end of the right splanchnic nerve by means of a glass rod producing a fall of blood-pressure. Time in 5 seconds.

I have obtained this effect with cats under various anæsthetics, and in the decerebrate and pithed conditions. Repeated attempts have failed to produce these results in the left nerve.

Coincident with the diminution of the rise of blood-pressure, a curious after rise becomes increasingly apparent. It occurs immediately after cessation of stimulation, and is very rapid in its formation. Ligature of the adrenal glands does not alter it, nor does ligature of the superior mesenteric or portal veins.

Continuation of the series of stimulations after exhaustion has taken place causes a *fall* of blood-pressure to be manifested, and eventually a condition is reached when even the strongest stimuli evoke falls of blood-pressure. The falls are most easily elicited by mechanical stimuli (Fig. 1).

Such results indicate that the right splanchnic nerve contains a considerable number of vaso-dilator fibres.

My thanks are due to Prof. Swale Vincent, without whose assistance and advice much of the work would have been impossible.

J. H. Thompson.

Department of Physiology,
Middlesex Hospital Medical School, W.1.

Dug-out Canoe in Algoa Bay.

The origin of the dug-out canoe, over which there was so much controversy, has now been finally settled. I have ascertained definitely that the canoes are in use in the East Indies, mostly at Celebes and the Malacca. At the latter place there are men who actually make them for sale.

The blocks with holes in them, at the sides of the canoe, are five in number. Three are for supports for plank seats on which the paddlers sit. The other two are for the purpose of securing the bamboos to which the outriggers are attached. The slot at the bottom of the canoe is for the insertion of the base of a pole for a sail.

F. W. FitzSimons.

Port Elizabeth Museum,
Port Elizabeth, Feb. 18.

Some Modes of Mechanical and Animal Locomotion.

By A. Mallock, F.R.S.

Such questions as how do birds fly, how do fish swim, how do ships steer, or snakes crawl, have been subjects of interest from very early times.[1] The present note is concerned with these and some other forms of locomotion, all of which may be placed under the heading of motion in fluids and motion on solids. Motion in fluids includes ships, airships, flying machines, birds, winged insects, fish, whales, and various swimming insects and Crustacea. Motion on solids refers to various legless creatures such as snakes, molluscs, and microscopic organisms.

Motion in Fluids.

A very general proposition applicable to all cases may be stated with regard to motion through a fluid; namely, if a body moves with a velocity v and experiences a resistance R, momentum is generated (either by pushing, pulling, or rubbing) in the direction of the motion such that $d(MV)/dt = R$. Here MV is an abbreviation for the integral of the mass of each element of fluid × velocity imposed on it by the progress of the body. If the source of power is contained in the moving body, an equal variation of momentum in the opposite direction must be generated in the fluid to overcome the resistance.

For the present purpose the source of power, whether screw, wing, paddle, or jet, may be called the accelerator, since its purpose is merely to accelerate the fluid in a direction opposed to R. The ideal accelerator may be taken as an area placed broadside to the stream, supplied with means of increasing the potential of the fluid passing through it, and experiencing therefore a reaction equal to the accelerating force. To determine what total flow and what velocity is required to produce a given reaction, let A be the area of the accelerator, v the velocity of the fluid, and ρ its density. The flow of mass is ρAv. If R is the given reaction and F the accelerative force acting on the fluid, and if $R = Mg$, then M is the mass of fluid which weighs R and occupies a volume Av. Thus $\rho AvF = Mg$. M is a constant, so that $F/g = 1$ and $A = \text{volume} \div v$. Take, for example, the case where the fluid is air and let $R = 1000$ lb. and $A = 1000$ ft.[2] A thousand lb. of air has a volume of about 12,800 cubic feet, and this volume per second will, starting from rest, acquire a velocity of 32 ft./sec. in passing through the accelerator when acted on by a force equal to its own weight. If the area is halved the velocity must be doubled and $F = 2g$, and so on.

The power required to produce the velocity is vR. In the diagram (Fig. 1), curves are given showing, in term of the area of the accelerator, the velocity of the air current necessary to cause a reaction of 1000 lb., and also the horse-power required to maintain it. A curve is added showing the diameter of the stream if the cross-section is a circle.

In this diagram it is assumed that the accelerator itself is stationary and that therefore all the work goes in creating currents in the air. If, however, the pressure drives the accelerator forward at a velocity v_2, then, in the absence of any acceleration, the flow of mass through the accelerator will be ρAv_2 per sec., and if v_1 is the velocity which must be added to this flow to maintain the reaction R, the power required will be $R(v_1 + v_2)$, and the requisite accelerating force will be less than that indicated in Fig. 1 in the ratio $v_1/(v_1 + v_2)$, *i.e.* a

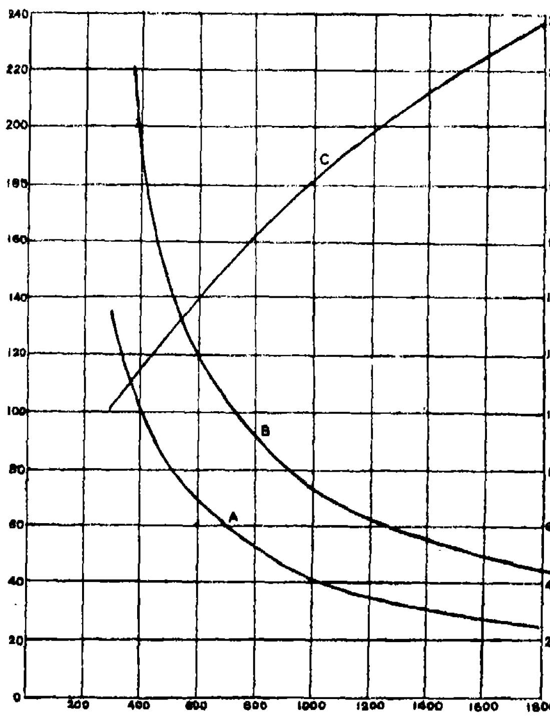


Fig. 1.—Curve A. Ordinates show the velocity in ft./sec. which must be given per sec. to a volume of air weighing 1000 lb. (in terms of the area over which the volume extends) in order that the reaction against acceleration should be 1000 lb. Curve B. Horse-power required to maintain the stream. Curve C. Radius of a cylinder of the same section area as that of the stream.

smaller force acting at a higher speed on a greater mass.

A somewhat similar case is that of a barge being poled along at a speed v_1 against a resistance R. If the bottom of the canal is hard and the pole does not slip, the bargee walks aft at the speed v_1 and does useful work at the rate v_1R. If, however, the pole slips at the speed v_2, he has to walk at the rate of $v_1 + v_2$, expending power $R(v_1 + v_2)$, of which Rv_2 is wasted.

For bodies the weight of which is borne by the fluid (such as airships, fish, etc.), the stream emitted by the accelerator is in the direction of the fluid resistance, but for flying machines, birds, and

[1] See Proverbs xxx. 18, and Epistle of James iii. 4.

winged creatures in general, whose weight has to be supported dynamically, the stream must have a downward momentum component Mv_y, giving $d(Mv_y)/dt = W$, while the horizontal component Mv_x makes $d(Mv_x)/dt = R$.

In flying machines, the horizontal component, corresponding to R, is supplied by a screw, and the weight is supported by the inclined surface of the wing. With flying animals, however, the wings have to propel and also to support the body.

Fig. 2 shows diagrammatically the attitude of the wing during one complete beat. The propulsion effect is dependent on the change of wing angle during the up-and-down stroke, and is similar to the propulsion in sculling with a single oar. The weight is supported by the downward current induced by the curved wing section.

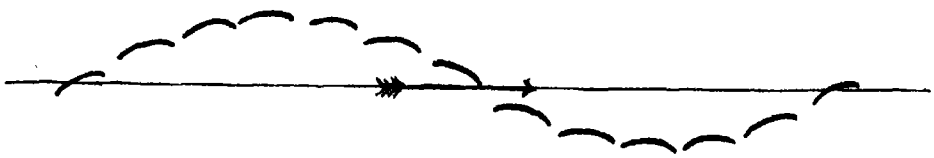


FIG. 2.—Diagram showing the attitude of the wings of a bird during one complete beat.

When a plane surface moves in a fluid, making an angle a with x (the direction of motion), it experiences a resistance R and a lateral force L in a direction y. L/R varies with a and has a maximum value of about 10 when the fluid is air or water. If the wing, instead of being a plane, is suitably curved and convex on the upper surface, the ratio L/R may approach 20. The reason for the approximate doubling of the lift is indicated in Fig. 3. The flow of the stream past the plane surface is as in (*a*), and past the curved surface as in (*b*), from which it may be seen that the downward component of momentum is nearly doubled in the latter. I need not here refer to the dynamics of these two forms of flow, on which there has been much discussion.

Birds which soar with their wings stationary make use in general of ascending air currents, though it is possible, as was shown by the late Lord Rayleigh, that when the velocity of the wind is different at different levels, they may soar by passing alternately into strata of quicker and slower wind speeds, provided that the speed gradient is sufficiently steep. I do not know, however, of any observations proving that this method is actually used. Ascending currents are formed in many ways, such as by the ascent of heated air, or by the configuration of the ground or waves on a water surface. With their long experience, birds have probably learnt to make use of any conditions which give the desired result.

Dr. Hankin, in India, made many observations on the soaring of birds, and found that none of the birds on the plains began to soar until the sun had risen for some time, and I myself have noticed that, on a hilly tropical island, soaring does not begin until the sea breeze has been established. From this it seems probable that ascending currents are the chief agents in soaring flight.

Hovering, that is, keeping the body stationary in still air by the working of the wings, is only found in Nature in small birds and insects. The heaviest bird which I have known to hover is our English kingfisher, but humming-birds are the typical vertebrate hoverers. More striking examples are to be found amongst insects, such as hawk-moths and hover-flies, but the best of all is a dipterous fly (Bombylius), like a small humble-bee, which when feeding on a flower will insert and withdraw its proboscis as steadily as if it were controlled by a fine adjustment screw.

The kestrel hawk has the power of keeping its position for short intervals with wonderful exactness. This, however, is not true hovering, but merely flying against the wind at the speed of the wind. In all true hovering the attitude of the body is nearly vertical, and the mean plane of motion of the wings approaches the horizontal.

The limitation of the size of hovering animals is, as may be gathered from Fig. 1, the small power to weight ratio in muscular action. From the diagram also it may be seen how futile it is to attempt to construct hovering machines, using as accelerators screws of size common in aeroplanes.

If inventors or designers could develop a machine which, with 1000 lb. total weight, could carry a 100 h.p. engine with an accelerator of any kind of an effective area of 600 ft. to 1200 ft. (which in the form of a screw would imply a diameter of 40 ft. to 60 ft.), a hovering machine would become a possibility.

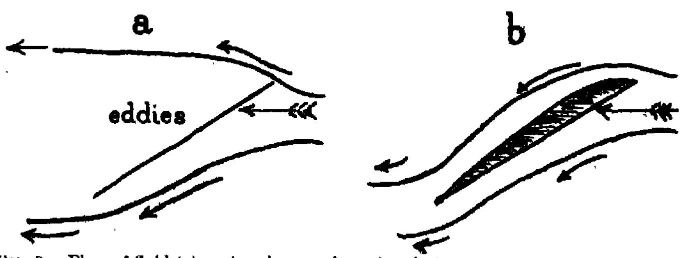


FIG. 3.—Flow of fluid (*a*) past a plane surface placed obliquely in a stream; (*b*) past a surface plane on the upstream surface but with a convex back.

There are many examples in Nature of the use of oars and paddles. The chief paddlers are the swimming and diving birds with webbed or partially webbed feet. The general action of paddling is indicated in Fig. 4, which shows the position of the foot and the opening and closing of the toes during one complete stroke. When referred to a fixed point in the body, the foot describes a nearly circular path, and the successive positions of the web are not unlike those of floats in a feathering paddle-wheel.

The contrast between acceleration by paddles and wings may be well observed at the Zoological

Gardens when the diving birds are fed, for the penguin uses its short wings to fly under water, and I think that anyone would give the prize for speed and manœuvring power to the wings.

It is worth noting that these under-water wings, not having to support the weight of the bird (and therefore not having to give a downward component to the fluid on which they act), are nearly plane surfaces, and not, as in the case of air wings, convex on top.

The most familiar examples of the use of natural oars are found in the Dytiscus family and in the water-boatmen (Notonecta). Here one pair of legs greatly exceeds the other in length, and the last joints are bordered by a row of stiff bristles which stand vertically up and down during the backward or propelling stroke, but collapse in a horizontal plane as the leg is moved forward, thus in effect forming an oar which feathers under water.

Another and very curious example is found in the Gyrinidæ beetles. Here the tarsi are expanded into long paddle-shaped blades capable, when not in use, of folding within an enlarged upper joint. See illustrations *a*, *b*, *c* in Fig. 5. I do not know whether these blades are used as oars or as wings, but it would be possible, and certainly interesting, to take moving photographs of their action with the lens focused on the underside of the water surface.

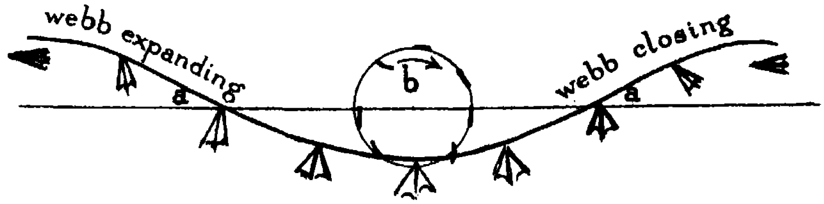
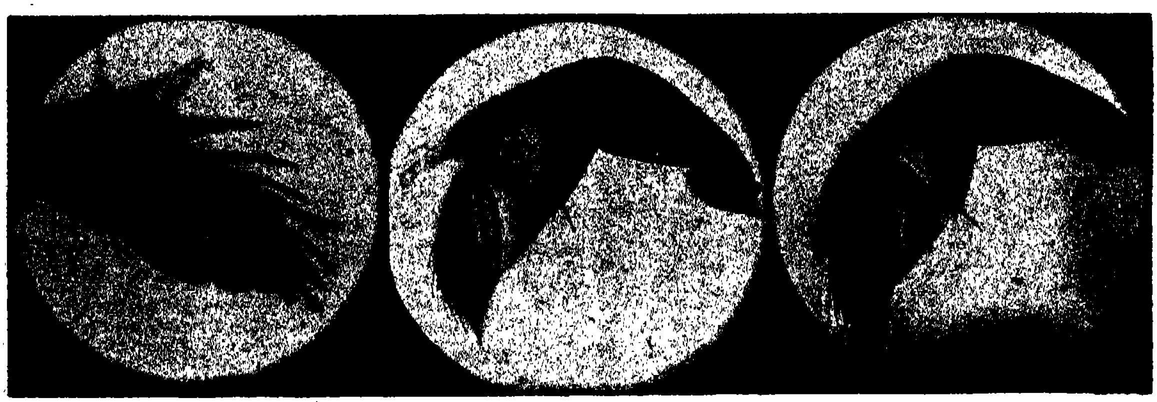


FIG. 4.—Diagram showing the action and position of the webbed feet of a swimming bird (*a*) with reference to a fixed point (*b*) with reference to the body of the bird.


a b c
FIG. 5.—Swimming legs of Gyrinus, showing paddle-shaped tarsi (*a*) fully extended, (*b*), (*c*) partly closed.

In upright-swimming fish and whales the accelerator is the tail fin or flukes, and to some extent the tail end of the body, the action being that of sculling with a single oar. The greater part bulk and weight of both these classes consists of the muscles working the accelerators. The outstanding difference in the mechanism in Pisces and Cetaceæ is that in the first the muscular action bends the spine into a curve alternating to the right and left, while in the latter similar motions are caused up and down (Fig. 6).

Flat fish (soles, etc.) have two modes of progression: one for moving slowly in contact with the ground, the other being kept for quicker travel. In these fish the dorsal and anal fins are greatly developed, extending from head to tail. For slow movement these fins are bent into a waved surface (Fig. 7), the waves, with the water between the fins and the ground, travelling in a backward direction.

When higher speeds are desired the body is raised from the ground and the main series of muscles, which are connected with the spine and ribs, act in the same way as in the upright-swimming fish, but the flexure of the spine is now up and down, instead of from side to side.

Among the rays the ribs are almost wanting, and the whole width of the body is occupied by the greatly developed pectoral fins. The fin-rays are very numerous, and each of these is connected with a muscle rather similar in form to the muscles which in other fish are attached to the ribs.

I have had no opportunity to observe the way in which the rays use their pectorals, but it seems likely that it is similar to the action of the dorsal and ventral fins in flat-fish.

Flying-fish when submerged swim as the other upright-swimming fish, and must for a short time at least be able to travel very fast, for I have seen them rise close to the side of a ship going 15 knots and pass ahead at perhaps 4 or 5 knots faster. While in the air the pectoral fins act as glides only, as may be shown by the small size of their muscular attachments, but where the water is smooth they can prolong their flight by sculling with the tail fin,

keeping its lower half in the water, so that the weight is supported by the air and the propulsion given by the sea. It is interesting to notice the increase in the speed of the fish after the tail is immersed.

The steering of ships, especially those with small

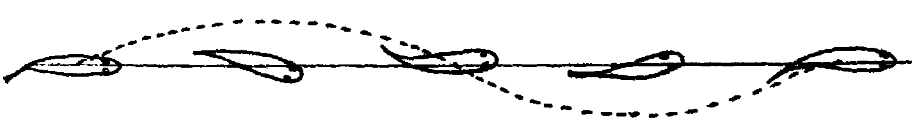


Fig. 6.—Showing the position of tail fin of an upright-swimming fish during one complete cycle.

rudders, is not completely explained by the action of the stream on an oblique rudder surface.

The course of an even perfectly symmetrical ship is unstable if not steered, since the centre of fluid pressure is in advance of the centre of inertia. In consequence of this instability, the wake tends to make an angle with the line of the keel, and thus to exert a turning movement on the ship. Even a small rudder, however, is sufficient to determine the direction of the instability, that is, whether the wake shall deviate to port or starboard, and a large part of the efficiency of the helm is dependent on this cause.

The unstable wake gave a great deal of trouble in some of our earlier warships, and there was a class of small gunboats (meant originally, I believe, for service in the Chinese rivers) which were notorious for their erratic steering. There was a story of a captain of the *Excellent* entering Portsmouth Harbour on one of them being hailed by the master of a sailing barge beating out with: "Now, sir, if you will tell me what part of the harbour you want to get to, I'll try to squeeze into the rest."

Fig. 7.—Showing wave-like form given to the dorsal and anal fins of flat-fish when moving slowly.

The manner of the progress of snakes has been much misrepresented. In Prof. Owen's "Anatomy of Vertebrates" there is a figure of a snake in the attitude of a looper caterpillar, like a Greek Ω. It has been said also that a snake 'walks' on the ends of its ribs; also it has been stated that it can, without any curvature of the body, move in a straight course by the ratchet-like action of the large ventral scales.

So far as my own observation goes, a snake on a flat smooth surface is in a very helpless condition, and can only progress by slightly raising the curved body on the right and left sides of the course alternately and straightening the raised portions. The track left by a snake in crossing a dusty road looks like a succession of horse-shoe marks such as are represented in Fig. 8. If there are any projections on the surface—grass, sticks, stones, branches, or in fact anything against which the body can get a 'purchase'—the snake bends itself into a curve to fit one or more of the projections and causes the curve to travel backward along the body, so that, with reference to the projections, the curve remains stationary and the body passes through the shape (Fig. 9).

The coefficient of friction between the body and the projection is involved in this, and here no doubt the edges of the scales on the under surface are of use in preventing backward slip.

The crawling of molluscs has not, I think, ever been satisfactorily explained, and I can only contribute two observations which bear on the subject.

(1) Having harnessed a large *Helix aperta* by a silk thread to a spiral spring, I found that it could pull about two and a half times its own weight

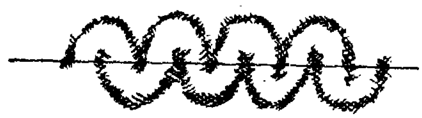


Fig. 8.—Track of a snake on a flat dusty surface.

before the foot began to slip on the surface on which it was crawling.

(2) Taking young specimens of the same snail, which are translucent, and examining the foot by transmitted light, it was seen that, so long as the animal was in motion, dark waves were passing in a forward direction through the substance of the extended foot. There were two or three of these waves visible at the same time. Whether they indicate muscular contraction or regulate the secretion of mucus remains to be determined.

That there is some periodicity in the secretion of mucus is proved by the intermittent tracks with which snails mark garden walks, leaving patches of mucus separated by clear ground. The intervals between the marks are very constant so long as the character of the ground does not change.

On dry ground more mucus has to be expended, and where there is dust it is not uncommon to find a snail has died from exhaustion. On a

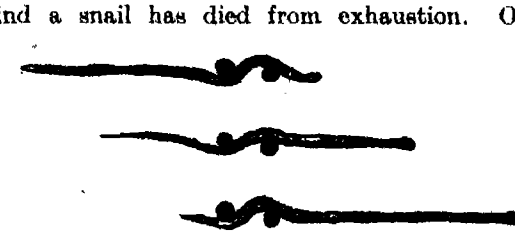


Fig. 9.—Showing mode of progression of a snake.

dusty road having on one side a drying ditch and on the other a wet one, I once saw the tracks of a number of young Limax which had tried to cross. Not one had succeeded. The tracks, in parallel lines a few inches apart, extended from 6 inches to 2 feet over the dust,—a dead snail at the end of each.

Many microscopic forms of life are capable of

moving slowly by the action of cilia. The action of cilia seems to be that each individual hair is capable of extension and retraction as well as of lateral bending, and that in the extended state the extremities are all moving in the same direction, thus causing a flow of fluid over, or giving motion to, the ciliated surface when in contact with a fixed body, an action which is not unlike that of the fire-bars in an automatic grate.

I know of no explanation of the mechanism by which the cilia are actuated or of the conditions which determine their periodicity.

Nova Pictoris as a Double Star.

A RECENT note in our astronomical column stated that observations in January at La Plata and Johannesburg showed that Nova Pictoris was surrounded by a nebulous ring. About Mar. 26 the La Plata observers noted that the appearance of this ring had altered; they telegraphed to Johannesburg, asking for an examination to be made with the 26-inch refractor; this was done, and revealed the fact that the star appeared double.

A Reuter telegram on Mar. 28 added that the position angle was 70°, the components were about equal in magnitude, that each was nebulous, and that the distance between their centres was half a second. It was added that separation of two stellar points at this distance would have been easy, and that under the actual conditions a darker band could be detected between the nebulous discs. On the other hand, Dr. Spencer Jones, His Majesty's Astronomer at the Cape, in a statement quoted in the *Times* for Mar. 29, gives the distance between the stars as one-fifth of a second. The Johannesburg estimate is probably to be preferred, the telescope there being larger, and the observers having much practice in measuring difficult binaries.

Dr. Spencer Jones adopts the view that the outburst was due to an actual collision of two stars, which have now drawn apart sufficiently to enable them to be seen separately; this is the theory that Mr. Bickerton has advocated for the last forty years, but most astronomers have decided that there are far too many Novæ for this explanation to be tenable in general. It would be expected to happen only once in many million years. Nova Pictoris, however, differed in several respects from the average Nova, so the possibility of a collision need not be immediately dismissed; an opportunity will be afforded to test the suggestion when measures of the pair have been taken for some months. The rate of angular separation would not be uniform; it would slow down owing to the mutual gravitation of the stars, which would pass each other on hyperbolic paths.

There is, in any case, one important difference from Bickerton's theory; he postulated the formation of a third body between the stars, which would be for some time more luminous than them; but the Johannesburg telegram mentions a darker region in the middle.

Harvard College Bulletin 852, published in November last, quotes Mr. Davidovich's spectroscopic parallax 0·006″ (giving a distance of 540 light-years) and derives a proper motion of −0·042″ in R.A. (great circle) and −0·018″ in declination. This is from comparison of old plates with recent ones, both taken with the 24-inch Bruce refractor, the time-interval being 24·2 years. The original magnitude of the star was 13 (absolute magnitude 7); if there were two stars on the old plates, their images would probably be blended. The above motions give position angle 247°, which is very nearly in line with the angle 70° now reported.

The outburst occurred on May 25, 1925, so that the interval up to the detection of duplicity is 2 years 10 months; assuming that the stars were then together, this gives 0·18″ as the average annual rate of separation; but it would have been much more rapid at first, and would now have sunk to perhaps a third of this, so that a trustworthy measure of the rate cannot be expected for several months.

The occurrence is unprecedented in the history of Novæ, and is of great interest; the similarity of the two stars in magnitude and appearance leaves little doubt that they are at the same distance from us, and that the phenomenon is not to be explained by the motion of the Nova revealing an independent star that previously was hidden in its rays.

Obituary.

Mr. E. W. Maunder.

THE death of Mr. Edward Walter Maunder on Mar. 21, at seventy-six years of age, will be regretted by astronomers in many parts of the world. Mr. Maunder was for many years a member of the staff of the Royal Observatory, Greenwich, and his appointment indicated the beginning of the change in the character of that establishment that has occurred in the last half-century. In his report, read on June 1, 1872, the Astronomer Royal, Airy, put to the Board of Visitors the proposition that a continued series of observations of the solar spots, and perhaps some solar spectroscopic work, of which he spoke with less certainty, might fitly be undertaken at Greenwich, though the Observatory would then become *pro tanto* a physical observatory, and hinted that its operations might be extended in that direction in the future. This resulted in the appointment of Maunder as photographic and spectroscopic assistant on Nov. 6, 1873, and in the first half of the following year a spectroscope by Browning was attached to the 12¾-inch equatorially mounted telescope, then known as the Great Equatorial, and a photo-

heliograph that had been used at Kew was installed in the Observatory grounds, both of which were given into Maunder's charge.

Thus began the forty-year series of photographs of the sun that was made under his direction. The first decade of the period was before the general use of the gelatine dry-plate, and the task of taking photographs by the collodion process daily, as weather permitted, was somewhat arduous. Maunder was partly relieved of this by the appointment of a skilled helper, and was able to devote some time by day to spectroscopic examination of the chromosphere and prominences, whilst at night the instrument was used for measuring the displacement of lines to determine velocities in the line of sight, occasionally for mapping the spectra of planets and stars, or, sometimes the telescope was used without the spectroscope for visual examination of, or for micrometric work on, the planets. Notes on the spectra of two Novæ, with others on similar subjects, are to be found in the *Monthly Notices of the Royal Astronomical Society* under Maunder's name, and for the most part the observations here mentioned are in the volumes of that publication. After the accession of Christie to the office of Astronomer Royal, the work of photographing and recording the sunspots was developed in several ways. The photo-heliograph was adapted so that (from April 4, 1884) the solar image had a diameter of 8 inches instead of 4 as hitherto, and the Greenwich photographs were supplemented by others taken at Dehra Dun and elsewhere to make the series complete.

This naturally made more demand on Maunder's time, and the personnel of the department was increased, but about the time of the sunspot maximum of 1894, the spectroscopic work at Greenwich was given up that he might devote himself wholly to the sunspots. The record of their positions and areas was kept by him with care and skill until his retirement in November 1913, and beyond the bare record, his ingenious tabulations and diagrams are of much value. A re-determination of the position of the sun's axis, published in 1912 and 1913, and a diagram showing the distribution of spots in latitude during three or more cycles, known as the 'Butterfly' diagram, may be mentioned, but his papers that received most attention were those on the association of terrestrial magnetic disturbance with the appearance of sunspots. A diagram in the *Monthly Notices* of November 1904, which displayed the solar longitude of the centre of the disc that was contemporaneous with the occurrence of magnetic disturbances in the years 1882 to 1903, showed unmistakably that magnetic storms are of solar origin. The idea of a short period in magnetic phenomena was not new, but it is doubtful whether it had been before exhibited so vividly.

It does not belittle Maunder's actual astronomical work to say that his greatest service to the science was the founding of the British Astronomical Association. In his early years at Greenwich he had formed a large circle of astronomical acquaintances, and in the year 1890 he was led to conceive the idea of an Association of amateur astronomers for mutual help, who because of their sex, or by other circumstances, might be precluded from joining the Royal Astronomical Society. Mainly by his efforts such an Association was formed, and the position of the organisation to-day, with its roll of a thousand members, many of whom are contributing observations of unique character and importance to astronomy, testifies to its success.

Maunder went abroad on six occasions to observe a total solar eclipse—twice as a member of a British official expedition; once as a guest of the Canadian Government, and three times he was a member of a party organised by the British Astronomical Association. On four of these occasions he was favoured with fine weather.

Maunder had a ready pen, considerable command of language, and wrote much. He was acting editor of the *Observatory* magazine from 1881 until 1887. At one period he contributed the Astronomical Column to this journal, and at another did similar office for the now defunct *Knowledge*. He edited the *Journal of the British Astronomical Association* from its foundation until the end of the fourth volume, and from 1896 until 1900; and the complete series contains many articles by him on topics of varied nature, archaic astronomy being one of them. His book, "Astronomy without a Telescope," has found many readers, as has his "History of the Royal Observatory," whilst his elucidation of certain scriptural passages in his work "Astronomy of the Bible" elicited commendation from ecclesiastics in high position, the book itself being in keeping with the devoutness that was a marked feature of his character.

Maunder was twice married. His first wife died in 1888, leaving a family of three sons and two daughters, who survive him. In 1895 he married Miss A. S. D. Russell, who was formerly on the staff of the Royal Observatory, and is not unknown in the astronomical world. He joined the Royal Astronomical Society in 1875, and was a member of its council for several years, serving as honorary secretary from 1892 until 1897. He retired from his post at the Royal Observatory at the end of the year 1913, but was recalled during the years of the War to carry on the sunspot record.

Prof. Theodor Curtius, emeritus professor of chemistry in the University of Heidelberg, died at Heidelberg on Feb. 9 in his seventy-first year. Curtius, who was well known as the discoverer of hydrazine, hydrazoic acid and the azides, discovered also the method of obtaining aliphatic diazo-compounds. Lead azide, which he first prepared, soon became an important substitute for mercury fulminate as a detonator.

We regret to announce the following deaths:

The Right Hon. Viscount Cave, G.C.M.G., who had just resigned from the office of Lord High Chancellor, and Chancellor of the University of Oxford since 1925, on Mar. 29, aged seventy-two years.

Dr. William C. L. Eglin, vice-president of the Philadelphia Electric Company and president of the Franklin Institute, on Feb. 7, aged fifty-eight years.

News and Views.

IN September next an important meeting of the International Illumination Commission, which was formed in 1900 and includes both the gas and electrical interests, is to be held in America. The objects of the Commission are the study of all subjects bearing on illumination and its cognate sciences, and the establishment of international agreements in illumination matters. There are at present National Illumination Committees in Austria, Belgium, France, Germany, Great Britain, Holland, Italy, Japan, Switzerland, and the United States of America. For the first time in the history of the Commission, a British president has been elected, namely, Mr. C. C. Paterson, Director of the Research Laboratories of the General Electric Co., Wembley. The Commission has already established an international standard of light, and is now dealing with such subjects as definitions and symbols, factory and school lighting, *automobile headlights, heterochromatic photometry*, photometric accuracy, fundamental research on glare, colorimetry. The British National Illumination Committee, which is closely associated with the Sectional Illumination Committee of the British Engineering Standards Association, the membership being practically identical, will be responsible for nominating delegates to represent the British viewpoint and British interests, and is anxious to secure adequate representation at these meetings. It is hoped that the delegates will include representatives of the Government departments, municipalities, the National Physical Laboratory, the electrical industry, the gas industry, and the principal associations interested in illumination matters. Mr. Buckley, of the National Physical Laboratory, Teddington, who is the secretary of the British National Illumination Committee, will gladly furnish full particulars.

THE Report on Scenery-Preservation for 1926–27, issued by the Department of Lands and Survey, New Zealand, makes pleasant reading. Among many interesting reservations recently added is the Te Koru Pa in the Taranaki District. The pa, which was at one time the headquarters of the Ngamahanga Hapu of the Taranaki Tribe, is situated in a horse-shoe bend of the Oakura River, and, apart from its historic interest, has long been held in high regard as a favourite picnicking-ground. It forms one of the very few remaining examples of a pa with stone-faced glacis or parapets surrounding the tiki or citadel. The narrow neck connecting the pa with the mainland was in the old days defended by a very deep trench backed by three terraces, all of which were faced with stone to a height of 15 feet in places. This area was a gift to the Crown from the native owners. Mr. Wilkinson's report on Kapiti Island, which is in his care, contains much that will appeal to the naturalist. For example, he writes: "Nearly all over, or at least in places where the forest-roof is open, the *Uncinia riparia* is becoming a pest and is a menace to bird-life. . . . Not only does it hold small birds, but even the morepork is not able to extricate himself when once he is properly caught. The unfortunate part about it is that the plant is seeding, and therefore in its dangerous stage, just when the young birds are beginning to fly about. I have several times rescued birds, and in nearly every case they were adult birds, so that young birds caught must eventually die of starvation or be taken by the wekas."

THE Report also notes the improvements effected by an Amending Act of 1926. This gives permission for the destruction of certain troublesome animals under stringent provisions. Power is conferred on local authorities to contribute towards the cost of acquiring scenic reserves and towards their improvement and maintenance. So far as possible, the control of reservations is vested in local authorities or special boards, and honorary inspectors are appointed. This affords enthusiasts an opportunity of performing useful service of value to the State, and encourages among the general public a regard for natural beauty. In England we have to protect our downs from the seaside bungalow. In our antipodes, "The advent of the seaside dwelling in the Sounds has proved an important factor in the improvement to the scenery during the past few years. Most of the owners of these are enthusiastic nature-lovers, and, besides protecting the remnants of native bush on their properties, have extended these by planting more native or introduced trees. In this way many hundreds of acres which a few years ago were in bracken or burnt bush are rapidly becoming reafforested, and prove a welcome addition to our efforts in conserving what we can of the original native bush that beautified the Sounds."

THE Ministry of Agriculture and Fisheries has issued a statement of the measures taken to prevent the introduction into Great Britain of foot-and-mouth disease from South America. Epidemics of this disease have been traced to carcases imported from Europe, and the research committee investigating the subject has determined that the virus, if present, remains active in frozen carcases for 76 days. Negotiations were conducted with the Governments of Argentina, Brazil, and Uruguay, and the Ministry's Senior Veterinary Inspector, Mr. J. L. Frood, visited those countries and conferred with the officials there. Finally, Lord Bledisloe agreed to undertake a mission to the three countries to modify, if necessary, and to ratify agreements awaiting final approval. Agreement was reached respecting the measures necessary to prevent the importation of the foot-and-mouth disease virus with the frozen meat which comes from the three countries named. The two principal clauses institute veterinary inspection of the animals before removal from the *estancias*, and of the animals at the freezing establishments before and after slaughter, with isolation of herds in the event of symptoms of contagious disease appearing among them.

THE Folkestone Natural History Society, which was founded on April 4, 1868, has been celebrating its diamond jubilee. On Saturday, Mar. 24, a visit was

paid to Snowdown College. At a public meeting held on the following Wednesday, short addresses were delivered by Mr. A. H. Ullyett on the history of the Society, by Dr. Walcot Gibson, on the value of local natural history societies, and by Mr. C. A. B. Garrett, on natural history in schools. During the evening especial attention was directed to the part the Society has played in the inception of the excellent Town Museum now under the able curatorship of Captain Moody-Foster. Occasion was also taken to present a set of silver-plate to Mr George Chapman Walton, in recognition of his long services to the Society as honorary secretary and as president—an office which he has filled since 1905. A lecture by Prof. Julian Huxley on the progress of biological science during the past sixty years, delivered on Friday evening; and a conversazione with exhibits and demonstrations, held on Saturday, Mar. 31, terminated a very successful anniversary of one of the oldest natural history societies in Great Britain.

A meeting for the discussion of geophysical surveying was held at the Institution of Civil Engineers on Mar. 28, under the chairmanship of Sir John Flett, Director of the Geological Survey of Great Britain. The chairman, in his introductory remarks, emphasised the value of geophysical methods in the study of geology and mining, and indicated that the results recently obtained by the Geological Survey have proved entirely satisfactory. Dr. W. E. P. M'Clintock described a survey with the Oertling torsion balance over the Swynnerton Dyke in Staffordshire, by the Geological Survey, and showed the closeness with which the position of the intrusive dyke had been located and its features investigated. Not merely could the limits of the dyke be established, but also it was shown that the dyke was inclined slightly to the vertical. He stressed the convenience of the Oertling protecting hut, and the general convenience and portability of the apparatus. Mr. E. Lancaster-Jones outlined the evolution of a new instrument recently constructed for the measurement of gravity gradients. This instrument, termed a 'gradiometer,' is unaffected by curvature, and may be readily transported by one man. In speed of operation it is a considerable advance on previous instruments, and it should enable both reconnaissance and detail gravity surveying to be effected with greatly increased economy and efficiency. An account of field work with this instrument was given by Captain H. Shaw, who showed results that have been obtained in tidal areas. In one case an important fault showed up prominently, and was located with accuracy and interpreted in detail. In a second area, a noticeable subterranean feature was revealed, and by means of a dense station network it was possible to delimit this anomaly, and to give a complete interpretation of its characteristics. The sensibility and reliability of the instrument were shown to be quite up to standard, while the resulting gravity gradients were unusually consistent, and conformed completely to those previously obtained in adjacent areas. Captain W. H. Fordham spoke on the magnetometer and its applications to geology and mining, and described a new type of magnetometer recently produced by Messrs. Oertling Ltd., on the lines of the earlier Thomson-Thalen instrument.

Semi-destructive earthquakes occurred in north-eastern Italy near Udine (about 40 miles north-west of Trieste) on Mar. 26 and 27. The later and more violent shock was recorded at Kew at 8 hr. 34 min. 56 sec. A.M. (G.M.T.); the other at 2 hr. 43 min. 1 sec. P.M. The district visited by them is one in which earthquakes are of moderate strength and frequency. About 50 miles west of Udine is Belluno, a small town that almost coincided with the epicentre of the strong earthquake of June 29, 1873. This earthquake was studied by Prof. H. Höfer (Wein, *Ak. Sber.*, vol. 76, pt. 1, 1877, pp. 819-856) and is probably the first attributed to an origin in two distinct foci. Höfer suggested that two faults were then in action simultaneously, one running south-east, the other east, from a point near Belluno. The latter, as traced by him, passes close to Udine and Tolmezzo, places at which much of the damage caused by the recent earthquakes occurred. A further earthquake, described as violent, was recorded at Kew Observatory on Mar. 31 at 0 hr. 35 min. 2 sec. G.M.T. The epicentre is estimated to have been 1620 miles away, probably between Greece and Crete. The disturbance recorded at Kew was considerably more violent than that produced by the recent earthquake in the Italian Alps.

By the provisions of an enactment about to be introduced in the Federal Council of the Federated Malay States, it will be made an offence to take fire-arms or other apparatus for killing animals or birds into a game sanctuary or reserve. Game rangers will be given power to seize animals, birds, trophies, or fire-arms, etc., which have been used in the commission of an offence. A notification in the *Federated Malay States Government Gazette* announces that rewards for the destruction of 'noxious animals' will be paid on the following scale: Tigers, full grown, 25 dollars each, cubs, 10 dollars each; leopards, full grown, 15 dollars each, cubs, 5 dollars each; crocodiles, up to 2 feet in length, 25 cents each, more than 2 feet long, 3 cents an inch; crocodiles' eggs, 25 cents each; hamadryads and conras, 5 cents per foot. Claimants for rewards are required to produce the carcase or fresh skin in the case of tigers or leopards; in the case of a crocodile, the unbroken vertebral column will suffice.

The Perkin Medal was instituted by the Society of Dyers and Colourists in commemoration of Sir William Perkin, who died in 1907 during his presidency of the Society. It is awarded at intervals of two or three years for discoveries of outstanding importance in connexion with the tinctorial arts. Previous recipients of the medal have been Profs. Graebe and Liebermann, for their synthesis of alizarin (1908); Prof. Adolf von Baeyer, for his synthesis of indigo (1911); Comte Hilaire de Chardonnet, for his pioneer work on artificial silk (1914); Prof. A. G. Green, for

his discovery of primuline (1917); M. R. Vidal, for his work on sulphur black (1919); Mr. H. Lowe, for his work on the production of permanent lustre on cotton (1921); Mr. C. F. Cross, for his discovery of viscose (1923); and M. M. Prud'homme, for his work on aniline black and alizarin blue (1925). At the annual dinner of the Society, held in Manchester on Mar. 23, the Perkin Medal was presented to Dr. R. E. Schmidt, of Elberfeld, for his remarkable work on anthraquinone and allied bodies, which has led to the discovery and commercial production of a whole series of fast dyestuffs. The medal, which was struck in gold, was modelled by the late F. W. Pomeroy, R.A., and is an excellent presentation of Perkin's head in profile.

THE protection from lightning flashes of petroleum tanks, which are often assembled over a large area, is a problem of considerable importance. The flames arising from burning oil often reach great heights, and in some cases the burning oil can only be prevented from spreading over the adjoining land by digging up trenches round the blazing area. In the *Electrical Review* for Mar. 9, a method is described which has been installed in America for protecting such areas. Colonel Wilcox claims that it secures absolute immunity. Steel towers are connected round the area and are connected at the top by a ring of wires in a horizontal plane. When the atmosphere is electrified, brush discharges take place from points on this ring. This undoubtedly minimises the danger. We agree with Sir Oliver Lodge, however, in thinking that it fails to give absolute protection. There is no reason why a flash of the 'impulsive rush' or *B* type should not strike an object inside the ring. The experiments carried out in America on a small model of this protective device produced only *A* flashes, and in this case almost absolute protection would be secured. St. Paul's Cathedral in London is protected by a horizontal loop encircling the dome and by other conductors. Six-point aigrettes are jointed at intervals to the loop and similar aigrettes are used at Westminster Abbey. K. Hedges, who designed both systems, recognises the powerful effects of points in levelling down excessive stresses, but he does not claim that they give absolute protection. The accident at Tunbridge Explosive Works in 1918, when hermetically sealed drums of nitro-glycerine were detonated, although the lightning conductors were of the most modern type and in excellent condition, proves how difficult it is to guard against a *B* flash.

THE decision of the eastern associated submarine cable companies to co-operate with Marconi's Wireless Telegraph Co., Ltd., in developing 'world-radio' is a wise one. They have successfully overcome many difficulties during the last eighty years, but the rapid development of the beam system of radio and possible competition in world-radio by foreign companies at last induced them to see that co-operation was the wisest policy. The recent Imperial conference of representatives of the Dominions discussed the question of cable-radio, and both the cable companies and Marconi's gave evidence, but so far the discussions at the conference have been kept secret. Until the Imperial government has notified its decisions, the Marconi-eastern combination is handicapped by not knowing what powerful interests will have to be considered and consulted. In the *Electrician* for Mar. 23, R. Belfort lays stress on this aspect of the problem. He points out that the virtual arbitrators of the situation may themselves be formidable competitors, as they can own and exploit both cable and radio enterprises. The Americans also have a vast organisation of radio, telephone, and cable companies which are continually developing their methods and extending their operations. It seems probable that the Commercial Cable Co. of America will soon possess a complete round-the-world cable-radio service. A similar girdling of the earth will probably also soon be accomplished by the Western Union Telegraph Co. These and other competitive developments make it difficult to prophecy how profitable the new enterprise will be. America occupies a fortunate position, as its communication companies are all under private control. Mr. Belfort thinks that just as the Eastern company was unable to resist Marconi competition, so it is possible that a Marconi-Eastern combination may not be strong enough to confront American and other foreign competition. In our opinion, however, the improved service will increase the revenues, and this increase should be sufficient to satisfy the legitimate claims of all the competitors.

BY the Protection of Lapwings Act, 1928, which received the Royal Assent on Mar. 28, and is now in force, the sale, or possession for sale, for human consumption of lapwings' eggs and also of the bird itself between Mar. 1 and Aug. 31 in each year, is absolutely prohibited. The Act applies equally to native and to imported eggs and birds.

THE Gold Medal of the Institution of Mining and Metallurgy has been awarded to the Right Hon. Sir Alfred Mond, "in recognition of his scientific and industrial services in the development of the mineral resources and metallurgical industries of the British Empire." The Medal will be presented to Sir Alfred Mond at the annual general meeting of the Institution to be held at Burlington House on Thursday, May 17.

THE Council of the Royal Anthropological Institute has awarded the Huxley Memorial Medal for 1929 to Baron Erland Nordenskiöld of Göteborg. He has also been invited to deliver the Huxley Memorial Lecture in November of that year. Baron Nordenskiöld's researches in the archæology and ethnology of South America hold a deservedly high place in the estimation of anthropologists, and the award will be welcomed as a merited recognition of many years' valuable work.

IT was announced in the House of Lords on Mar. 29 that a committee of inquiry had been set up to inquire into the possible danger arising from the use of lead tetra-ethyl in motor spirit, composed as follows: Sir Frederick Willis (chairman), Sir George Buchanan, Dr. Bridge, Mr. Pye, Sir Charles Martin, Sir Robert Robertson, Major Galwey, Dr. C. H. Lander, Prof.

A. C. Chapman, Sir William Willcox, and Prof. Dixon. The secretary to the committee is Mr. S. F. S. Hearder, Ministry of Health, Whitehall, S.W.1, to whom all communications should be addressed.

Friday evening discourses after Easter at the Royal Institution include: "Heirlooms of Industry in the Science Museum," by Sir Henry Lyons; "Carriers of Electricity in the Atmosphere," by Prof. A. M. Tyndall; "Life's Unsuspected Partnerships," by Prof. Doris L. Mackinnon; "Engine Knock and Related Problems," by Mr. A. C. Egerton; "The Results of the further Excavations at Ur," by Mr. C. Leonard Woolley; and "The Waves of an Electron," by Prof. George P. Thomson.

Applications are invited for the following appointments, on or before the dates mentioned:—Temporary assistant quantity surveyors and temporary architectural draughtsmen under the Mines Department—The Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (April 14). An assistant pathologist in the Laboratories of Pathology and Public Health, 6 Harley Street, W.1—The Secretary (April 20). A teacher of engineering subjects at the Cheltenham Technical School—The Secretary, County Education Office, Shire Hall, Gloucester (April 20). A lecturer in electrical and mechanical engineering at the Forest of Dean Mining School, Cinderford—The Secretary, County Education Office, Shire Hall, Gloucester (April 20). A secretary to the delegacy of the University of London for co-operation with Training Colleges in the London District in accordance with a Scheme approved by the Board of Education—The Principal Officer, University of London, South Kensington, S.W.7 (April 21). A test assistant in the Chemical Department of the Royal Aircraft Establishment—A.273, Chief Superintendent, R.A.E., South Farnborough, Hants. A head of the Mechanical and Structural Engineering Department of the Borough Polytechnic Institute—The Principal, Borough Polytechnic Institute, S.E.1.

Our Astronomical Column.

The Recent Transit of Mercury.—*Circular No. 75* of the Union Observatory, Johannesburg, contains a discussion of the observations of this phenomenon made at several observatories. In the mean, the phases were 23 seconds earlier than the predicted times, as compared with 30 seconds in 1924. It will be remembered that the lunar errors are also slightly diminishing. The view is now largely held that these fluctuations indicate variability in the earth's rate of rotation, the periods of the oscillations being somewhat irregular, but considerable fractions of a century. Dr. Benjamin Boss (*Daily Science News Bulletin*, Science Service, Washington, Feb. 28) suggests that there are in addition fluctuations of much shorter period (days or hours) in the rate of rotation; he thus explains the puzzling anomalies found in the meridian determinations of time and Right Ascension at most observatories. He suggests as an explanation that the solid surface of the earth, when raised by lunar and solar tides, may not completely settle back, but remain raised for some time, and then at last reach a breaking point and return abruptly. Such settling back would sometimes reach the magnitude of an earthquake, and in fact Dr. Boss notes that his time variations show relationships with the frequency of earthquakes.

Stellar Parallaxes from Allegheny Observatory.—The excellence of the numerous parallax determinations made at this observatory is well known, and regret will be felt that the latest instalment (*Yale University Transactions*, vol. 6, Pts. 1 and 2) is the last with which Prof. Schlesinger will be personally concerned. There are three stars of special interest in the list. The parallax found for Barnard's star of record proper motion is 0·550″. It is noted that this is the best determined stellar parallax, the mean of seven good determinations being 0·538″. For ϵ Hydræ the value found is 0·026″, in good agreement with 0·025″, found spectroscopically from the radial velocities of the close components. Betelgeuse is interesting from the large angular diameter given by the interferometer. The value found for its parallax is 0·013″; the trigonometrical determinations range from 0·011″ (Mount Wilson) to 0·024″ (Yale heliometer). The mean of seven spectroscopic determinations is 0·011″; but the spectroscopic scale must be a little uncertain for such extreme giant stars, the means of graduation being restricted. The well-known binary 70 Ophiuchi has a parallax of 0·184″. The probable errors of these parallaxes are about 0·01″ or less.

The Spectra of Comets.—Several important papers on this subject have appeared recently, including discussions by N. T. Bobrovnikoff, of various Yerkes photographs taken during the period 1908–1927 (*Astrophysical Journal*, vol. 66, pp. 145 and 479). The first of these treats of Halley's Comet in considerable detail. The spectra were studied photometrically with a self-registering microphotometer and compared with direct photographs. A variation in size and brightness of the principal monochromatic images of the head indicates the development of the CN and C + H, rather than the Swan, bands as the comet recedes. Two types of continuous spectrum were discovered—one due to reflected sunlight, and the other the comet's own spectrum with a maximum intensity at λ4000. The existence of the latter depends on the comet's heliocentric distance, only appearing at distances greater than 1·2 astronomical units.

The second paper deals with the spectra of 22 comets, all of which resemble Halley's in the above respects and in the existence of sudden changes in their spectra. The change from solar to cometary type of continuous spectrum takes place usually at a distance of about 0·7 astronomical units from the sun. Bredichin's theory of cometary tails is not supported by these observations, and fluorescence is suggested as a probable origin of cometary spectra.

A third paper on comets comes from Meudon, by M. F. Baldet (*Annales de l'Obs. d'Astr. de Paris*, tome 7). In this paper a historical survey is given of our present knowledge of the subject, with various tables of wave-lengths which should be of considerable value in the identification of cometary lines. Detailed discussions follow of the spectra of eight comets, and of laboratory researches into the spectra of relevant sources. It is to be regretted that the author does not always follow the recommendations of the International Astronomical Union in the printing of his photographs.

Research Items.

Avokaiya Fishing.—In *Man* for March, Mr. E. E. Evans-Pritchard, who has visited the Moro tribes of Mongalla Province on behalf of the Sudan Government and with the financial assistance of the Royal Society and the Laura Spelman Rockefeller Trust, describes the interesting methods of dry-season pool-fishing employed by the Avokaiya tribes. They use fish scoops made in a few minutes from millet stalks, tied together with cords of fibre. The mode of procedure is as follows: a line of boys is formed across the pool or stream, who draw the scoops all together across the pool or push them in front of their bodies. When the end of the pool is reached the boys form a semi-circle around the bank. When the number is insufficient to form a continuous line, they cover the distance as best they can, and small boys swim and splash on the open side of the pool. Small boys also swim about to frighten fish into the scoops, while the boys at the end of the line feel under the banks with the same object. Simple as the process looks from the bank, it is more difficult than it seems, as is shown by the difference in the catch when experienced fishers take part. A great deal depends upon the celerity with which the mouth of the scoop is closed when a fish has entered. Both the Avokaiya and the Moro are agricultural peoples, and the fish form a welcome addition to the food supply. The mode of fishing here described seems to be more of a play activity than a method of economic utility. The Moro Meza use fish poisons, but the Moro Kodo also use nets and large hand-worked hooks.

India and the Pacific.—In the *Ceylon Journal of Science*, vol. 1, pt. 4, Mr. A. M. Hocart publishes some supplementary notes on his studies of the Indian and Fijian caste systems. He now states that in addition to the absence of the fourth caste in Fiji, the absence of the third caste in Samoa is to be noted. The power is divided or contested between the nobles and the masters of ceremonies, just as a tendency in this direction is to be observed in India, where traditions show the Vaisyas dropping into obscurity and the aristocracy resolving itself into two rival castes, Brahmins and Kshatriya. India retains, however, the fourth unitiated caste, whereas the Samoans have assimilated their fourth caste to the nobility. The existence of the four-caste system is preserved in the history of the Four Brothers of Upolu, who each went out to seek a country for himself and his people. When they divided up their possessions, Sana received the staff and fly-whisk, the insignia of the public orator or master of ceremonies, the spear and club were given to Ana, the digging stick with which yams are planted to Tua, but Tolufale received nothing. The fact that the orator is mentioned first may have a bearing upon the question whether the original position of the Kshatriya was first as is generally assumed. In both India and Samoa and Tonga, a nobleman may be a priest. In Samoa and Tonga chiefs may assume the orator's title if they have an ancestress of that caste. It is also suggested that the Indian barber caste may have to be identified with the caste known in Fiji as *mbouta*, who are exempt from the consequences which follow when anyone touches the sacred body, and especially the head, of the chief. Epithets employed of them suggest they may be of noble descent or a clan of noble bastards. The Indian barbers may in the same way be derived from priests, *i.e.* descendants of a Brahmin father and a Sudra mother.

Russian Zoological Studies.—The *Annuaire du Musée Zoologique*, Leningrad, which has been very late in appearing, is now coming out very regularly, three parts of the vol. 27 and one of the vol. 28 having been published during 1927. These publications contain a very long series of zoological papers on different groups. P. Schmidt gives revisions of two genera of fishes, Icelus and Gymnacanthus, while B. Iljin published a critical list of Gobiidæ of the Black Sea. On mammals there are papers by B. Vinogradov (on the mechanism of gnawing and mastication in some burrowing rodents); Flerov, on mammals of the Tchorokh district in Transcaucasia, and on a new subspecies of *Ochotona hyperborea* from the Polar Ural; M. K. Serebrennikov describes the fauna of rodents of the Samara province, and S. S. Ognev gives a description of a new genus and species of cat (*Eremælurus thinobius* Ogn.) from Transcaspia. On birds there is only one paper, by B. Stegmann, on birds of the Alai steppes, but there is also a paper by C. A. Kurova on trematodes of the family Echinostomatidæ from birds in Turkestan. Papers on invertebrates include, to mention only a few, a list of Acarina of the Kamtchatka, by S. Thor; revision of two genera of Polychæta, by N. Annenkova; a list of the Orthoptera of Crimea, by E. Miram; descriptions of Solifugidæ from Africa, by A. Birula; list of Hydroidea and Alcyonaria from the Barents Sea, etc.

The May-flies of India.—The study of May-flies is so little advanced in tropical regions that a description of the material contained in the Indian Museum and other Eastern institutions is especially welcome. In *Records of the Indian Museum*, vol. 29 (1927), Dr. B. Chopra provides the first part of a general account of the Indian species and their biology; this contribution, which occupies pp. 91-138, is illustrated with three finely executed plates. In his prefatory remarks on the wing venation, the author points out that the homologies of certain of the veins are still far from definitely established, and he provides a useful tabular comparison of the various systems of nomenclature that have been advocated. In view of the present position of the subject, the Comstock-Needham system is followed, and it has the advantage of having been more widely adopted than the schemes that have aimed at emending it. In the general classification of May-flies the work of Ulmer has been adopted almost completely, and in the present contribution certain of those species falling in the group Ephemeroidea are discussed and, where necessary, described at length. Of the new species discovered, one belongs to the genus Palingenia and two to Polymitarcys.

Modification of Development by Temperature Gradients.—Prof. Julian Huxley (*Roux Arch. f. Entwick. der Organ.*, Bd. 112, pp. 480-516) has subjected frog's eggs and embryos and chick embryos to temperature gradients in various directions (*a*) with the main axial gradient of the organism and thus adjuvant, (*b*) against the main axial gradient and thus antagonistic, and (*c*) lateral to the main axial gradient. The results seem to show that, during segmentation, at the higher end of the temperature gradient, division of cells is accelerated, with the result that adjuvant gradients accentuate the normal size differences between animal and vegetative cells, while antagonistic gradients diminish them. These alterations in segmentation have little effect on subsequent development. Lateral gradients applied to frog embryos in the neural plate to tail-bud stages produce

marked asymmetries which, however, do not always persist in subsequent development. Lateral gradients applied to chick embryos produce acceleration of development of the heated side with marked increase in the tissues and in the size of organs on that side. Antagonistic gradients applied to chick embryos cause enlargement of the primitive streak posteriorly, retardation of brain development, reduction in the head size in the later embryos, and precocious development of the hind limb buds. Adjuvant gradients produce opposite results on head size and limb bud development.

Nematode Spermatogenesis.—N. A. Cobb (*Jour. Washington Acad. Sci.*, **18**, No. 2, Jan. 1928) records observations on spermatogenesis in a free-living nematode, *Spirina parasitifera*, common an inch or two deep in sand between tide marks on both sides of the North Atlantic. Four spermatids are formed from a spermatocyte, but instead of metamorphosing into spermatozoa, each spermatid undergoes further changes and divisions and gives rise to a 'spermatidian tissue' of 64 and finally 128 cells. The male passes the spermatidian tissues into the uteri of the female. Fertilisation is preceded by an increase in size of that cell of the spermatidian tissue adjacent to the ovum next to be fertilised; this spermatidian cell is transformed into a 'spermule,' which fertilises the ovum. Whether every one of the 128 spermatidian cells metamorphose in this way is as yet undetermined. The author says that he knows of a large number of other species of nematodes belonging to numerous and varied genera in which the general appearances in the gonad of the male so closely resemble those described as to leave no doubt that their spermatogenesis follows a similar course.

Form Variations of the British Freshwater Pearl Mussel.—H. H. Bloomer gives an account of the variation of the British and Irish forms of *Margaritifera margaritifera* in *Proc. Malac. Soc. Lond.*, vol. 17. 'Form' in this paper is defined as "the external shape of the shell when observed from a lateral point of view without any regard to the shape of the teeth, muscular impressions, or other internal characters." Twelve different 'forms' are figured on photographic plates, including one from the River Wye which presents "a general conformity with certain characters which seem to justify making it a new local variety," var. *siluriana*. Local distribution is discussed river by river, and brief diagnoses of the dimensions and appearance of the contained pearl shells given.

Traverse Methods.—The United States Coast and Geodetic Survey has issued as *Special Publication No. 137*, a small manual of first order traverse which, in spite of its slender bulk, is a useful summary of the methods employed in traverse work in the American surveys. Field methods and office computation are both covered. The manual is a useful companion volume to that on first order triangulation recently published.

Periodicities in the Nile Floods.—From a long series of Nile flood records, extending from A.D. 641 to 1451, taken from the original Coptic records and corrected to the modern calendar, Dr. C. E. P. Brooks has investigated the question of periodicity and gives his results in a paper in the *Memoirs of the Royal Meteorological Society*, vol. 2, No. 12. The method employed for analysing the data is that known as the difference-periodogram. The result was the discovery of 19 periodicities of lengths varying from 1·91 to 76·8 years, some of them well established and others of doubtful validity. Some of these periodicities bear a simple relation to one another, as the series 5·52, 11·06, 22·12, 33·49, 66·0, 76·8 years. In fact, eleven of the periodicities agree within 1 per cent. with a simple multiple or sub-multiple of 22·12 years. One of the remaining periodicities could not be determined accurately, but another has a discrepancy of so much as 3·5 per cent. A few of these periodicities fit with those recorded from other data, especially the 33·49, which agrees fairly well with the variable Brückner periods. The more difficult task of finding a cycle of variation in the length of the periodicities led to no conclusive results, but there were indications of a 500-year period.

The Outer Shells of the Earth.—A stimulating discussion by Prof. R. A. Daly of recent evidence bearing on the structure of the lithosphere appears in the *Amer. Jour. Sci.*, Feb. 1928. The disagreement between the results of A. Mohorovičić, Gutenberg, and Jeffreys on the thickness of the sial of the continents is pointed out, and it is shown that owing to the absence of any generally accepted solution, there is still uncertainty as to wave velocities at different depths in the crust. It is thought that, under the low stress conditions of seismic waves, the rocks may have higher effective elastic moduli than under the high pressure conditions of laboratory investigations. Corroboration of this idea is found in an analysis of the hysteresis curves of Adams and Coker. Thus the data of seismology do not as yet forbid belief in a basaltic substratum. It is thought that the velocities of earthquake waves in holocrystalline basalt and glassy basalt would be nearly identical at the contact, and therefore that the latter, if it exist, will be difficult to detect. Thus the substratum below a certain depth may be rigid but glassy. The postulate of an earth shell of peridotite *near* the crust is considered to be both unnecessary and unjustified by evidence. A new interpretation of the intermediate layer is offered. Jeffreys regards this as tachylyte and Holmes as diorite and quartz-diorite. Daly suggests that it may represent a quartz-bearing rock at a temperature beyond the transition point of α-quartz to β-quartz (575° C.). The sudden change of elastic properties at the inversion temperature indicates that Daly's view has much to commend it.

Thunderstorms as Sources of High Potentials.—In *Forschungen und Fortschritte*, of Feb. 20, there is an interesting article by A. Brasch, F. Lange, and C. Urban on a project for obtaining extremely high potential differences, for use in such experiments as Rutherford's on atomic disintegration, from thunderstorms. It is estimated that within practicable heights above the earth's surface, of a few hundred metres, there are available at times potential differences of 5-30 million volts. For this purpose a cable 660 metres long has been stretched across a valley near Lugano, carrying near its middle point, 80 metres above the ground, a collecting network. Details are given of the arrangements for insulation of the cable and for the measurement of the potential differences. Preliminary measurements made during the only suitable thunderstorm which occurred during the period of observation indicated a potential difference of above one million volts, causing a spark across an air gap more than 4 metres long.

Magnetic Theory.—In volume 4, No. 4, of the *Proceedings of the Imperial Academy* of Japan for 1928, Prof. K. Honda puts forward in a short paper a new theory of the origin of magnetism based on the structure of the atom. In present theories, magnetic properties are attributed to the outer

electrons of the atoms, but Prof. Honda attributes diamagnetism only to these electrons, his explanation of the property being along the usual lines. Para- and ferro-magnetism he attributes to the nuclear electrons, which revolve in the nucleus with speeds approaching that of light, and produce magnetic moments of the requisite magnitude. In order to endow this atom with the power of turning towards a magnetic field, he supposes that a certain number of the protons revolve in the opposite direction to the electrons. In ferro-magnetic substances the angular momentum of the nucleus is supposed small, so that a magnetic field easily turns them, while in paramagnetic substances the momentum is great. According to the author, a quantitative examination of the theory leads to the explanation of many observed facts in magnetism.

TOTAL REFLECTION OF ELECTRONS.—An interesting suggestion has been made by O. Klemperer, in the *Zeitschrift für Physik* of Feb. 24, to the effect that electrons, which are known to act under appropriate conditions as if they were diffracted, can also be totally reflected. If a particle entering a solid from a vacuum is retarded, the speed of its associated phase wave must be increased, when the corresponding index of refraction becomes less than unity, and for sufficiently oblique incidence, penetration of the surface cannot take place. This idea receives a certain amount of support from some experiments that were done several years ago on the secondary emission of electrons from the surfaces of various bodies bombarded at different angles by homogeneous beams of primary electrons. For electrons which had been accelerated through a fall of potential of a few kilovolts, the retardation in glass and some other insulating substances was equivalent to between one and two kilovolts, and although this is admittedly higher than would be expected from thermionic and photo-electric phenomena, its value for metals is much smaller, and of the order of what is required to account for the apparent contraction of the spacing of the atomic planes in a crystal of nickel indicated by the diffraction experiments of Davisson and Germer.

ISOMORPHISM OF AMMONIUM AND PHOSPHONIUM HALIDES.—Although a tendency to isomorphism is evident between ammonium and phosphonium halides in which all the hydrogen atoms are replaced by alkyl radicles, for example, tetra-ethylammonium bromide and tetra-ethylphosphonium iodide, the absence of isomorphism among non-substituted ammonium and phosphonium salts has resulted in the view that the resemblance between the groups NH_4 and PH_4 was merely formal. In a paper published in the volume for 1927 of the *Rendiconti dell' Accademia delle Scienze e Matematiche* (Naples), Congilio and Caglioti show, however, that crystallisation of a solution containing ammonium and phosphonium iodides gives rise to mixed crystals of the ammonium iodide type, containing phosphonium iodide in proportions varying to a maximum of 1·92 per cent.

PREPARATION OF LEAD TETRA-ETHYL.—*Report No. 29, Aeronautical Research Institute, Tokyo Imperial University*, by T. Tanaka and T. Kuwata, contains a study of the preparation of lead tetra-ethyl from ethyl chloride, using Grignard's reaction. Lead tetra-ethyl was obtained by the action of lead chloride upon ethyl magnesium chloride below 5° C. The crude product was purified by treating the ethereal solution with oxygen in the presence of dilute hydrochloric acid until it was colourless and crystallising out the triethyl lead chloride present in the solution. The lead tetra-ethyl had an unpleasant odour and boiled at about 82° C. under 11 mm. pressure. It decomposed on heating to 400° C. and at ordinary temperatures became turbid on exposure to air and sunlight.

THE CO-ORDINATION VALENCY OF ALUMINIUM IN ITS SALICYLATO DERIVATIVES.—In its complex compounds, the co-ordination number of aluminium is either four as in the alkali aluminates, or six as in cryolite. The two stable hydrates which are apparently formed by aluminium oxide, may accordingly be regarded as $H[Al(OH)_4]$ and $H_3[Al(OH)_6]$. In one case aluminium resembles boron with a low co-ordination number, and in the other it shows its resemblance to iron and chromium. In the January number of the *Journal of the Chemical Society*, G. J. Burrows and I. W. Wark describe an investigation of the salicylato derivatives of alumium. Various derivatives of aluminosalicylic acid $H_2\left[(C_7H_4O_3)_2Al\begin{smallmatrix}OH\\OH_2\end{smallmatrix}\right]$ were prepared in which the co-ordination valency of aluminium is six, indicating, therefore, its resemblance to iron and chromium. An unsuccessful attempt was made to resolve the alkaloidal salts of the above acid into optical isomerides.

COMPLEX ETHYLENETHIOCARBAMIDO-SALTS OF UNIVALENT AND BIVALENT METALS.—Owing to the presence of two amino-radicals as well as a thiocarbonyl group, thiocarbamide forms polynuclear as well as mononuclear derivatives with metallic nitrates. The co-ordinating properties of the amino groups may, however, be inhibited by incorporating the two nitrogen atoms in a five-membered ring as in ethylenethiocarbamide, $\begin{matrix}CH_2-NH\\ | \\ CH_2-NH\end{matrix}\!\!>\!C=S$, represented by *etu*. The preparation of a large number of the complexes formed between this compound and various metallic salts is described by G. T. Morgan and F. H. Burstall in the *Journal of the Chemical Society* for January. Each molecule of the base is considered to contribute two electrons from its sulphur atom to the co-ordination complex and, thus, in the compound $[Cu, 4\,etu]NO_3$ the cuprous ion acquires eight additional electrons, thereby becoming equivalent to the rubidium ion. Similarly, silver and cadmium complexes are electronically equivalent to cæsium and barium ions respectively. Such analogies are supported by the fact that these complex nitrates give rise to neutral solutions and by the electrical conductivities of these solutions.

AN ELECTRICAL INDICATOR FOR HIGH-SPEED ENGINES.—J. Obata and Y. Yosida describe in the *Reports of the Aeronautical Research Institute of the Imperial University of Tokyo* (No. 28, December 1927) an electrical indicator for high-speed engines which gives excellent results. The principal difference between this instrument and the usual mechanical or optical one lies in the use of a steel disc 2 mm. thick and 5 mm. in diameter. Compared with ordinary discs, its thickness is very great. The minute motions of this disc caused by the pressure in the cylinder are recorded by an exceedingly sensitive electrical method called the 'ultra-micrometer' method, which utilises a generating valve circuit. Using two small engines, several records of actual engine pressure were obtained by an Einthoven string galvanometer, a Lutz-Edelmann string electrometer and a Duddell oscillograph. The results show that this electrical indicator gives correct diagrams for high-speed engines for which ordinary indicators cannot be used. The calibration of the indicator was made statically, a standard pressure gauge of the Bourdon type and compressed air being used.

Scientific and Industrial Research.

PROMOTION and co-ordination of scientific research by the State on any widespread scale is still novelty enough to invest the recently published Report of the Committee of the Privy Council for Scientific and Industrial Research for 1926–27, accompanied by the Report of the Advisory Council for the same period, with a special degree of interest. To the reports are attached a summary of work conducted by the various research organisations functioning under the auspices of the Department, and appendices containing tabulated information of a statistical and bibliographical nature, together with references to the development of organised research in other parts of the Empire.

In addition to the work of the research associations, the activities of the National Physical Laboratory, the Geological Survey, the Fuel Research Station, the Building Research Station, and the Forest Products Laboratory are described, and much information is given concerning the progress of work on food storage and transport, water pollution, and chemotherapy. It is satisfactory that important investigations at the Low Temperature Research Station, which have been delayed for lack of funds, can now be proceeded with in view of the receipt of a substantial grant from the Empire Marketing Board. There is, however, still urgent need for a coastal station devoted to the study of the preservation of fish and the utilisation of fish by-products. The magnitude of some of the issues at stake can be adjudged by reference to work in progress demonstrating the successful conversion of coal into liquid fuels; it still remains to be seen whether the new industry will be firmly established before existing sources of petrol begin to fail. The Advisory Council makes some pertinent remarks on the conditions under which the Geological Survey and the Museum of Practical Geology are housed. It is earnestly to be hoped that the scheme for a new building, once authorised by Parliament but still suppressed on the grounds of economy, will soon be put into effect.

A glance at the summary of work in hand during the year demonstrates the great diversity of the interests involved. The study of chemical reactions at high pressures is being carried on both at the Chemical Research Laboratory, Teddington, and at the Imperial College of Science and Technology; the Aerodynamics Department has dealt with a very full programme, including tests of airship models and the elimination of wing-flutter, in the investigation of which mathematical analysis has afforded a large measure of success. Considerable progress has been made in fuel research, despite hindrance due to the stoppage in the coal industry. The keeping qualities of apples are believed to be concerned with the protoplasm content and the extent of the sugar reserves, and the possibility of a precise prediction of the duration of life of the fruit under any set of conditions by means of chemical examination at harvesting is predicted. Radio observations made during the solar eclipse are mentioned; 'wireless' enthusiasts will also be interested to note that differences in wave attenuation are attributed largely to the absorbing effect of trees, greatest attenuation being observed in the most densely wooded parts of the country, and that the large number of receiving aerials in the London area appears to have a considerable energy-absorbing effect. The number of specific problems submitted to the British Museum Laboratory tends to increase; the work specially referred to in the report includes the mounting, cleaning, and preservation of delicate materials, the identification of early porcelain, and the unrolling of brittle manuscripts on leather.

The report would have been incomplete without some reference to the work of the National Research Council of Canada, the Australian Commonwealth Council for Scientific and Industrial Research, and the New Zealand Department of Scientific and Industrial Research, to the activities of the South African Departments of Mines and Industries, Agriculture, and Forests, and to those of various Indian Departments.

Origin and Development of Portion of the Australian Flora.

IN the second part of his presidential address before the Australasian Association for the Advancement of Science at Hobart, delivered on Jan. 16, Mr. R. H. Cambage discussed the "Origin and Development of Portion of the Australian Flora." The position was summarised as follows:

There appear to be more genera common to Africa and the eastern half of Australia only, than to Africa and the western half of Australia only, so that evidence of a direct land connexion between these two countries is meagre.

It is thought that many genera which are common to Africa and Australia have reached these countries from the same source in the north, and have then developed in response to environment.

From available evidence it would seem that, at least since Cretaceous time, the northern hemisphere has had a greater land mass than the southern, and, as a result, there has been more room for plant development in the north than in the south. Probably the Pleistocene and even earlier glacial periods have been instrumental in permitting many genera to pulsate across the tropics from temperate northern regions, and in the process, and after arrival in the south, there have been much radiation, development, and evolution. Although there probably has been more migration to Australia from the north, there is evidence in some cases of secondary radiation from the south, especially in the genus Eucalyptus.

It seems undoubted that some genera common to Australia and New Zealand have reached both countries from the north, some species coming down the east coast of Australia, while others have gone by way of New Caledonia and adjoining islands to New Zealand.

Except for a land connexion between north-eastern Australia and islands to the north, perhaps so late as Pliocene time, Australia has long been isolated from the rest of the world.

There appears to be more evidence in favour of a former land connexion between Antarctica and South America, and perhaps New Zealand and Australia, than between Africa and Antarctica.

Studies of the many changes which have taken place in the history of the world's flora, of its adaptability to environment, its response to change of climate and soil, its ability to overcome many adverse conditions, all combine to impress one with the conviction that the marvellous act of creation not only embodied the initial giving of life, but also provided inherent power and initiative for the necessary development and evolution required for the persistence of that life, in harmony with its varying surroundings and dominating influences.

Past and Present Peoples of Chinese Turkestan.

At a meeting of the Royal Anthropological Institute on Tuesday, Mar. 27, Sir Arthur Keith gave an account of a people who lived in the eastern part of Chinese Turkestan in the earlier centuries of our era. His account was based on five skulls which were obtained by Sir Aurel Stein during his third expedition (1913–15) to central Asia. The explorer found these skulls in sites within the eastern and southern fringe of the Taklamakan desert—sites now dried up and forsaken, but irrigable and inhabited when the Tarim basin of Chinese Turkestan formed part of the corridor along which in past times Chinese trade flowed towards the west.

The people from these ancient cemeteries show a mixture of characters, some of which are Mongoloid, others of which are Caucasoid (or Iranian), but on the whole the Mongoloid traits are the more evident. Amongst the Lopliks and other peoples still inhabiting the eastern and south-eastern fringes of the Tarim basin are found individuals which come very near to the Loulan type found in the ancient cemeteries. From data collected by Sir Aurel Stein and collated by Mr. T. A. Joyce, it is apparent now that the peoples at the eastern end of the Tarim basin—the floor of which is formed by the Taklamakan desert—are transitional in type. When traced towards the north and towards the east they rapidly become Mongolian; when traced along the south side of the Tarim basin towards the west the Iranian type prevails more and more and becomes pure when the Pamirs and the valley of the Oxus are reached. The Loulan people who lived in the eastern part of the Tarim basin more than 1500 years ago were of a transitional type. Sir Aurel Stein's discoveries show that the racial frontier between Mongolian and Caucasoid types in this part of the world has not greatly altered its position since the Christian era began. The Loulan people were probably true Huns.

Intermarriage and migration do take place across racial frontiers, and most anthropologists explain a mixed type, such as the Loulan, as a result of intercrossing. In Sir Arthur Keith's opinion such an explanation leaves the most important facts of the problem unexplained. We have, in the first place, to explain the origin of the primary types—the Mongoloid and Caucasoid. We have to explain the greatest racial divide in the world, one many thousand miles in length, which crosses the Old World and separates peoples of a Mongoloid type in the east and north from others of a Caucasoid type in the west and south. This divide is traceable from the north-west corner of Europe to beyond the mouth of the Ganges in Asia. The great divide crosses the Taklamakan from west to east; the Loulan people lived on it. We cannot explain the origin and distribution of peoples of Mongoloid stock and the existence of the great racial divide unless we presume that evolution is true and that the stocks which we find on one side of the divide and on the other have come into their present states of body and brain in the areas where we now find them. If, as we presume, Mongoloid and Caucasoid stocks have in the course of time become differentiated from a common type, then between the extreme forms there ought to be, or to have been, transitional types occupying intermediate zones. If evolution is true we ought to find intermediate types on frontier zones, and that is what we do find. In Sir Arthur Keith's opinion the Loulan people should be interpreted, not as products of hybridity, but as of a natural evolutionary process.

In unravelling the Mongoloid from peoples of Caucasoid affinities, head form is not decisive. Mongoloid peoples are of all degrees of long-headedness and of all degrees of round-headedness. So are Caucasoid peoples. The Loulan people, who had heads of medium size, were intermediate between long and round. As a rule the Mongoloid peoples of central Asia had the larger heads and brains; the Iranian peoples of the Pamirs were small headed and not big-brained. The main points which serve for the discrimination of Mongoloid peoples are hair, skin colour, and facial form. A considerable part of Sir Arthur Keith's paper was devoted to Mongolian characters of face and the methods which should be applied for their analysis and measurement. In conclusion, he thanked the Government of India for the benefits which have been conferred on science through the expeditions led by Sir Aurel Stein who, in Sir Arthur's opinion, has done more than anyone to clear up the racial constitution of the peoples of central Asia.

Water Movements in the Straits of Gibraltar.

Prof. Raphael de Buen publishes an account of the oceanographical investigations which have been carried out by Spain in the Atlantic and Straits of Gibraltar, in the *Journal du Conseil International pour l'exploration de la mer*, vol. 2, No. 3, December 1927.

Periodic fluctuations in the depth at which particular temperatures occur have been noted by the *Dana* Expedition in 1921 and by the various Spanish expeditions in this area. They were attributed to tidal phenomena (Nature, **109**, 45; 1922), but Prof. de Buen goes a step further. Since the periodicity does not correspond with that of the Atlantic tide, he considers that they owe their origin to deep-seated Mediterranean tidal waves.

The author does not consider that a sub-surface current of Mediterranean water wells out into the Atlantic over the ridge between Gibraltar and the African continent, such as has been shown to take place by Danish and Norwegian oceanographers (*loc. cit.*).

Prof. de Buen writes: "It may be seen in all the series of observations made during the campaign of the *Almirante Lobo*, as also in my maps (published in the *Rapport Atlantique*, 1926), which are based on the observations made during the campaigns of the *Dana* and the *Thor*, that at no time do the Mediterranean waters penetrate to the Atlantic. This must not, however, be accepted as an established fact until further investigations have been carried out, having as their object to discover whether at any time, at the moment when the bottom waters approach most nearly to the surface, some quantity of Mediterranean water does not find its way into the Atlantic. The Mediterranean influence in the Atlantic was found in all the observations to be nil. It is therefore necessary to seek some other explanation of the existence of warm dense water to the south-west of Ireland, in which some experts have considered that they could see a markedly Mediterranean character."

Somewhat inconsistently, "the layer of Mediterranean water which penetrates into the Ocean through the Straits of Gibraltar" is cited a few pages later as a possible explanation of the migration of sardines in the neighbourhood of Cadiz.

University and Educational Intelligence.

London.—Dr. W. W. Jameson has been appointed as from Jan. 1 to the University chair of public health tenable at the London School of Hygiene and Tropical Medicine. Dr. Jameson received his medical education at the University of Aberdeen, the Rotunda Hospital, Dublin, and University College, London. From 1914 until 1919 he was assistant and lecturer in the Department of Hygiene at University College, London, and since then he has been Medical Officer of Health of different London boroughs. In 1926 he was appointed lecturer on public health and preventive medicine at Guy's Hospital Medical School. He is the author of "A Synopsis of Hygiene" (Churchill), of which a second edition has been published, and of papers on public health matters.

Dr. E. E. Turner has been appointed as from Sept. 1 to the University readership in chemistry tenable at Bedford College. Dr. Turner was educated at Coopers' Company's School, London, at East London College (1910–14), and Sidney Sussex College, Cambridge (1916–19); he obtained the degree of D.Sc. (Lond.) in 1920. After holding posts at the Goldsmiths' College, London, and at the Technical College, Huddersfield, he worked during 1919–21 as lecturer in organic chemistry, University of Sydney. For the period 1921–23 he was chemist in the Research Department at the Royal Arsenal, Woolwich, and since 1923 has been senior lecturer in chemistry at East London College. He has published numerous papers independently and conjointly in *Proc. Roy. Soc.* and in the chemical journals.

The title of reader in physical chemistry in the University has been conferred on Dr. Samuel Sugden, in respect of the post held by him at Birkbeck College. Dr. Sugden studied at the Royal College of Science from 1912 until 1914. Later he became a research chemist in connexion with explosives in the Research Department of the Royal Arsenal, Woolwich. In 1924 he obtained the degree of D.Sc. (Lond.). He has been lecturer in chemistry at Birkbeck College since 1919. His published work includes papers on the determination of surface tension and its variation with temperature and some related functions, on the parachor and chemical constitution, and on molecular volumes at absolute zero, published in the *Journal of the Chemical Society*, and a translation of Stock's "Ultrastrukturchemie," under the title "The Structure of Atoms" (Methuen).

St. Andrews.—A scholarship of £100, tenable for three or four years at the United College, St. Andrews, by a student who is resident in the University Residence Hall, has just been established by the gift of Dr. David Russell of Markinch. The new Russell Scholarship is available to candidates who have spent at least two years in a secondary school under the Fifeshire Education Authority, or whose parents or guardians are resident in Fifeshire, and preference will be given to a candidate from Markinch district.

The Ramsay Memorial Fellowships Trustees will consider at the end of June applications for fellowships, one or more of which will be limited to candidates educated in Glasgow. The value of each fellowship is £250 annually, plus a grant for expenses. The fellowships are held normally for two years, but may be extended for a third year. Applications must be received by June 5 by the Secretary, Ramsay Memorial Fellowships Trust, University College, Gower Street, W.C.1.

The Ministry of Agriculture and Fisheries is prepared to receive, up to May 15 next, applications for grants in aid of scientific investigations bearing on agriculture, to be carried on in connexion with a university, university college, or other approved institution or society in England and Wales during the academic year beginning Oct. 1, 1928. Particulars of the conditions on which these grants are offered are set out in form A.53/T.G., obtainable from the Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1.

An appeal for a capital sum of £50,000 for the extension of the Ramsay Laboratory of Chemical Engineering at University College, London, and for its equipment, was made recently by the Chemical Engineering Building and Equipment Fund Committee, of which Sir Alfred Mond is chairman. The response up to the present time has produced £23,555. Among the subscribers are: Imperial Chemical Industries, £10,000; The Shell Group, £5000; The Gas Light and Coke Company, £5000; Dunlop Rubber Company, £1000; Messrs. Reckitt and Sons, Ltd., £1000. In addition to the capital fund for the building and equipment, an income of £6000 a year is required for the maintenance of the Laboratory. Towards this £3191 has already been promised for the first five years and £2600 for the second five years. The Committee is anxious to complete both funds as speedily as possible in order that the new building may be proceeded with. Donations and subscriptions may be sent to Sir David Milne-Watson, at University College, London (Gower Street, W.C.1), who will be glad to supply any further particulars.

The Royal Technical College, Glasgow, records in its report on the work of the session 1926–27 an increase from 4149 to 4169 in its total enrolment. This followed four sessions of decreasing numbers, reflecting the depressed condition of the engineering and shipbuilding, mining and metallurgical industries with which the College is closely connected. Of the 934 day students, 245 pursued degree or diploma courses, and 136 other day students attended twenty or more hours a week. University degrees, including one D.Sc. and three Ph.D., were obtained by 36 students. Experimental and research work carried out for local industrial firms, much of it having reference to problems arising out of the use of very high temperatures in steam engines, continued to grow. In the Department of Chemistry, a special laboratory was equipped for the use of the Scottish Coal Survey Committee, and the whole of the analytical work and most of the research in connexion with Scottish coals will henceforth be centred in the College buildings. With the aid of a grant from the Iron and Steel Institute much new apparatus was acquired. In the engineering laboratories a series of investigations on the creep of metals approached completion. The School of Navigation, now the largest of its kind in Great Britain, arranged a course of study for cadets serving on board ship. This pioneer effort in continuation class work for youths at sea attracted attention in other countries. The School of Pharmacy was recognised by the authorities concerned as providing complete facilities for candidates for the B.Pharm. degree of the University of London and the higher qualification of the Pharmaceutical Society of Great Britain.

Erratum.—The announcement of the appointment of Dr. J. C. Earl to be professor of organic chemistry in the University of Sydney in our issue of Mar. 31, p. 519, was placed incorrectly under St. Andrews. Dr. Earl is a graduate of St. Andrews, but has been lecturer in organic chemistry in the University of Sydney since 1922.

Calendar of Customs and Festivals.

April 8.

EASTER DAY: the greatest of the three great festivals of the Christian Church. It is generally agreed that it coincided with and replaced a pagan festival. Traces of such a festival are to be seen in both ecclesiastical and popular observance. The form of morning greeting, "Christ is risen," with the reply, "Christ is risen indeed," which was formerly the rule, and is still observed in the Greek Church, might be held to imply, in the light of other customs, the survival of a belief in a real and annually recurring resurrection, such as that which was the cardinal doctrine in the Eastern cults of Adonis and Attis.

A brief account of the observance of Easter among a modern peasant population serves to bring out the essential elements in the festival pointing to the survival of ideas belonging to an earlier stage of religious belief. In Macedonia the Resurrection is celebrated twice. The first occasion is at a midnight mass on Easter Eve, when the service begins in the open. When the Gospel of the day has been read and the hymn "Christ is risen" has been sung, Lent is considered to be over. Guns are fired amid shouting, the eggs and cakes which have been brought by the worshippers are eaten, and the priest lights a candle, calling upon the congregation to light their tapers from his candle. This they hasten to do. The church doors are then thrown open after a challenge and reply, and the congregation troops in to the service. The second mass takes place on Easter Day, when the worshippers repair to church, each with a lighted taper. After the service, general greetings and the reconciliation of any enmities take place before entering upon the three days' feast, in which the exchange of presents of eggs coloured red and the eating of lambs roasted whole are the principal features. The Paschal fire is kept alight during the whole of the Paschal week.

The representation of the Crucifixion by an image is a common feature in the Roman as well as the Greek Church, and in the southern parts of Europe it is a custom for this representation to be carried in procession on Good Friday. A period of general lamentation and mourning follows until Easter Day, when there is firing of guns and fireworks or a bonfire, and a feast of a lamb. Frazer notes the resemblance of this custom in particular to the mourning for the death of Adonis and the rejoicing at his resurrection. The parallelism with the death of Attis on the tree is, as he notes, also especially close.

Early churchwardens' accounts indicate that English practice, in addition to the Paschal candle, included a representation of the Crucifixion, and in one case a figure of Judas is mentioned.

LENTEN AND EASTER FIRES.—The ceremonial extinction of all lights in church on Easter Eve and rekindling them from the Paschal taper preserves the idea of purification which underlies the custom of kindling bonfires at Easter and at various other times during Lent, but especially on the First Sunday, which was widely spread among the European peasantry. The custom was purificatory and protective. The larger the fire, the wider the area over which it brought prosperity to the crops.

THE PASK EGG.—The custom of making presents of eggs, the symbol of new birth and fertility, is very widely distributed. It occurs in most European countries as well as in the East. The eggs are boiled, gaily coloured, though most frequently red, and otherwise ornamented, sometimes being covered with or made of silver. In Persia this use of the egg was associated with the feast of the vernal equinox. In Egypt it occurs among both Moslems and Copts, at the time of the Coptic Easter in both cases. The eggs are used in a game in the north of England which is also found in Egypt, in the Balkans, and elsewhere. The eggs are rolled or struck against one another, the conqueror, *i.e.* the egg which breaks another, counting up victories until vanquished in turn.

April 9.

EASTER CELEBRATIONS.—Reference has already been made to the feast of a roasted lamb which follows the Easter services. In England the great dish was a gammon with green herbs or a tansy pudding, *i.e.* a pudding of bitter herbs. There are frequent records of the distribution of doles such as the cakes impressed with the shape of two females at Biddenham in Kent, or the cake once cut up and distributed to children in Twickenham church on Easter Sunday. These may have a sacrificial character, for the cross bun or Easter cake was originally an offering or part of a sacrificial meal, as was the lamb.

EASTER MONDAY.—Of numerous observances, only the more significant can here be noted. It was the occasion for sports, or rather contests, especially with a ball. In the Early Church bishops used to sport at handball with the inferior clergy. The significance of such contests as marking the break between two seasons, such as winter and spring or summer, has already been noted. There is, however, a group of customs which, while not superficially related, when taken together appear to have a deeper significance. At Coleshill in Warwickshire young men tried to catch a hare, and if they brought it to the parson before ten o'clock, they were rewarded with a gift of a calf's head, a hundred eggs, and a groat. The hare is here a symbol of fertility. At Greenwich on Easter Monday girls used to roll down the hill. This is well known from a number of parallels as a fertility custom. In various parts of England and Wales, but especially in the north, the custom of heaving or lifting obtained. On Easter Monday the men used to lift the women, either on their arms or in a chair, and obtained a kiss or the forfeit of a shilling for their pains, while on the following day the women heaved the men. The custom of lifting or jumping is noted by Frazer as occurring among the European peasantry to promote the growth of the corn.

In Yorkshire and Durham on Easter Sunday or Monday the young men stole the buckles from the girls' shoes. On the following day the girls stole the buckles or the hats of the young men. The property was redeemable on the Wednesday by a small pecuniary forfeit to be spent on a tansy pudding. At Portaffery, in the north of Ireland, it was the custom for hundreds of young people to resort to a walk outside the town, when the men kissed the girls promiscuously without offence. Finally, in a Glamorgan custom, a burlesque meeting of men held on the Sunday and Monday was taboo to women. Any woman caught observing the proceedings was liable to lose her shoe, which was redeemed by a kiss, or, if a married woman, a small fine. Of these customs, some are obviously connected with fertility; others involving a rivalry of the sexes, the stealing of a shoe or shoe buckle, and kissing either as a right or a forfeit, suggest the sexual licence which among primitive peoples has been noted as characteristic of seasonal festivals and as a means of promoting fertility.

Societies and Academies.

LONDON.

Linnean Society, Mar. 15.—**Stanley W. Kemp**: Whaling research and the work of the *Discovery* Expedition. The principal object of the *Discovery* Expedition is the study of whales and whaling in the southern hemisphere. The history of whaling in the north shows that species have been reduced, sometimes almost to the point of extinction, by methods far less deadly than those at present employed. Experience indicates that when once a stock of whales has been seriously depleted, recovery, if it is ever effected, is a matter of centuries, and it follows that, if too many rorquals are taken in the south, there is a grave risk that a very important source of wealth will be destroyed. The actual extermination of any species of whale, however, is most improbable under present conditions, for long before this point can be reached, commercial operations would cease to be profitable. The two ships of the expedition, the *Discovery* and the *William Scoresby*, have for the most part been engaged in research on the plankton and hydrography of southern waters with the view of obtaining precise information on the environment of whales. In the south, whale-food appears to consist exclusively of a single species of Euphausia (a crustacean related to the decapods), and a special study of this species and the reasons for its great abundance in certain parts of the Antarctic has been made. Hydrographic work, to determine the physical and chemical constitution of the water, has been undertaken in conjunction with the planktonic observations (see also NATURE, Oct. 30, 1926, p. 628).—**P. J. Greenway**: The forest flora of south Central Africa. Much of the material was collected by Mr. R. Bourne, of the Imperial Forestry Institute, while on a tour of inspection on behalf of the Northern Rhodesian Government. The collection represents 131 species, comprised in 80 genera and 34 families. The three families of Leguminosæ furnish the largest number of species. Only two genera, Monotes and Marquesia, of the Dipterocarpaceæ, are met with; of the former there are several reputed specimens, which are fairly common in the dry savannah-forest. *Marquesia macroura* Gilg, the 'Musesjie,' is one of the most abundant trees in Northern Rhodesia and the Katanga, where it attains a height of 65 to 80 feet; the wood is described as very hard and of good quality, and is used for finishing houses and in carriage-building. Of especial interest is the occurrence of a species of Hirtella (Rosaceæ). This genus is chiefly American in its distribution, being represented by about 40 species in Central and South America.

EDINBURGH.

Royal Society, Mar. 5.—**H. Graham Cannon**: On the feeding mechanism of the fairy shrimp, *Chirocephalus diaphanus*. Chirocephalus feeds on minute suspended particles. Water is sucked in between the limbs mainly from in front and from above, the animal normally swimming on its back. The trunk limbs are phyllopodia armed with a series of backwardly projecting endites, of which the proximal is comparatively large. Food particles are drawn into the mid-ventral space by the suction produced by the forward stroke of the limbs. They are prevented from passing into the inter-limb spaces by the long setæ borne on the basal endites and are finally blown towards the mouth by the anteriorly directed feeding current.—**Charles Henry O'Donoghue** and **Eileen (Bulman) Abbott**: The blood vascular system of the spiny dogfish, *Squalus acanthias* Linné, and *Squalus sucklii* Gill. The objects of the paper are (1) to provide a comparative account of the blood vascular system of a generalised selachian, and (2) to revise the homologies and consequently the nomenclature of certain of the more important vessels. The fact that the branchial arches in the embryo Squalus are practically identical with those in the embryos of all the higher groups of vertebrates gives a key to the homologies of the anterior arteries. Thus, for example, the vessel termed the posterior carotid by Parker, or external carotid by other authors, is the same vessel as the stapedial of the mammalian embryo or the adult reptile.—**S. Williams**: Sporangial variation in the Osmundaceæ. There is a considerable range of variation in the sporangia of the Osmundaceæ, particularly as regards the characters of the annulus. The bearing of these variations on the systematic placing of certain fossils is discussed, and it is concluded that Kidstonia, Boweria, and possibly *Discopteris Rallii* may be assigned to some near relationship with the Osmundaceæ. The variations described also provide evidence for the view that the sporangia of the Osmundaceæ lead on to those of Plagiogyria and so on to those of the Gymnogrammoid forms.—**Claude W. Wardlaw**: Size in relation to internal morphology. (3) The vascular system of roots. The passage of water into the tracheides and wood vessels of roots is largely dependent on the close association of the living parenchyma cells with the tracheides and wood vessels. In root steles of increasing diameter, the xylem does not remain of uniformly simple structure (as in small roots) but becomes progressively disintegrated and complex. By these changes the large surface of contact with the living parenchyma cells is maintained. Thus the changes in the structure of the xylem in roots of increasing diameter are such that actual size does not act as a limiting factor to the important physiological activities of the tissues involved.—**J. Caldwell**: Localised translocation in the swede. The south-facing half of a Swede 'bulb' grown under ordinary field conditions is more largely developed than the north-facing side, and analysis shows that it contains an appreciably larger amount of total carbohydrate. Asymmetry can be induced artificially by removing the leaves from one side of the shoot during the growth of the bulb. The carbohydrate manufactured in the leaves of one side of the shoot is thus apparently stored in the corresponding region of the bulb. Confirmatory evidence of localised translocation is afforded by the behaviour of a stain such as eosin, which, when introduced at the cut end of a petiole, is distributed over the corresponding third (approximately) of the vascular cylinder in stem and bulb.

PARIS.

Academy of Sciences, Feb. 27.—**Marcel Brillouin**: The kinetic theory of a gas in the neighbourhood of a wall. Position of the mathematical problem.—**Th. Anghelutza**: Generalised symmetrical and symmetrisable nuclei.—**A. Buhl**: Permutable operators and groups of transformations.—**Octav Onicescu**: The topological properties of the transformation defined by a uniform function of the complex variable z.—**Julius Wolff**: A property of a series of rational fractions.—**Ch. Dévé**: A machine with automatic epicycloidal transformations for working optical glass surfaces.—**Svyngedauw**: The deformations of the element of the pulley belt which approaches the pulley.—**E. Baticle**: The theory of equilibrium of heavy massifs submitted to pressure from below and its applicability to the stability of barrages and slopes.—**M. Mesnager**: Remarks on the preceding note.—**P. Fatou**: The sense of the displacement of the node of certain orbits.—**R. Ferrier**: Molecular geometrical

specificity.—**E. Brylinski**: The velocity of the earth. Remarks on a recent communication of Piccard and Stahel.—**Girault**: The principle of relativity and the law of gravitation.—**Mario A. da Silva**: The affinity of oxygen for the electrons.—**R. Cornubert**: α-Dimethylcyclohexanones.—**L. Bert**: Houben's reaction. This is a method of preparing hydrocarbons based on the reaction $RMgX + R'X' = RR' + MgXX'$. The small yields frequently obtained by Houben's reaction appear to be due to the condensing action of the magnesium halides produced. This action somewhat resembles the action of aluminium chloride in the Friedel and Craft reaction. The yields are much improved by using as a diluent a saturated hydrocarbon such as cyclohexane or petroleum ether boiling between 70° and 90° C.—**Stanislas Landa**: The slow combustion of hydrocarbons. The slow combustion of paraffin wax by air at 280° to 300° C. The following substances have been identified among the volatile oxidation products: acetone, methyl alcohol, butyric aldehyde, methylethylketone, ethyl alcohol. Higher aldehydes were also present. These results are regarded as confirming the views of Bone on the slow combustion of hydrocarbons.—**J. Campardou and M. Séon**: The decomposition of the acid anhydrides. The preparation of anhydrides by direct dehydration of the acids. Some acetic anhydride is produced by the action of titanium dioxide on the vapour of acetic acid at 300° C.—**Gibault and P. Rougerie**: Magnetic measurements in the east of France. Results are given for 28 stations, 8 of which are new. The isomagnetic curves in this region show no marked magnetic anomaly, but in the north-west of the Department of the Meuse the slight deformation of the curves indicates a prolongation of the magnetic anomaly of the Ardennes.—**Ph. Joyet-Lavergne**: Contributions to the study of the chondriome of a fungus of the genus Saprolegnia. The filaments of the chondriome give reactions characteristic of glutathione. The chondriome possesses both oxidising and reducing properties.—**Raymond-Hamet**: The effects of the simultaneous stimulation of the vagus and of the sympathetic on the heart and on the intestine.—**Maugnon and E. Knithakis**: Variations of the pH of the blood and of the alkaline reserve in the course of watery diet in the dog.—**M. Abeloos**: The cycle of growth in *Planaria gonocephala*.—**C. Mathis, A. W. Sellards, and J. Laigret**: The sensibility of *Macacus rhesus* to the virus of yellow fever. Three specimens of *Macacus rhesus* were infected, one by inoculation with the blood of a yellow-fever patient, and the two others by bites of mosquitoes infected by the same patient. All three died from yellow fever.

ROME.

Royal National Academy of the Lincei, Dec. 4.—**F. Severi**: The correspondences between the points of a variable curve on an algebraic surface.—**G. Scorza**: The fundamental sub-groups of a group.—**U. Cisotti**: Helico-conical vortices. The designation spiral has been given to a type of plane vortices which result from the compounding of the motion due to a plane punctiform source with a circulatory motion around the same, the lines of flux being logarithmic spirals about the position of the source, to which they tend asymptotically. Prosecution of this notion leads to the development of a type of spatial vortices arising from the composition of the motion due to a spatial punctiform source with circulation about an axis containing the source; such are termed helico-conical vortices, since the lines of flux are conical helices, which give Archimedean spirals as their projections on any plane normal to the axis.—**L. Cambi and Ada Clerici**: The action of nitric oxide on the thiosulphates of metals of the eighth group (1). The formulæ attributed by Manchot to nickel and cobalt nitrosothiosulphates, namely, $[(S_2O_3)_2Co(NO)_2]K_3$ and $[(S_2O_3)_2Ni(NO)]K_3$, correspond as well with univalent cobalt and nickel, with NO as a neutral additive molecule, as with tervalent cobalt and bivalent nickel with NO as a residue of hyponitrous acid. The supposed univalency of the metal is based on purely formal deductions, and does not correspond with the chemical behaviour of the two compounds or with the conditions of their synthesis. The NO radicles of these thiosulphates exhibit the same behaviour as those of the nitrososulphides and are thus residues with the functions of halogens.—**P. Vinassa**: Symmetry in the electrons. Of a total of 3830 artificial organic and inorganic compounds examined, more than 3700 have even molecular numbers, so that the rule recently given for the mineral components of the earth's crust is of general application. The term *electronyl* being given to the atomic entity active by the effect of the number of electrons in excess or deficit of the nuclear charge existing in them, it may be shown that (1) the number of electronyls represented in the principal states of equilibrium is always 8 or 12, and (2) electronic numbers corresponding with groupings of five or seven electrons are always lacking.—**P. R. Pirotta**: Agrarian ecology and the International Grain Conference.—**F. Sbrana**: The approximate calculation of a harmonic function in three variables and of its successive derivatives.—**V. Hlavatý**: The reduction of orthogonal systems of linear differential equations.—**G. Vranceanu**: The trigonometrical stability of equilibrium in dynamics.—**B. Finzi**: Stationary slow motions of viscous liquid films.—**G. Krall**: Functional dependency on the outline of the Green-Somigliana tensor for elasticity equations.—**G. Andreoli**: Certain of Lie's infinite groups connected with the theory of algebra and with the absolute differential calculus.—**C. Mineo**: A formula, analogous to that of Stokes, for the determination of geoids with deviations of the vertical.—**F. Rasetti**: The intensity of the lines of the principal series of potassium. Determinations of the number of dispersion electrons for the first lines of the potassium series show that these do not obey Trumpy's law, according to which the coefficient of probability of transition from the state mP to the state S decreases in proportion to $1/m^3$, although this law holds for the higher terms of the series.—**G. Natta and M. Freri**: X-ray analysis and crystal structure of cadmium-silver alloys (2). The β'-phase of these alloys, obtained by re-heating the β-phase below 480°, is resolved into a mixture of crystals of the α- and γ-phases when re-heated below 200°. This transformation occurs only with solid solutions of silver in the compound AgCd, but not with those of cadmium in this compound or with alloys still richer in cadmium. The γ-phase of the system exhibits close structural analogy to the γ-phase of the brasses, and has a cubic elementary cell of side $a = 9 \cdot 99$ A., containing 52 atoms, the calculated density for the alloy with 64·1 atomic per cent. of cadmium being 9·59; the hypothetical chemical compound constituting this phase may be given the formula Ag_5Cd_8. The δ- and ϵ-phases, comprising alloys with 67 to beyond 90 per cent. of cadmium, give photograms of the same aspect, the lines corresponding with a compact, hexagonal structure having the axial ratio $c : a = 1 \cdot 58$. The η-phase has the same crystal structure as cadmium and consists of solid solutions of silver in the cadmium lattice.—**A. Quilico**: Sulphonation of phenolic ethers with aminosulphonic acid. The formation of ammonium p-anisolesulphonate by the action of aminosulphonic acid on anisole appears to be applicable to phenolic ethers in general.—**G. Cumin**: Certain

rocks encountered in the perforations of Ripi (Latium).—**R. Fabiani**: Remains of mammifers in the Tertiary and Quaternary of Ragusa (Sicily).—**Giambattista Dal Piaz**: Outliers of the Dent Blanche in the post-Triassic formations of Grivola.—**G. Montalenti**: Rearing of termites without the protozoa of the cæcal pouch.—**M. Fedele**: The organisation and the functional characteristics of the nervous activity of the Tunicata (3). The visceral nervous system.—**P. Pasquini**: The lentogenic capacity of the optical vesicle in the embryos of amphibia and the 'organiser' of the crystalline lens.—**R. Savelli**: A case of incomplete dominance in the achene of maize.—**V. Bambacioni**: The development of the female gametophyte and the increase of the chromosomes in the chalazal region in *Fritillaria persica* L.

Official Publications Received.

BRITISH.

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. 57, July to December 1927. Pp. viii+249-468+18+47. (London.) 15*s*. net.

Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society. Edited by H. Munro Fox. Vol. 3, No. 2, March. Pp. 93-176. (Cambridge: At the University Press.) 12*s*. 6*d*. net.

Descriptive Account and Catalogue of the Home Office Industrial Museum and Exhibits, with Explanatory Notes. Pp. vi+178+14 plates. (London: H.M. Stationery Office.) 3*s*. 6*d*. net.

Leeds Public Libraries. What to Read on Psychology. By Prof. William McDougall. Pp. 20. 2*d*. What to Read on Citizenship. By H. A. L. Fisher. Pp. 28. 2*d*. What to Read on English Economic History. By G. D. H. Cole. Pp. 40. 2*d*. What to Read on Evolution. By Prof. J. Arthur Thomson. Pp. 31. 2*d*. (Leeds.)

Seale-Hayne Agricultural College, Newton Abbot, Devon. Report of the Advisory Departments, 1927. (Pamphlet No. 27.) Pp. 81. 6*d*. Department of Plant Pathology: Fourth Annual Report for the Year ending September 30th, 1927. (Pamphlet No. 25.) Pp. 29. 6*d*. (Newton Abbot.)

Annals of the (Mededelingen van het) Transvaal Museum. Vol. 12, Part 3: The Sphegidae of South Africa, Parts ix and x, by Dr. George Arnold; Stone Age Cultures on the Zululand Highfeld and in Northern Natal, by Dr. V. Lebzelter and F. K. O. Bayer. Pp. 191-288+plates 8-17. (Cambridge: Printed at the University Press.)

Proceedings of the Edinburgh Mathematical Society. Edited by Prof. T. M. MacRobert and Prof. H. W. Turnbull. Series 2, Vol. 1, Part 2, March. Pp. 71-138. (London: G. Bell and Sons, Ltd.)

Journal of the Royal Microscopical Society. Series 3, Vol. 48, Part 1, March. Pp. xv+127. (London.) 10*s*. net.

Philosophical Transactions of the Royal Society of London. Series A, Vol. 227, A649: The Mechanical Equivalent of Heat. By Prof. T. H. Laby and E. O. Hercus. Pp. 63-92. (London: Harrison and Sons, Ltd.)

Memoirs of the Punjab Irrigation Research Laboratory. Vol. 1, No. 1: A Statistical Examination of the Sensitivity of a Water Table to Rainfall and Irrigation. By Bernard Howell Wilsdon, with R. Partha Sarathy. Pp. ii+52. (Lahore: Government Printing Office.) 1.12 rupees; 2*s*. 4*d*.

Seale-Hayne Agricultural College, Newton Abbot, Devon. Four Years' Variety Trials with Potatoes. By A. Noble. (Pamphlet No. 24.) Pp. 15. 6*d*. Grassland Management: a Report on Intensive Stocking and Nitrogenous Manuring, 1927. By T. J. Shaw. (Pamphlet No. 26.) Pp. 20. 6*d*. (Newton Abbot.)

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 6: Standard Methods of Drying Sultana Grapes in Australia. By A. V. Lyon. Pp. 16. (Melbourne: H. J. Green.)

FOREIGN.

U.S. Department of Agriculture. Farmers' Bulletin No. 1543: Insects Injurious to the Rice Crop. By J. W. Ingram. Pp. ii+17. (Washington, D.C.: Government Printing Office.) 5 cents.

Occasional Papers of the California Academy of Sciences. No. 14: The Rudistids of Southern Mexico. By Robert H. Palmer. Pp. 137 (18 plates). (San Francisco.) 1.75 dollars.

Proceedings of the United States National Museum. Vol. 72, Art. 25: Synopsis of Pentatomid Bugs of the Subfamilies Megaridinae and Canopinae. By W. L. McAtee and J. R. Malloch. (No. 2721.) Pp. 21+2 plates. (Washington, D.C.: Government Printing Office.)

Merentutkimuslaitoksen Julkaisu Havsforskningsinstitutets Skrift. No. 45: Regelmässige Beobachtungen von Temperatur und Salzgehalt des Meeres im Jahre 1925. Herausgegeben von Gunnar Granqvist. Pp. 47. 20 Fmk. No. 46: Die thalassologische Terminfahrt im Jahre 1926. Von Risto Jurwa und Erik Palmén. Pp. 20. 20 Fmk. No. 47: Die Tätigkeit des Instituts für Meeresforschung im Jahre 1926. Von Rolf Witting. Pp. 17. 20 Fmk. No. 48: Beobachtungen von Strom und Wind an den Leuchtschiffen in den Jahren 1924 und 1925. Von Erik Palmén. Pp. 23. 20 Fmk. (Helsinki.)

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 31: Some Experiments on Periodic Columnar Forms of Vortices caused by Convection. By Torahiko Terada, and Second Year Students of Physics. Pp. 47+5 plates. (Tôkyô: Kôseikai Publishing House.) 1.00 yen.

Smithsonian Institution: United States National Museum. Bulletin 141: Collection of Heating and Lighting Utensils in the United States National Museum. By Walter Hough. Pp. viii+114+99 plates. (Washington, D.C.: Government Printing Office.) 70 cents.

Crystallographic Tables for the Determination of Minerals. By Victor Goldschmidt and Samuel G. Gordon. (Special Publication No. 2.) Pp. 70. (Philadelphia: Academy of Natural Sciences.) 1.50 dollars.

New York Academy of Sciences. Scientific Survey of Porto Rico and the Virgin Islands. Vol. 11, Part 1: Insects of Porto Rico and the Virgin Islands. Diptera or Two-winged Flies. By C. H. Curran. Pp. 118. (New York City.)

Columbia University Bulletin of Information. Professional Courses in Optometry: Announcement 1928-1929. Pp. 85+3 plates. (New York.)

Veröffentlichungen aus dem Kaiser-Wilhelm-Institut für Silikatforschung in Berlin-Dahlem. Herausgegeben von Prof. Dr. Wilhelm Eitel. Erster Band. Pp. v+269. (Berlin: Gebrüder Borntraeger.) 28 gold marks.

Agricultural Experiment Station: Michigan State College of Agriculture and Applied Science. Technical Bulletin No. 87: Paper Wrappers and their Effect upon Physical and Chemical Properties of Horticultural Products. By H. D. Brown. Pp. 29. Technical Bulletin No. 91: Taxes on Michigan's Rented Farms, 1919-1925. By R. Wayne Newton. Pp. 34. Special Bulletin No. 162: Pruning the Red Raspberry. By Stanley Johnston and R. E. Loree. Pp. 28. Special Bulletin No. 167: Chicory Growing in Michigan. By C. E. Cormany. Pp. 11. Special Bulletin No. 168: The Management of Michigan Muck Soils for the Production of Onions. By Paul M. Harmer. Pp. 48. Special Bulletin No. 174: Spraying Calendar. By W. C. Dutton, R. H. Pettit and C. W. Bennett. Pp. 81. (East Lansing, Mich.)

CATALOGUE.

Medizinische Fachkataloge: Biologie, Physiologie, Pathologie. Pp. 144. (Berlin: Julius Springer.)

Diary of Societies.

TUESDAY, APRIL 10.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—G. J. Wells: The Report of the Heat Engine and Boiler Trials Committee.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—C. H. Oakden: The Invention of the Micropolariscope.—Prof. W. T. Gordon: Rocks of Organic Origin.

THURSDAY, APRIL 12.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Dr. Hele-Shaw and T. E. Beacham: The Variable Pitch Airscrew.

INSTITUTE OF METALS (London Local Section) (Annual General Meeting) (at 83 Pall Mall, S.W.1), at 7.30.—R. B. Pilcher: Alchemists in Art and Literature.

OIL AND COLOUR CHEMISTS' ASSOCIATION.

FRIDAY, APRIL 13.

ROYAL SOCIETY OF MEDICINE (War Section), at 4.—Annual General Meeting.

ROYAL SOCIETY OF MEDICINE (War and Otology Sections), at 4.30.—Special Discussion on Effects of Middle-ear Disease on Efficiency in Civil and Military Life.—Speakers:—For Section of War: Wing-Comm. D. Ranken, Major Hare, and Surg.-Comm. Maxwell. For Section of Otology: S. Scott, Dr. T. J. Faulder, and T. R. Rodger.

ROYAL ASTRONOMICAL SOCIETY, at 5.—J. J. M. Reesinck: Note on the Theory of the Outer Layers of a Pulsating Star.—Prof. E. A. Milne: The Effect of Collisions on Monochromatic Radiative Equilibrium.—R. Invrea: Occultations of Stars by the Moon, observed at the Royal Observatory, Pino Torinese, 1926-1927.—B. M. Peek: Occultations observed at Herne in 1927.

ROYAL SANITARY INSTITUTE (at Sessions House, Maidstone), at 5.—Dr. A. Greenwood and others: Discussion on The Health of Hop Pickers and the Sanitation of Hop Pickers' Encampments.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—A. Page: Address.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (Annual General Meeting) (at Engineers' Club, Manchester), at 7.—Dr. R. H. Pickard: Fundamental Researches in the Leather Industry.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7.30.—Annual General Meeting.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. P. Morris: Calculating Apparatus and Diagrams for Engineers.

PHILOLOGICAL SOCIETY (at University College), at 8.—N. W. Thomas: African Words in New English Dictionary.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (jointly with Chemical Engineering Group) (at Engineers' Club, Birmingham).—Dr. C. M. Walter: Paper.

CONFERENCE.

APRIL 13-16.

GEOGRAPHICAL ASSOCIATION (at Oxford).

April 14.—Sir Halford Mackinder: The British Empire in Relation to the Geography of the World (Lecture).

April 16.—Col. C. H. D. Ryder: Surveys from Air Photographs (Lecture).—Dr. L. Dudley Stamp and others: Discussion on Practical Steps in Regional Survey Work and Local Studies.

SATURDAY, APRIL 14, 1928.

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Cotton Research and Industry.

IN a recent issue (Mar. 10, p. 362) we directed attention to the scientific work being carried on in the cotton fields by the Empire Cotton Growing Corporation, and the possibility of this work being checked, if not discontinued, because of the difficult position in which the Lancashire industry finds itself. The publication of the reports of the experiment stations founded by the Corporation for the year 1926–27, comes therefore at an opportune moment; as they throw a considerable light on the character of the research instituted —probably in the long run the most important of its many activities. A sound scientific basis appears to have been laid for the success of its effort to increase the quantity and improve the quality of the cotton being produced within the British Empire. These reports are collected in a handy volume of about 250 pages, interspersed with tables, diagrams, plates and maps, and placed before the public at the low figure of half a crown.

The founding of an experiment station concerned with any particular crop is by no means so simple a matter as it might appear, and usually follows years of local study. Even when the need for it has been demonstrated and the problem to be solved has been clearly defined, a thorough survey of the country has to be made in order to determine the most suitable site, special attention being paid to such economic factors as communications, transport facilities, supplies, as well as climate and soil. It is often found advisable to take up a small area of land for a couple of years to make sure that no adverse factors have escaped notice. This preliminary survey work of the Corporation, made at a time when no staff was available for the running of the stations, deserves a passing reference. Experienced officers were deputed to travel over practically all of the cotton-growing tracts in the Colonies; and in this work the Corporation was specially fortunate in securing the co-operation of a number of senior members of the Indian agricultural service, who were permitted to retire on proportional pensions under the Reforms Scheme. A series of valuable reports has been sent in and published, and some idea was thus formed as to where research was most likely to be profitable.

As to the staffing of the stations, a wide net was spread over the scientific and agricultural schools in Great Britain, and selected students were encouraged by scholarships to undergo post-graduate training to fit them for cotton research.

The response was on the whole good, and many of these students are already at work. The stations reported on this year are naturally in all stages of development, varying from a few acres tentatively acquired, to large ones with full equipment and buildings, and the reports are in consequence of very different interest and value. It is evident, however, that the Corporation has within a remarkably short period succeeded, in spite of great difficulties in obtaining suitably trained officers, in building up an agricultural department of an entirely novel character, namely, one devoted to the study of one crop scattered over the whole range of British Colonies in the warmer tracts. There are in the present volume reports from Queensland, the Transvaal, Natal, Swaziland, Southern Rhodesia, the Anglo-Egyptian Sudan, Uganda, Nyasaland, Nigeria, and Fiji, prepared by plant breeders, entomologists, and agriculturists in charge of separate areas.

It must be remembered that the research work recorded in the pages of the reports is only a portion of that being conducted by the officers of the Corporation. The Cotton Research Station in Trinidad is not included; and it is somewhat difficult to draw the line between the Corporation's work and that of the existing agricultural departments of the various Colonies, because there seems to have been a gradual drafting of men sent out by the former into the expanding Colonial service, whenever it has been found possible to allocate funds for the purpose. The unity of aims and the perfectly amicable relations existing between the officers under these two controlling bodies is a marked characteristic of the work of the Corporation.

Before proceeding, however, to more detailed reference to the character of the scientific work embodied in these reports, it is natural to inquire why the local agricultural departments cannot deal with the work undertaken by the Corporation; and also why this particular crop—cotton—needs financial assistance from Great Britain, as against such staples as rubber, tea, and sugar, for which research is provided for locally. The answer to the first question is fairly simple. The agricultural department in any colony has charge of the whole of the crops grown within its limits; and it can rarely afford to depute an officer entirely to the study of one crop, however important.

The second question is not capable of quite so simple an answer, because it depends on the distribution of capital. The capital connected with the cotton industry is located in Lancashire, while that in tea, sugar, and rubber lies chiefly in the places where these crops are grown. The cause for this is to be found in the character of the raw material yielded by the plant in either case. The cotton plant produces, naturally, in the fields, a raw material in its finished state; and all that is required is for this to be collected, kept dry and clean, and sold to the local buyer for pressing and forwarding to the mills at home. But in tea and sugar, and at present in rubber, the produce of the plant is in such a condition that it has to undergo complicated treatment before it can be sent across the ocean. Taking sugar as an example, the canes are full of sweet juice which has to be expressed, and which is then liable to rapid deterioration in the air; and the more stable sugar has to be extracted from it on the spot as expeditiously as possible. Furthermore, the canes grown on an acre of land will vary in weight from, say, 20 to 50 tons or more, and the transport of this mass of material to the crushing mill is an important item of expenditure. For both of these reasons the sugar factory must be placed as near to the cane fields as possible; and the capital for the erection of an efficient, up-to-date sugar factory will run to some £200,000. A similar location of factory on the plantation is also necessary for tea and rubber; and in all three cases a large tract of land must be acquired and put permanently under one crop—which, in effect, adds considerably to the capital to be sunk on the spot. Moreover, whether the selling price be high or low, cultivation must proceed and the factory be kept going: in sugar, at any rate, closing down the factory in lean years would spell ruin.

The growing of cotton is under entirely different conditions. There is no local capital involved, and anyone who owns a bit of land can either grow it or not at will; when prices are high the area increases, and when low other crops are grown instead. Rotation of crops, practically impossible in the other staples mentioned, is a prime necessity, and is everywhere practised in native cultivation; therefore a change of crop is easily effected. To attempt to collect a levy on the growers for the prosecution of research would immediately curtail the area sown, and thus defeat the object in view. It is obvious then that, with cotton, the capital required to finance research must come from the mills; and the Cotton Corporation, as representing them, takes the part of the fairy godmother to the cotton growers. It acts on the principle that improving the quality is the surest way to increase the quantity, in that

it enhances the price received by the cultivator; and thus the two aims of the Corporation are inseparably connected. The most encouraging features in the project are that the class of cotton raised in British Colonies is, as a rule, distinctly better than that grown in the United States, which it is designed to replace; and also that land and labour cost less, and therefore it can be more cheaply produced.

One glance through the reports will convince anyone that each tract has its own set of problems, and in most cases may have its own limiting factors; and the idea of one central experiment station devoted to cotton growing can at once be abandoned. In the Union of South Africa the annual rainfall is the basal factor, and has been found to be distinctly unreliable; and, in addition, a minute insect attacks the leaves to such an extent that it is essential to breed types resistant to this pest. In Nigeria the limiting factor seems rather to be competition with other crops, coupled with transport difficulties, and a cotton fetching a high price is needed. Nyasaland is chiefly concerned at present with working out the most suitable rotations for three sets of conditions: European plantations, and native cultivation for high and low areas. Fiji is devoted to the finer counts, and can grow Sea Island cotton, but, owing to the practical disappearance of the market for this during recent years, is concentrating on obtaining a long-stapled type which is more marketable. Queensland, however well she may grow cotton, will sooner or later have to face competition between that raised by white labour and native grown from elsewhere. The Anglo-Egyptian Sudan, with its varying conditions of moisture—obtained solely by irrigation, by rainfall, and by the two together—practically covers the whole field of cotton breeding and cultivation. Speaking generally, these tracts appear to be able to grow perfectly good cotton, but all require the services of (1) plant-breeders to evolve the most suitable type of cotton to be grown, (2) entomologists to preserve it from the local insect pests, and (3) agriculturists to grow healthy crops at the least possible cost.

Probably the most promising direction for a permanent increase in cotton growing in the British Empire is at the moment in India, but that country has its own problems and its own well-developed scheme of cotton research. There are vast possibilities in the Sudan, and great hopes are entertained in the Union of South Africa.

It will be sufficient here briefly to refer to the work being carried out in these two places. The outstanding factor in South African research is the Jassid infestation, which has practically wiped out the standard varieties hitherto relied upon. It has been observed that hairiness in the leaves is a distinct hindrance to the development of this insect; and the plant-breeder at Barberton has succeeded in evolving hairy forms strongly resistant to the Jassid, and at the same time with the good qualities of those forms it is necessary to replace. This result is being hailed with satisfaction by the planters everywhere, and the strains obtained will apparently also be required in Southern Rhodesia. This piece of research is particularly creditable, in that it has been conducted under most disheartening conditions; a record drought has visited South Africa during the last three years, again and again spoiling the experimental plots.

The report from the Sudan covers more than forty pages; but considering the large tract of country dealt with and its greatly varying conditions, this is not at all excessive. Special attention is now being paid to the southern, more tropical section, where a good deal of native cultivation has been inspected during the year. Although there is plenty of work still to be done in the northern, irrigated areas, it is perhaps to this southern rain-fed tract that we may look for the greatest permanent increase in cotton growing. A good deal of exploratory work is thus included in the report, and this portion is extremely interesting. Observations are recorded on the gradually changing vegetative covering of the country, with the increasing rainfall on going south; and studies are mentioned of root range and the character of the different layers of soil in various place—always a matter of interest in the Sudan—as indicating likely areas for expansion. Variety plots have been laid down and a certain amount of selection has been begun among the native-grown crops.

It is obvious that a great deal of important scientific work is being done on the Corporation's experiment stations, all tending towards the ideal of making the Lancashire mills less dependent on the vagaries of the United States cotton supply; and it would be little short of a disaster if the work were checked at the present stage.

When a new disease broke out in the Java canefields and swept through the island from end to end, the planters, although smarting from a loss of £200,000 in one year, came together and agreed to tax themselves in support of a scientific department to fight the disease. The amount of

the levy was at first small, but it paid so well that it has been gradually increased, until the annual amount spent on scientific work is at present £100,000. Again, when the trade slump in 1921 threatened the Hawaiian sugar industry, the attitude of the heavily hit planters was expressed by the director of the experiment station in the following motto: "More investigation, more experimentation, more research, leading to higher yields per acre and lower costs per ton of sugar"; and there was no suggestion of the planters cavilling at this increase in their levy.

One result of the action in these two instances appears to-day in the fact that Java and Hawaii are producing more than five tons of sugar per acre, against round about two tons in all the other chief cane-growing countries [1]—a matter of some significance now that the sugar industry is in low water. The tea and rubber planters have within the last few years started their own research stations; at any rate one sugar concern, the Colonial Sugar Refining Company, runs its own agricultural, entomological, and mycological research; and a perception of the losses incurred by disease has in one case caused this company to multiply its mycological staff, so that every field on every estate can be thoroughly surveyed, and appropriate cultivation and scientific remedies applied. It is to be hoped that such will be the feeling inspiring the action of the Lancashire cotton trade, in the present deplorable condition of the larger section of this industry.

Botanical Records in the Rocks.

Handbuch der Paläobotanik. Von Prof. Dr. Max Hirmer. Mit Beiträgen von Dr. Julius Pia und Dr. Wilhelm Troll. Band 1: *Thallophyta, Bryophyta, Pteridophyta.* Pp. xvi + 708. (München und Berlin: R. Oldenbourg, 1927.) 48 gold marks.

IN a 'handbook' of palæobotany, botanists, geologists, and others interested in the story of plant-life in the past expect to find a summary of the labours of students who have made it their business to collect and interpret the botanical records of the rocks. Prof. Hirmer's volume in the main satisfies this requirement. Among the many questions which experts are expected to answer we may include the following: What light is thrown upon the evolution of plants by the samples of vegetation preserved in sedimentary strata? Does a comparison of the successive floras which have flourished on the earth's surface afford evidence of a continuous progressive development from simple to more complex types? Or is there reason to believe that a comparison of extinct and recent plants demonstrates a marked tendency towards recurrent cycles—a rapid rise to power and the successful colonisation of wide spaces on the part of certain groups, followed by their decline and by the apparently sudden appearance of new dynasties destined for a time to play the leading rôle in the world's vegetation?

In the second volume the author will no doubt deal with some or all of these general questions. The volume before us is mainly descriptive and carries us to the end of the Pteridophyta. Dr. Julius Pia contributes an introductory section on the preservation of plants as fossils, and to him have also been entrusted the Algæ and Fungi. No text-book of palæobotany is considered to be complete without a chapter on the various methods of fossilisation: there is, however, one aspect of the subject which is generally overlooked or inadequately treated. The present is in many respects the key to the past: geologists are accustomed to speak of the imperfection of the record, and it needs but little imagination to realise that the emphasis placed by Darwin on this imperfection was not exaggerated. On the other hand, we should be in a better position to form a just estimate of the proportion borne by fossils to the mass of contemporary vegetation if we had a fuller knowledge of what is now happening in different areas inhabited by trees or by herbaceous plants. We should like to know more about the conditions under which rivers are now accumulating in the sediments of deltas representative samples of the vegetation on their banks and on the higher ground watered by the parent streams; the relation of woody to herbaceous plants; the capacities of different kinds of vegetable debris to resist wear and tear; and so on. One suspects that many of the older floras are represented in the rocks almost exclusively by plants that were confined to certain habitats. By a closer study of the processes of rock-building at the present day, it might be possible to estimate with greater precision the chances of preservation of material derived from different geographical regions. Hints on the preparation of unpromising specimens for microscopical examination would have been a useful addition to the chapter on fossilisation.

The account of calcareous Algæ is on the whole very satisfactory; it directs attention to the wealth of form of such Algæ as the Dasycladaceæ in Mesozoic and Tertiary seas as compared with

[1] Maxwell, "Economic Aspects of Cane-Sugar Production," p. 57.

the relatively small number in the seas of to-day. The treatment of fossil Bacteria, of the problematical genera Pila and Reinschia, and of some of the other supposed Thallophyta, might with advantage have been more critical. Dr. Pia unfortunately reverts to the old name Prototaxites for the Silurian and Devonian plant which is usually known as Nematophyton, and he assigns it to the Brown Algæ. The systematic position of this genus is still very uncertain, but it is almost certainly not in the Phæophyceæ. At the end of each section is appended a bibliography, which is usually adequate. Dr. Troll gives a useful survey of the Bryophyta and directs attention to the important discovery by Mr. J. Walton of specimens of very modern-looking Liverworts in the English Coal Measures.

The greater part of the volume is written by Prof. Hirmer, who compresses much into his well-illustrated descriptions of the Palæozoic representatives of the several groups of Pteridophyta. Most of the figures are taken from previously published books and papers: diagrammatic drawings illustrating morphological features are a welcome addition, and restorations of Lepidodendra, Sigillariæ, and Calamites are in many respects an advance upon previous attempts. Students will be grateful to the author for having collected much information from widely scattered sources and for making it available to the botanical reader. In his summaries of the morphological characters at the end of the descriptive accounts, he makes many suggestive comparisons of extinct and living types, but he tends to over-emphasise points of detail, and does not sufficiently consider readers who desire to know in what respects such plants as Lepidodendron, Calamites, and other Palæozoic forest trees differed from their modern descendants.

In the account of Psilophytales, Rhynia and Psilophyton are placed in different families, a separation which it would be difficult to justify. The lack of secondary phloem in stems of Lepidodendron well provided with secondary wood is an interesting fact worthy of greater prominence. No evidence is furnished in support of the statement that Asterocalamites was widely distributed in Upper Devonian floras. The account of Mesozoic ferns compares unfavourably with that of the Palæozoic genera; it fails to bring out the contrasts in geographical range between extinct and recent species, and it does not sufficiently illustrate the relative antiquity of the several families. There is no reference to an important paper by Prof. Halle on the schizæaceous fern Ruffordia, and Dr. Bommer's description of Weichselia, a fern assigned on insufficient data to the Cyatheaceæ, is overlooked.

Such criticisms as have been made are not intended to be an expression of disapproval of the volume as a whole: on the contrary, the reviewer heartily welcomes the publication of a work which in some respects differs from all earlier books on palæobotany. The author undertook a very laborious and difficult piece of work; the first volume is by no means free from errors and its descriptive summaries are very unequal in value. We look forward with interest to the appearance of the second volume. A. C. S.

Lucretius.

T. Lucreti Cari de Rerum Natura libri sex. With Notes and a Translation by H. A. J. Munro. Fourth edition, finally revised. Vol. 2: Explanatory Notes. With an Introductory Essay on the Scientific Significance of Lucretius, by Dr. E. N. da C. Andrade. Pp. xxii+424. (London: G. Bell and Sons, Ltd.; Cambridge: Deighton Bell and Co., 1928.) 12*s*. 6*d*. net.

MUNRO was the chief scholar in Cambridge fifty years ago, and his study of Lucretius gave him a prestige such as pure scholarship confers no longer upon any man. He was a perfect editor in his own scholarly way; yet he brought little sympathy and less knowledge to bear on the scientific doctrines taught in the great scientific poem which he edited. He admits that Lucretius has produced "a very complete and systematical account of the natures and properties which belong to the two great constituents of the universe, matter and void"; but Munro says bluntly that "We of course care not for the scientific value or truth of the poem, but for its poetical grandeur and efficacy upon our imaginations."

Indeed it is full of fine things which charm our ears and stir our imagination. Phrases like 'mors immortalis' or 'flammantia moenia mundi' cling to the memory; the whole parable of the Talents is wrapped up close in 'vitaque mancipio nulli, datur omnibus usu'; and after two thousand years 'tantum religio potuit suadere malorum' has not lost its sting. But after all, scientific doctrine and not literary beauty is the main thing in this, the one great scientific poem of the world: so scientific men have prized this great epic for 'its scientific value or truth' ever since it was written. Celsus and his brother physicians (the scientific men of Rome) were all Epicureans, and doubtless

knew the poem by heart; Giordano Bruno and Gassendi preached its doctrines and impressed them on seventeenth century philosophy just when physical science was awaking to its first golden age; Boyle quotes the poem repeatedly; and later on Tyndall, Clifford, Kelvin and Clerk Maxwell himself, in their several ways and degrees, admired and praised it. Newton found in it (among other important things) a clear statement of the Galilean principle of the falling body: "Et quamvis res leviores, quæ æris vel aquæ resistentiam difficilius vincunt, in his fluidis descendant tardius, tamen in spatio vacuo ubi nulla est resistentia atomos omnes tam graviores quam minus graves propter gravitatem sibi proportionalem æquali celeritate descendere, *sic docet Lucretius*."

Lucretius attributes the phenomena of the world to necessity, or as we should say, to physical law: 'nam certe neque consilio,' for verily not by design, was the world made. He holds just as Bacon did, that teleological explanation should be left severely alone by the natural philosopher; he understands as well as did Lagrange, that (to borrow a phrase from Larmor) the great desideratum of a science is its reduction to the smallest number of dominating principles; and the greatest of all these dominating principles he found in the atomic theory. Within our own lifetimes the atom was but an hypothesis, first a useful, then an indispensable hypothesis—one of the most potent of scientific *Denkmittel*, or modes of economising thought. Then Maxwell, Clifford and Kelvin began to show that atoms *must* exist, and nowadays we know at last that they *do*. They are no longer hypothetical, but as real as any other objective things; and we wonder more than ever before at the marvellous insight and prescience of the ancient founders of the atomic theory.

Less than a twelvemonth ago I paid my last visit to Arrhenius. As we walked past the Museum hard by his house, and looked up at the great names inscribed upon its walls, Arrhenius said, "Surely Democritus was the greatest of them all." It was the mantle of Democritus which Epicurus wore, and it was at Epicurus's feet that Lucretius sat to learn the story of the atoms; but who it was that had told it to Democritus we do not know. Democritus was a rich man's son in a provincial town, about the time when Xerxes drew his broken fleet and army home from Salamis; he has left nothing of his very own, save a few hearsay fragments and broken sentences out of his many books. Yet at this day a great physicist looks on him with something like awe, and speaks of him with reverent admiration; for he was the father, so far as all our pedigrees can go, of the most fundamental postulate of all physical science.

The shadows which surround the person of Democritus are but part and parcel of the mystery which hides the origin of the Greeks and the sources of their wisdom. Pythagoras, Thales, Heraclitus, and others besides Democritus are shadowy and all but legendary figures; we trace our science and learning back to them almost as the Japanese trace their empire to the sun and moon. But even Greek wisdom did not come straight from heaven; there were brave men before Agamemnon and wise men before Democritus. The world had rung with the clash of armies and the fall of ruined empires before the day of Greece began; time and again an old order passed away, giving place to new; but doubtless when almost everything was lost, a few seeds of ancient learning, Hittite, Chaldean, Cretan, Egyptian and what not, fell upon good Greek soil and multiplied an hundredfold. Our ignorance of what did happen, and how and when, is the deepest puzzle and the greatest romance of history.

While Democritus's own words are all but vanished, and very few of Epicurus's remain, Lucretius's poem gives us the completest, plainest account we have of any ancient system of philosophy; we read it without effort, and reading it we feel at home. Though we translate Plato and Aristotle into our own tongue, the language they speak is not yet our own; nor do they think and reason in our modern, western way. But any of us may read Lucretius, and under all his splendid diction find nothing hard to follow, nothing anomalous or strange. The present re-issue of Munro's "Lucretius" is vastly the better of a short preface (of some twenty pages) on the scientific significance of Lucretius, by Prof. E. N. da C. Andrade; who not only gives us a singularly clear epitome of the Epicurean philosophy, but also manages to illustrate it by modern instances in a wonderfully happy way. For example, Prof. Andrade not only reminds us of Le Sage's corpuscular, or atomic, theory of gravitation, but also tells us that Le Sage entitled his treatise "Lucrèce Neutonien"; that in short, he got it from Lucretius, and acknowledged the debt. Prof. Andrade shows us how Sir Isaac Newton and Sir William Bragg went straight to Lucretius for the phrase "the Nature of things,"—as before them no less a person than Paracelsus had also done. Again, he shows how Lucretius supposed the atoms of a solid (unlike the smooth round atoms of a liquid) to be

hooked and so to cling together; and how these hooked atoms were used in the seventeenth century, even by John Bernoulli himself, and how they have served their turn again with modern chemists to explain chemical combination and valency. Only yesterday (I mean fifty years ago) Crum Brown used to describe to us beginners the carbon atom, with its four little hooks or 'hands,'—as Kekulé's flash of insight had conceived it a few years before, in that Annus Mirabilis when the "Origin of Species" appeared. As for the smooth round atoms to which Lucretius attributed the fluidity of a fluid, they come pretty near to Dr. Harold Jeffreys' brand-new concept of the structure of a liquid, as formed of 'units' (each an aggregate of molecules), 'perhaps roughly spherical,' and mobile on one another.

Each generation may study Lucretius in the light of its own knowledge. Gassendi compared his teaching with that of Copernicus and Kepler and Gilbert; we think of him in the light of J. J. Thomson's work, and Rutherford's and Bragg's. Prof. Andrade even shows how Dr. G. C. Simpson's newest theory of thunderstorms, with the raindrops borne up on rising air-currents, has its counterpart in the 'seeds of fire' which, according to Lucretius, are carried up into the 'hollow clouds.' I am inclined to think that the sixth book, in which this and other meteorological passages occur, is mostly derived from another source; and, interesting as it is, is less profound than the more strictly Epicurean portions of the poem.

The whole epic is but a short one, of some seven or eight thousand lines; but there is scarcely a passage in it which has not some close and peculiar interest for ourselves. The hereditary germ-plasm of Weismann, and Darwin's 'pangenesis,' are no other than the Lucretian doctrine of 'primordia,' which, variously combined, lurk hid within the parent's body and are handed on from father to son—'quae patribus patres tradunt a stirpe profecta.' The conservation of matter is proclaimed more than once, and with the utmost clearness: 'res . . . non posse creari | de nilo neque item genitas ad nil revocari'; or again, 'nam neque adaugescit quicquam neque deperit inde.' The conservation of energy is almost as clearly laid down. The very atom itself is declared not to be in ultimate analysis; but itself to consist of certain *minima*, which never did and never will subsist of themselves, for of their very nature they are primary and minimal constituents of the other—'alterius quoniam est ipsum pars primaque et ima.'

On one strange point of the Lucretian doctrine (the kernel of the whole thing, according to some) Prof. Andrade says very little; though what he does say is very much to the point. This is that *exiguum clinamen*, by which the atoms swerve ever so little, and only now and then, from their straight determined path: and so are brought into collision, which collisions are the starting-point of a new order of things. Thus a certain freedom of action is possessed even by the atom, and is the first faint adumbration of our own soul's free-will —'unde haec est nobis innata potestas.' Here Lucretius tries, as did Epicurus, to get behind the more unqualified and more relentless materialism of Democritus. It reminds us of that 'something more' which many a physiologist is constrained to postulate when physical science fails him to explain the humblest of his vital phenomena. It reminds us in a more apt and more important way (without our pressing the analogy too far) of Newton's famous scholium: "a cæca necessitate, quæ eadem est semper et ubique, nulla oritur rerum variatio."

D'ARCY W. THOMPSON.

Early Man and Civilisation.

(1) *Ancient Civilisations: from the Earliest Times to the Birth of Christ.* By Donald A. Mackenzie. Pp. xix + 283 + 12 plates. 12*s.* 6*d.* net. (2) *Footprints of Early Man.* By Donald A. Mackenzie. Pp. xviii + 190 + 16 plates. 5*s.* net. (London and Glasgow: Blackie and Son, Ltd., 1927.)

WITHIN recent years the evidence relating to the extinct members of the human family and the cultural achievements of the pioneers among our own species has increased at such a rapid rate that the intelligent public, and not a few of the professional archæologists themselves, are apt to be bewildered in the face of all this new information. Few of those actually engaged in the work of recovering this new evidence have the time or the wider knowledge successfully to undertake the task of interpretation and exposition. A legion of writers has rushed in to supply this widely felt need; but, unfortunately, most of them have not exercised their own judgment, but have simply followed one or other of the professional authorities. Hence, Mr. Donald Mackenzie, a writer of great literary ability, who has read widely and critically, and with independent judgment has interpreted what he has learned in the light of his knowledge of the folk-lore of the Scottish Highlands, has come to occupy the unique position of an independent and lucid expositor of the progress in this difficult department of anthropology.

In the larger of his two new books he discusses in a fresh and interesting way the origin of civilisation and the history of its development in Egypt, Crete, Sumer, and Mesopotamia, with brief but illuminating sketches of the origins in Persia, India, and China, and many apt illustrations, culled from other places, of the factors involved in the process of invention of arts and customs.

The smaller book is concerned mainly with the remains of extinct types of man—a subject with which Mr. Mackenzie is not so familiar—but it also presents a clear sketch of the field covered by the larger work.

Both books include accounts of the most recent discoveries, and reveal a nicely balanced perspective in the view they present of the whole field of inquiry. What lends a particular charm to Mr. Mackenzie's work is the series of scraps of apt corroborative evidence which he collects from unexpected places and weaves into his lucid and entertaining narrative. For example, he has been able to discover several important references, ancient and modern, to that too much neglected region, the Wadi Alaqi in Nubia, which in all probability was the first place in the world's history where metals were worked. The ancient mines of gold and copper ore are said in one of Mr. Mackenzie's quotations to cover an area of one hundred square miles.

These books are so excellent and useful that they are sure to run into new editions. Hence it seems to be worth while to direct attention to some of the statements that need modification. Rhodesian man did not have "a more highly developed brain" than Neanderthal man ("Footprints," p. 51); nor is it accurate to say that Piltdown man had a head such as is described on p. 14, or is "nearer to the modern man species than was the Neanderthal" (p. 168); it was Dr. Lawrence Balls, and not Mr. Lucas (p. 177), who identified the botanical material from mummies; the late Prof. Montelius was a Swede, and not a Frenchman (p. xviii), and Mr. Charles R. Knight did not visit the Rancho-la-Brea pits or see the material collected there (p. 24). In the larger book the statement that "the maximum date for the dawn of the Palæolithic Age is 125,000 B.C." calls for correction; and in both works a source of confusion would be avoided if the word "neolithic" were omitted altogether.

In spite of these lapses, the books are perhaps the best introductions to their respective subjects at present available.

Our Bookshelf.

A Handbook of the Birds of Eastern China (Chihli, Shantung, Kiangsu, Anhwei, Kiangsi, Chekiang, Fohkien and Kwangtung Provinces). By J. D. D. La Touche. Part 4 (containing Families Ploceidæ, Fringillidæ, Bombycillidæ, and Hirundinidæ). Pp. 293-398 + plates 10-13. (London: Taylor and Francis, 1927.) 7*s.* 6*d.* net.

The present part of Mr. La Touche's "Birds of Eastern China" contains the Families Ploceidæ, Fringillidæ, Bombycillidæ, and Hirundinidæ, the sequence adopted by the author being the same as that in the new edition of "The Avifauna of India." The present part nearly concludes the true passerine birds, and we understand that Part V. will include the remaining Passeres and, we hope, the Pico-Passeres, containing the Woodpeckers, Barbets, and other forms very richly represented in China.

Of the true finches, the author includes twenty-six species and sub-species, whilst of buntings there are no fewer than thirty. We must note that in the centre of the genus Emberiza, the author has evidently, by mistake, interpolated the two genera, Passerina and Calcarius. It is true that many systematists lump all three genera under Emberiza; even those who do, however, usually place these two genera either at the end or at the beginning of the group. In dealing with the Fringillidæ, we are struck by the remarkable knowledge displayed by the author of the habits and nidification of so many of its members, a fact that adds very greatly to the interest of the work. We notice that Mr. La Touche still includes the sparrows with the finches, and we are inclined to agree with him that, so far as our present knowledge goes, it is impossible to divide them, although, as Sushkin has pointed out, the sparrows have many characters which seem to ally them to the Ploceidæ or Weaver-birds.

The present part is fully up to the standard set by the author in the first three parts, and we anticipate with pleasure an early issue of the fifth part. The photographs at the end of the book are not only beautiful in themselves but also undoubtedly are a great help in assisting one to understand the country on which the book is written. The map included is merely the previous map issued, in which certain corrections have been made.

Synthetische und isolierte Riechstoffe und ihre Herstellung. Von Dr. Rudolf Knoll. (Monographien über chemisch-technische Fabrikationsmethoden, herausgegeben von L. Max Wohlgemuth, Band 10.) Zweite, vollständig neu bearbeitete und erweiterte Auflage, von Alfred Wagner. Pp. viii + 257. (Halle a. Saale: Wilhelm Knapp, 1928.) 14·50 gold marks.

In the new edition of this book the author has maintained the general plan of the original, but the process of revision has necessarily entailed a considerable expansion of certain sections. The descriptions of apparatus and plant used in iso-

lating and synthesising perfumes and their components form a particularly useful feature of the work; the general treatment is here supplemented by particular references to the manufacture of important specific substances, such as phenylethyl alcohol, cinnamic acid, salicylaldehyde, piperonal, and synthetic musk. The descriptions of quantitative determinations and of individual substances, although brief, are on the whole adequate for the purpose in view. This section of the book, however, cannot be exonerated from sins both of omission and commission: for example, the account of synthetic menthol is restricted to a mention of the reduction of menthone and pulegone with an excess of nascent hydrogen; and it is incorrectly stated (p. 82) that *d*-menthone, like *l*-menthone, yields a mixture of *l*-menthol and *d*-*iso*menthol when treated in this way. It need scarcely be pointed out, moreover, that *l*-menthone is not converted to *d*-menthone when treated with sulphuric acid, "nach der Inversionsmethode von Beckmann" (p. 164).

The references to natural sources could be augmented with advantage, and some of the existing references need correction: thus, it is surprising to find in this revised work a repetition of the statement, long since proved to be without foundation, that *l*-menthone occurs in the essential oils of *Eucalyptus hæmastoma*, *E. dives*, and *E. radiata*. A useful feature of the book is a list of thirty-two continental perfumery firms, together with a summary of the products in which they specialise.

J. R.

(1) *The Industrial Arts: their History, Development, and Practice as Educational Factors.* By Frederick J. Glass. Pp. xxiii + 311. (London: University of London Press, Ltd., 1927.) 12*s*. net.
(2) *Stencil Craft.* By Frederick J. Glass. (The Artistic Practical Handicraft Series.) Pp. vii + 64. (London: University of London Press, Ltd., 1927.) 1*s*. 6*d*.

IT is easy to recognise in any book by Mr. Glass the work of one whose knowledge is only equalled by his power of expressing his thoughts, not merely with the force of the artist, but also with the literary finish of a master. It is true that he makes a lapse respecting a so-called 'quotation' from Kipling, and in "The Industrial Arts" he wrongfully describes as "plate tracery" the lancet windows of Fig. 16. In this book, as in others, he develops the lines upon which teachers should advance in the instruction of their pupils in craftsmanship. It is barely exaggerative to remark that he surveys the crafts "from China to Peru"; what does he *not* touch upon, indeed? Incidentally, it scarcely seems accurate to describe Boccaccio as of "the same age" as Savonarola and Macchiavelli; he died long before either of these two saw the light. A few notes upon stencilling merely supplement the special handbook (2) on this subject, which Mr. Glass has just produced in a series of manuals recently noticed in NATURE. His books perhaps err on the side of recommending too comprehensive a study in the schools; his enthusiasm carries him away—but then it is such a generous enthusiasm.

P. L. M.

Physics in Medical Radiology. By Prof. Sidney Russ, Dr. L. H. Clark, and B. D. H. Watters. Pp. xii + 234. (London: Chapman and Hall, Ltd., 1928.) 12*s*. 6*d*. net.

THIS book has been written primarily for the use of candidates preparing for the examinations of various universities for a diploma in medical radiology and electrology. The information it provides is given in an exact and lucid manner, and the book is not only well adapted to meet the needs of the students it caters for, but should also appeal to other practising medical radiologists.

Some minor points call for comment. The data on p. 45 refer to the absorption of ultra-violet light by *dead* tissue. Some recent evidence has been obtained showing that the penetration through *living* tissue may be much greater. The half-life period of radium is given as 1680 years on p. 88, and 1760 years on p. 93, and certain of the constants quoted for other radioactive substances are not quite up-to-date.

We expected to find some reference in Chap. viii. to Duane's method of determining the 'effective' wave-length of a heterogeneous beam of X-rays, and also in a later chapter to the theory and use of an auto-transformer.

Two valuable appendices give the revised recommendations of the British X-ray and Radium Protection Committee, and a description of a hospital radium service. A misprint in the latter on p. 218 gives 'my' instead of 'our.'

The book can be recommended with confidence.

Apollonius: or The Present and Future of Psychical Research. By E. N. Bennett. (To-day and To-morrow Series.) Pp. 95. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., n.d.) 2*s*. 6*d*. net.

THIS review of the achievements and hopes of psychical research appears to be written without bias and with an undiminished confidence in the future. It wisely concentrates on the psychological aspects of this kind of research, and does not claim any authenticity for the physical phenomena which have so largely figured in its records. "In view," we read, "of the more immediate results of real value which may be secured from a study of the subjective phenomena of psychical research it is obvious that, unless a physical medium is willing sooner or later to submit himself frankly and honestly to every reasonable test proposed by the best scientific minds, it is comparatively useless for a researcher to spend his limited time in inconclusive sittings for the alleged marvels of telekinesis or materialisation."

Whatever may be the eventual value of the investigations of thought transference and automatic writing, there is no doubt that psychical research has rendered a service in throwing light upon many dark corners of the past.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Specificity of Ergosterol as Parent Substance of Vitamin D.

AN interesting relationship between chemical structure and potential biological activity has become apparent during the course of the work which started from the observation that ordinary cholesterol is rendered antirachitic by ultra-violet irradiation. As is now well known, it is not cholesterol itself, but an impurity contained in it in minute amounts which enables it to be activated, and this impurity is most likely identical with ergosterol, the characteristic sterol of fungi (ergot, yeast, etc.). A consideration of the molecular structure of sterols in this connexion leads to the suggestion that not only the presence of the unsaturated carbon linkings, but also their number, is a deciding factor in the photo-chemical production of vitamin D from ergosterol. Thus the saturated sterols, coprosterol, di-hydrocholesterol and di-hydrositosterol remain inactive after irradiation. Further, neither cholesterol nor sitosterol with one double bond, nor stigmasterol, cholesterylene, oxycholesterylene, and di-hydroergosterol, with two such linkings, can be activated. Ergosterol with three double bonds, however, possesses this property to such a high degree that its calcifying action can be demonstrated even in daily doses of 1/100,000 mgm. in rats, whilst daily doses of 2·4 mgm. cure rickets in children.

It became, therefore, of considerable interest to investigate whether the photo-chemical change connected with vitamin formation was specific for ergosterol, depending on the position of the three double bonds in the molecule, or whether other substances with three or more double bonds would also yield the vitamin on radiation. We had already previously established that squalene, the open-chain di-hydro-triterpene with six double linkings occurring in the livers of elasmobranchs, cannot be activated, and the same holds for the oxygenated olefinic terpenes, nerolidol and pseudo-ionone. The tentative conclusion seems justified that unsaturated open-chain compounds cannot be activated.

A relatively mild chemical treatment, that is, removal of hydrochloric acid from its hydrochloride, leads from ergosterol to iso-ergosterol. Although this isomer contains three double bonds, differing in their position only from those contained in ergosterol, it cannot be activated. This also holds for a second isomer, neo-ergosterol, obtainable from ergo-pinacol by distillation. From all this evidence, which results from the work of several observers, including especially Windaus and his collaborators and ourselves, it would appear that not only a typical ring-structure, but also a specific position in the molecule of the three unsaturated bonds, is essential for photo-chemical conversion into vitamin D.

This generalisation, however, would seem to be invalidated by the statement of Windaus and Holtz (*Nachr. d. Ges. Wissensch.*, Göttingen, 1927) that digitaligenin, the aglycone of the digitalis glucoside, digitalinum verum, can be rendered antirachitic by irradiation. Since digitaligenin is a hydroxy-lactone containing three double bonds and is structurally related to cholic acid, another sterol derivative, its activation would not seem improbable. The statement has already been accepted in the literature and has led to the deduction of the existence of more than one vitamin D in Nature.

A detailed consideration of Windaus and Holtz's experimental technique, however, leaves their conclusions open to doubt, since a solution of digitaligenin in olive oil was used for irradiation. The obvious criticism arises that the choice of olive oil as a solvent for this type of experiment is an unfortunate one. It is well known that olive oil itself becomes antirachitic when irradiated, a property common to vegetable oils in general. We re-examined this question by irradiating for the biological tests an alcoholic solution of digitaligenin under the same conditions as an alcoholic ergosterol solution. The irradiated substances, freed from alcohol and dissolved in inactive olive oil, were tested by our usual technique on rats of the same litter. The irradiated digitaligenin was given in doses of 1/10,000, 1/5000, 1/250, and 1/100 mgm. and was found entirely inactive, whilst the control rats, receiving 1/10,000 mgm. irradiated ergosterol, were free from rickets. In view of the correlation existing between the ultra-violet absorption spectrum and the potential activity of ergosterol, it was of interest to examine digitaligenin in this respect. We found, as was to be expected, that this unsaturated substance showed a strong absorption in the ultra-violet, differing entirely in character and position, however, from that of ergosterol. Instead of three absorption bands, of which the one at $280\mu\mu$ characterises ergosterol, digitaligenin shows only one band with a maximum at $340\mu\mu$, extending from $270\mu\mu$ to $390\mu\mu$. In addition, there is general absorption, and possibly secondary bands, in the region below $250\mu\mu$. Moreover, the broad absorption band of digitaligenin remains practically unchanged after two hours irradiation, whereas the ergosterol bands rapidly disappear under these conditions.

The fact that digitaligenin cannot be activated strengthens the assumption that only a molecular structure, such as that possessed by ergosterol, enables a sterol to be photo-chemically converted into vitamin D, and confirms the evidence already available for the view that ergosterol is the specific parent substance of vitamin D.

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Lead Tetraethyl in Internal Combustion Engines.

WHILE looking through the article by Dr. E. Mardles in NATURE of Mar. 17, my attention was arrested by Table V. This table, the origin of which is not stated, appeared in a Report of the U.S. Bureau of Mines, dated December 1924 (Serial No. 2661).

Dr. Mardles gives this table as a typical analysis of the deposits, but it should be emphasised, as I have endeavoured to do in another journal, that there is no such thing as a typical analysis of these deposits, because the deposits vary in quantity and kind according to the conditions of engine operation. With one engine, for example, it is possible to obtain 9 per cent. or 17 per cent. or 36 per cent. of the lead supplied in the petrol, in the deposits on the cylinder heads and pistons. The percentage can be fairly accurately controlled by varying the conditions of operation.

Just above Table IV. in Dr. Mardles' article, the statement is made that "The results of prolonged engine trials with fuel containing not more than 6 c.c./gal. confirm the claims made that ethyl petrol will not injure spark plugs, valves, or stems." As against this statement may be quoted the following from a very noteworthy paper on "Dopes and Detonation," by Prof. H. L. Callendar, Capt. R. O. King,

and Flight-Lieut. C. J. Sims (*Engineering*, April 9, 1926, p. 475): "The patentees recommend, however, that the mixed dope called 'Ethyl fluid' should not be used in a greater proportion than 5 c.c. per gallon, each 5 c.c. containing 3 c.c. of lead ethide, which, according to the A.M.L. tests, would permit an increase of compression ratio of about 10 per cent. The importance of this limitation has recently been confirmed by an endurance test of 100 hours on a Napier Lion engine of 450 h.p. at the Royal Aircraft Establishment. . . . Shell Aviation spirit was used for the first 50 hours with 5 c.c. per gallon of the normal ethyl fluid. For the second 50 hours B.P. Aviation spirit was employed with 5 c.c. per gallon of ethyl fluid, containing a larger proportion—namely, 2·5 c.c. of ethylene dibromide—the content of lead ethide being 3 c.c. in both cases. . . . After 50 hours, the spark-plugs showed heavy deposits of lead salts and high leakage of gas through the mica. After 100 hours these defects were intensified. All plugs showed signs of having been severely over-heated, and the deposits of salts formed an easy flash-over path. Three cases of punctured mica were noted, which would render the plugs useless in an engine."

These results have been confirmed in varying degrees in motor-car engines, but all engines do not show anything like the same susceptibility, and there is no doubt that the conditions of operation play an important part.

I am not free at present to discuss this subject here as fully as I might otherwise wish, but I feel justified in commenting on one further point in Dr. Mardles' article. Under the heading "Compression and Efficiency," it is stated that "considerable progress can be made with the use of higher compression ratios involving an annual saving in the aggregate of many million pounds sterling." This statement is amenable to simple arithmetical examination. Assuming a compression ratio of 5 to 1 for straight petrol and 5·5 to 1 for ethyl petrol—an increase of 10 per cent.—we find by interpolation from Table I. on page 424, that the indicated thermal efficiency would increase from 32·8 per cent. for straight petrol to 34·5 per cent. for ethyl petrol, an increase (theoretically) of 5·2 per cent. This increase is obtained at the expense of the added anti-detonants, and if these cost more than 5·2 per cent. of the fuel, there is 'in the aggregate' a loss. As a matter of fact, the present cost of doped fuel is 1*d*. per gallon more than the equivalent straight petrol, an increase of 1 in 14·5 in the London area, or 6·9 per cent. It is clear, therefore, that with existing prices, a motorist who raised his compression ratio by 10 per cent. in order to utilise the properties of the new fuel, would incur a loss in fuel costs alone of 1·7 per cent.

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THE observations made by Mr. Rowell that deposits in an engine after running on ethyl petrol are subject to considerable variation in quantity and kind are certainly true. This is indicated by the two analyses given in Tables IV. and V., the first made in Great Britain and the second in the United States. Naturally, the lead content would vary with engine conditions and would appear less, for example, with a high degree of carbonisation. There is also no significance between the amount of lead used and found respectively. Thus, the amount of final lead deposits from cars that have actually run 40,000 miles on ethyl petrol would bear only a small proportion to the 12 lb. of lead consumed, whilst with a car run for an hour on ethyl petrol the proportion would doubtless be higher.

The conclusion given in the article, that the results of prolonged engine trials confirm the claims made that ethyl petrol would not injure engine parts, was based in part on the extensive experience of motor-car manufacturers in the U.S.A. and of the U.S. Naval Air Service, which uses ethyl petrol almost exclusively for fuel.

The quotation made by Mr. Rowell from a paper by Prof. Callendar, Capt. R. O. King, and Flight-Lieut. Sims relates to early experiments on the behaviour of ethyl petrol in an aero engine, but subsequent research with lead tetraethyl in air-cooled aero engines can be summarised in the statement that after one hundred hours' run no ill effects on the engine were shown (*Jour. Roy. Aero. Soc.*, **30**, 731; 1926).

In spite of Mr. Rowell's calculations that the use of ethyl petrol is uneconomical, I still maintain that with the use of higher compression ratios there would be an annual saving in the aggregate of many million pounds sterling. This statement is independent of the increase in compression ratio obtainable with any particular petrol or engine, and it must be remembered that lead tetraethyl is but the first successful 'anti-knocker'; future research may yield others which it is hoped will enable the motor engineer, by removing restrictions due to fuel failings, to operate at a compression ratio in the neighbourhood of 7 : 1.

E. MARDLES.

The Non-Appearance of the Recombination Luminescence in the Reaction between Alkali and Halogen Atoms.

FROM the possibility of a direct dissociation of salt molecules of NaCl type in the non-charged normal atoms by the light action (Franck, Kuhn u. Rollefson, *Zs. f. Phys.*, **43**, 155; 1927) follows another possibility—*a direct recombination* of the alkali and of the halogen atoms in a salt molecule, followed by a continuous light emission. All attempts to find this recombination spectrum have been without result. The chemiluminescence spectra emitted in the reaction between alkali atoms and the halogens have nothing to do with the continuous bands known as the absorption bands of the salts in question.

These negative experimental results make it necessary to look for another mechanism of the building of the heteropolar molecules of this type instead of that of the inversion of dissociation. Some investigations on the chemiluminescence permit us to outline such a mechanism. From Polanyi's and his collaborators' investigations we can assume with considerable certainty that the reaction $Na + Cl_2$ in the gas phase follows the scheme:

$$\begin{aligned} Na + Cl_2 &= NaCl + Cl \\ Cl + Na &= NaCl' \\ NaCl' + Na &= NaCl' + Na' \\ Na' &= Na + h\nu. \end{aligned}$$

In this scheme the exciter of the chemiluminescence (in this reaction an intense line spectrum of sodium is observed) is a molecule NaCl', which has an excess of energy. The great intensity of the chemiluminescence suggests that the exciter (NaCl') must exist a sufficiently *long time* as an energy-rich molecule to meet a sodium atom. Such a long living molecule could be a *dipole* $\overset{+}{Na}\overset{-}{Cl}$, which is formed by the recombination of the sodium and chlorine atoms, and *gradually* loses its excessive energy of vibration by the emission of infra-red radiation quanta (Kondratjew, *Zs. f. Phys.*, **45**, 67; 1927).

We shall now see in what way such a recombination can occur. Plotting the potential energy E of the system atom-atom and then that of the system $\overset{+}{\text{ion}}$-$\overset{-}{\text{ion}}$ as a function of the distance r between two nuclei, we obtain two curves, which in the case of all heteropolar diatomic salt molecules *give an intersection* at a smaller or greater distance r_c. Such curves are represented in Fig. 1 (here J is the $\overset{+}{\text{ion}}$-$\overset{-}{\text{ion}}$ curve, A the atom-atom curve). At the intersection (r_c) the energies of the system (Me) (X) and of the system $(\overset{+}{Me})$ $(\overset{-}{X})$ are *equal*. At this point the valency electron of the metal can be 'adiabatically' transferred to the halogen atom, *i.e.* a transformation (Me) $(X) \rightarrow (\overset{+}{Me})$ $(\overset{-}{X})$ can occur. This mechanism of the building up of NaCl was proposed by the author

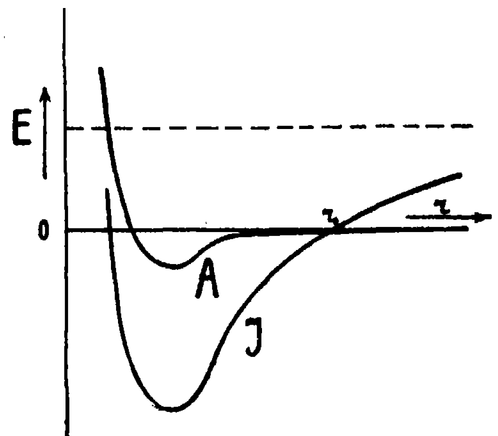

FIG. 1.

in the discussion on chemical kinetics in the first Physico-Chemical Conference in Leningrad in February 1927 (published in *Communications on the Scientific and Technical Works in the Republic*, vol. 23, Leningrad, 1927). The possibility of the transition (A) $(B) \rightarrow (\overset{+}{A})$ $(\overset{-}{B})$ is also suggested by F. London (London, *Zs. f. Phys.*, **46**, 455; 1928).

The molecule $\overset{+}{Me}\,\overset{-}{X}$ ($Me\,X$), formed in this way from the neutral atoms, can therefore exist for a comparatively long time in a high vibrational state. The energy of vibration of such a molecule can be increased by the absorption of the temperature radiation, to a quantity $Q + J - E$ (Q is the heat of reaction $Me + X = MeX$, J the ionising potential of the cation and E the electron affinity of the anion). It is quite possible that this circumstance explains the appearance in the chemiluminescence spectrum of lines the excitation energy of which considerably exceeds the reaction heat (Q).

As to the transitions $(A) \rightarrow (J)$ at the distances $r < r_c$ we can here expect *a priori* a spontaneous transition followed by emission of light. The wave-lengths of this radiation should be determined by the probabilities of the corresponding transitions. The absence of visible radiation in the reactions in question evidently suggests that the probability of the transition $(A) \rightarrow (J)$ at r_c and in the neighbouring points is very considerable.

Then we can expect the radiation in the case of recombination of one normal and one excited atom, the curves (Me') (X) or (Me) (X') and $(\overset{+}{Me})$ $(\overset{-}{X})$ of which do not intersect. It is very interesting, that in the chemiluminescence spectrum of the reaction $K + I_2$, a large continuous band is observed, but it is not observed in the case of the reaction $Na + I_2$ (Ljalikoff u. Terenin, *Zs. f. Phys.*, **40**, 107; 1926). At the same time the curves (K) (I) and ($\overset{+}{K}$) ($\overset{-}{I}$) do not intersect ($J_K - E < A_I$, $A_I = 2^2p_2 - 2^2p_1$ is the excitation energy of the metastable level of the iodine atom) and the curves (Na) (I′) and ($\overset{+}{Na}$) ($\overset{-}{I}$) do intersect.

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Science Teaching in Schools.

I SHOULD like, if I may, to make a few observations, as briefly as possible, on the recent correspondence in NATURE on this subject.

If any discussion is to materialise, two things may safely be taken for granted, namely, that there is likely to be much diversity of opinion, and that the bulk of that opinion will be in favour of modification rather than revolution. 'The inevitability of gradualness' applies here; and it may reasonably be urged (*a*) that the present system is not altogether devoid of good qualities, and (*b*) that the scientific attitude, which is far more important than mere book knowledge, may be acquired in any branch of science, whether physics, chemistry, or biology. I think we may assume that at present the abolition of the 'subject' system is impracticable, even if it were desirable. There are some who fear, not without justification, that too extended a course of elementary science tends to degenerate into what the Rev. Dr. Folliott stigmatised some years ago as "everything for everybody, science for all, schools for all, rhetoric for all, law for all, physic for all, words for all, and sense for none."

Again, it would be unfortunate if by any means, democratic or despotic, too exact a syllabus were to be imposed upon schools. We all have our own ideas, and teach best those things in which we are most interested. My plea is for greater liberty in this respect, and for more time in which to deal with essential mental and manipulative processes; and these can only be gained if the university examiners agree to modify their demands. They could easily do this, if they chose, and could thereby succeed in distinguishing between boys of real ability and those who had merely crammed far more efficiently than at present.

I have reason to believe that the suggestion was made last year that some of the university examiners should meet the Science Masters' Association in London, and that the examiners themselves were willing, and even anxious, to do so. It would be interesting to know on what grounds so desirable a step was frustrated.

A. K. GOARD.

Marlborough College, Wilts, Mar. 25.

FROM the recent correspondence which has appeared in NATURE on the teaching of science in schools, the most striking impression I have obtained is that on a problem which one would expect to be perfectly straightforward, opinions differ enormously. In other words, it is evident that those people who are now engaged in teaching science do not themselves know, as a body, what their aims and objects are, and what are the best methods necessary to attain them. Controversy is always stimulating, but when it arises from such a wide range of opinion it tends to hamper progressive movement, and has a bad effect on those people who in perfect good faith listen to each expert in turn.

As one who has taught many branches of elementary science for some years, it seems to me that the relations

of school and university play at present a dominating rôle in the science taught at schools, and the influence is not all to the good. The main object of schools seems to be to produce scholarships, and the main objects of universities to produce research workers. Such objects have a cramping effect on the whole organisation of science teaching. In the first place, very many boys from public and secondary schools never go near a university; and secondly, only a relatively small proportion of students who do go there become first-class research workers. The really good research worker survives under almost repressive conditions, and is often hampered by the people whose job it is to teach him. When research is so badly paid it seems a pity that it should be held up as an ideal to any students but the very best, especially since progress in the applications of science only partly keep step with the rate at which discoveries are made, as the modern system of agriculture in England shows very clearly.

The great mass of boys and students do not possess the research mind, and no amount of training in method will give it to them. In their scientific education they slowly, and often painfully, acquire some technical knowledge, most of which is of no further value when the examination is over. Pushing them hard merely dulls their wits and gives them a bad taste for science. They lack the imagination required for research, and the technical ability to handle apparatus with real success. They do, however, make up the bulk of those people who control our complex industrial system, because they possess general ability and character for leadership.

My personal complaint is that, while science has now illuminated the western world for some hundred years, no bold attempt has yet been made to reorganise and direct our social system in keeping with it. It has been given no cultural value, although it has had a profound and disturbing effect on all previous types of culture and æsthetic ideals. As a new force it yet lacks 'official' recognition except in Central and Eastern Europe, where it is beginning to affect art, literature, and possibly music. The coming of science and industry has completely changed the world. It has given us social, economic, and international, problems which cry aloud for scientific solutions; but unless the mass of the people is trained in the atmosphere of science, it will persist in attempting to solve these problems on traditional medieval lines. In this respect there is an enormous field for our educational institutions, which still waste time teaching the difference between density and specific gravity, and the number of stamens in a flower, in jargon which has been invented to make the task difficult. At present science as taught, with exceptions of course, is in the 'date' stage of history or the 'capes and peaks' stage of geography. It will only gain respect as an educational medium when it has set up cultural ideals which are attractive to all types of thinkers. Of course, evolution in the right direction is inevitably taking place in spite of efforts to prevent it, but we could accelerate the change considerably if we really pulled together.

R. Weatherall.

Eton College, Windsor, Mar. 28.

Beats by High-Frequency Interruption of Light.

For some time past we have been engaged in developing a compact laboratory method of measuring the velocity of light by utilising the Kerr electro-optic effect in nitrobenzene for obtaining very rapid intermittence in a light beam. The restoration of light by nitrobenzene (put between crossed Nicols) under electric stimulus is comparatively large and is almost instantaneous—the lag being of the order of 10^{-10} sec.

The Kerr cell employed was of the type developed by Karolus (for the Telefunken-Karolus system of picture transmission), and was kindly supplied to us by the Telefunken Company.

As in all such experiments for velocity determination the light has to be passed twice through the interrupting mechanism, it was thought desirable, as a preliminary step, to see if sufficient light would come out through two cells in succession. After overcoming considerable experimental difficulties, and by using sunlight as source, we were able to get sufficiently intense interrupted light passing out of the second cell. To test if the interruptions were taking place properly, the sunlight was focused on the first Karolus cell placed between crossed Nicols and excited by a valve-maintained oscillator of frequency about 10^6 cycles per second. The restored intermittent light was received on a second cell excited by another oscillator, differing in frequency from the first by a few hundred cycles. The emergent light, after passing through another Nicol, was received in a fall-plate camera, and the slow light beats resulting from the interference of the high-frequency interruptions in the two cells were photographed. Fig. 1 is a reproduction of such a photograph magnified three diameters.

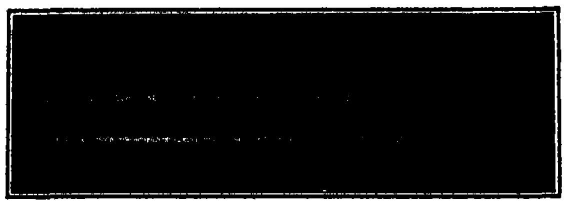

Fig. 1.

The frequency of the light beat was apparently double the frequency of the heterodyne beat note as heard in a telephone. We attempted to detect the light beats visually by bringing down the beat frequency to two or three per second. In this we were unsuccessful, obviously due to the forced synchronisation of the two oscillations (as noticed by Appleton, *Proc. Camb. Phil. Soc.*, vol. 21; 1922) taking place long before the difference in the frequencies becomes sufficiently small to make visual observation possible.

This beat method can be adapted to study the high-frequency interruption of light by resonating quartz, which Prof. Kerr Grant tried to photograph at a frequency of 144 kilo-cycles per second, but was unsuccessful (Nature, Oct. 22, 1927). It is only necessary to replace the first or the second Karolus cell by the resonating quartz. In his note, Prof. Kerr Grant suggests the employment of resonating quartz for obtaining interrupted light of very high frequency up to ten million per second. We are doubtful if this is practically possible. The thickness of a quartz crystal cut and ground to this frequency is very small (only a fraction of a millimetre along the electrical axis and normal to the optic axis, for it is about one millimetre even for a million-cycle) and it would be exceedingly difficult, if not impossible, to make any observation by passing light in a direction parallel to the optic axis.

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The Nature and Function of Golgi Bodies.

Prof. Gatenby says (Nature, Mar. 24): "Prof. Walker's original position was that *both categories of the cytoplasmic inclusions* [mitochondria and Golgi bodies] *are artefacts*. In his printed paper he merely claims that the Golgi bodies alone are artefacts." My "position" was, continued to be in my "printed paper," and still is, that *some of* the bodies claimed as mitochondria in fixed material are artefacts; and that those among the appearances claimed as Golgi apparatus, the presence of which in the cell cannot be accounted for without assuming the existence of this peculiar "organella," as Prof. Gatenby calls it, are artefacts. Thus it would seem that either he has not read what I have written, or that he is misquoting what he has read.

Both Prof. Gatenby and Dr. Ludford make much of the constant positions taken up by the Golgi apparatus in similar cells. Our knowledge of the chemistry of the cell is so limited that it is impossible to explain in many cases the position taken up by the separated lipins in different cells. I have, however, nearly ready for publication, an account of conditions in which my Golgi bodies may be made to take up a constant position in relation to the artificial nuclei in my mixtures, conditions which may well be produced by the nucleus of the living cell in certain circumstances.

I believe that all microscopic observations upon fresh cells removed from the living body of the multicellular animal should be accepted with caution. Changes must begin at once even under the most favourable conditions. It does not appear to me that the technique of the demonstrators of the Golgi apparatus "takes into account our biochemical knowledge of the solubilities of lipoids and other subtle cell bodies" as Prof. Gatenby says they do. The facility with which the colloids of the cell, more particularly perhaps the lipins, may be separated from each other and from the water with which they are associated, seems to be entirely ignored. Temporary separation might well occur under normal cell conditions, which would be rendered permanent by certain abnormal ones.

The formation of artefacts has been much neglected during recent years. They constitute perhaps the most dangerous pitfall for the cytologist. I cannot enter into the theory and practice of fixation and other processes, but for Prof. Gatenby's information would point out that maceration of material, among many other modes of treatment, is sure to distort the cells and their contents very seriously. What Prof. Gatenby would have us believe is "modern cytological technique" seems to be largely confined to those who demonstrate what he calls "cytoplasmic inclusions" and to neurologists.

If I were, as I certainly am not, the only cytologist living who did not believe in the "Golgi bodies," I fail to agree with Prof. Gatenby that this in itself would be a proof that I was wrong. Much greater men than he or I have occupied that invidious position in the past, and have proved right in the end.

May I point out that I still seek in vain for even a hint as to the function of the "Golgi bodies," which are assumed to exist as definite structures in all the cells of all animals and many plants. Also I have failed to extract information as to what becomes of the lipins in the cells that are treated by the "Golgi apparatus" methods.

I did not write of the archoplasm but of structures contained in it, and pointed out that these had been found in every animal investigated. Dr. Ludford's definition of the Golgi apparatus as a specialised area in the cytoplasm does not seem to agree with Prof. Gatenby's "batonettes." I would refer them both to D. Tretjakoff's paper, *Zeits. f. Zellforschung u. Mikro. Anat.*, Abt. B, 7 Band, 1 Heft., Feb. 1928.

Prof. Gatenby's naïve attitude that the value of his own interpretation of observations is increased by frequent repetition, and that he has reached the limits of cytological technique, reminds me of the Bellman in "The Hunting of the Snark."

> "Just the place for a Snark! I have said it thrice:
> What I tell you three times is true."

Charles Walker.

The University, Liverpool,
Mar. 23.

The Inner Photoelectric Effect with Silver Halides.

Consideration of the energy steps in the Born cycle for calculating the lattice energies of the silver halides leads to the following conclusions:

1. The photolysis of solid silver halide might occur *directly* to give halogen and metallic silver. This requires only a quantum at 8000 A. or longer, equivalent to the heat of formation of the halides from the elements.

2. This photolysis might occur *indirectly*, by way of separation of electrons from halide ions, followed by acceptance of the electrons by silver ions. This course would require (1) a quantum at $\lambda = 1300$ A., or beyond, to disrupt the lattice, then a quantum at $\lambda = 3000$ A., or beyond, to liberate electrons. In subsequent reactions, of electron acceptance, etc., energy might be freed, either as radiation quanta or by radiationless collisions, so that the final difference of energy equals the heat of formation. However, in this case (2) primary absorption of two quanta appears necessary, at thresholds much higher than those known to be operative in the photochemical decomposition of the silver halides.

Obviously, the contradiction might be simply dismissed by abandoning the view that the photolysis involves the intermediate liberation of photoelectrons from halide ions—a hypothesis suggested independently by K. Fajans and by the writer. But the phenomena of photoconductance definitely point to a relative freeing of photoelectrons, and Dr. F. C. Toy has shown (Nature, Sept. 24, 1927) that the discrepancy between the photoconductance absorption spectrum of the silver halides and the spectrum photographically active is removed by consideration of the thickness factor. Moreover, recently Dr. W. Vanselow and the writer have obtained independent evidence of the liberation of photoelectrons, *concomitant with the production of free halogen*, in a study of the photopotentials of silver-silver halide electrodes in electrolytes.

The difficulty of the energy quanta required cannot be dismissed therefore. The experimental evidence obtained with these cells has led to a modified theory of the inner photoelectric effect which is consistent with the writer's orientation theory of photographic sensitivity and latent image formation. By considering that both the lattice energy and electron affinity are lowered at interfaces, particularly at true interfaces with conductors, it seems possible for the inner photoelectric effect to occur at the lower wavelengths in question.

An interesting corollary is a possible relation of this to the theory of E. A. Baker (Nature, May 7, 1927, p. 685; *Proc. Roy. Soc. Edin.*, 47, 34; 1927), that "*two* quanta are concerned in photographic action, and that the two must be absorbed within a short interval of time, giving the effect of two distinct absorptions when the exposure is short, and of simultaneous absorption when the exposure is long. This indicates

that in the absence of a second absorption the effect of the first quantum is transitory, the action being of the type

$$A + h\nu \rightleftharpoons A'$$
$$A' + h\nu \longrightarrow A''."$$

If we regard the first quantum as necessary to loosen the lattice (to overcome lattice energy) and the second to release the photoelectron from the halide ion, it will be seen that the considerations advanced may support Dr. Baker's theory of reciprocity failure.

It is hoped to publish the discussion of lattice energy at an early date, and the study of the inner photoelectric effect in relation to latent image formation somewhat later. S. E. Sheppard.

Research Laboratory,
Eastman Kodak Company,
Rochester, New York, Mar. 2.

Vision and Reality.

If a philosopher may be permitted to take part in a discussion which seems to involve questions of scientific import alone, I would like to point out certain ideas which bear upon the problem of whether the eye has been so adapted as best to use the energy of sunlight. Sir John Parsons suggests (Nature, Jan. 21, p. 94) that this conclusion is consistent with the fact that the brightest part of the spectrum (of the luminosity curve) coincides with the summit of the curve of radiant energy. But Mr. T. Smith (Nature, Feb. 18, p. 242) presents another view—not inconsistent with the foregoing conception—in which vision is held to be so constituted as to bring out the sharpness of contours of bodies. This conclusion, while very important, does not seem to me to be especially novel. Prof. Eddington, in his "Stars and Atoms," also suggested that we have in the coincidence of the peak of the visibility curve with the peak of the curve of radiant energy an interesting case of evolutionary adaptation. But aside from these views, Bergson, it might be argued, had proposed something of the sort in his notion of the 'geometrising intellect.' This, at any rate, would be the case if the interpretation which the present writer puts on Bergson is the true one.

In presenting to my students in philosophy the 'problem of reality,' I have for several years employed the practice of pointing out the ways in which our knowledge of the external world is prejudiced by experiences to which our sense organs give rise. I have then always raised the question of how the world would appear if some of the limitations of our senses were overcome. More specifically, how would the world appear if our eyes were so constituted that we could see in the ultra-violet or the infra-red ends of the spectrum? If we could see in the infra-red end, bodies which are not in thermal equilibrium with their environments would then seem to be surrounded by a halo due to the heat rays which were being given off by the radiating bodies. In the same way, if we saw in the ultra-violet, all objects which give off these waves (for example, mercury) would be surrounded by a penumbra. This suggests the conclusion that the apparent sharpness of boundary of some objects is due to the structure of the human retina, that is, to the fact that vision is best in the yellow region of the spectrum.

This fact that sense experience (both in vision and in tactual experience, in so far as sight is 'anticipative touch' and tactual perceptions are synthesised with visual space) exaggerates the sharpness of contours, may be responsible for the sharp opposition between 'matter' and 'empty space.' The intellectual distinction between matter and energy may be a result of the fact that the eye, the organ of vision, is a direct outgrowth of the brain, the organ of thought. It is interesting to note that the 'quantum puzzle' is not being solved by making light corpuscular, but by making matter undulatory. In other words, perhaps the problems in some branches of science will be solved by unlearning some of the cerebral reactions or ideas which developed around sensory experience. Perhaps when we have become accustomed to Schrödinger's notion of substance as a set of wave-patterns, the idea of matter as something eternally and absolutely distinguished from energy-fields will be relegated to the science of mental palæontology as a fossil of human thought. Oliver Reiser.

University of Pittsburgh.

'Sports' and 'Reversion.'

The note on Dr. C. J. Bond's Galton Lecture, which appeared in Nature of Feb. 25, contains the following remarkable sentence (p. 292): "He [*i.e.* Dr. Bond] did not reflect, however, that 'sports,' although hereditary, must owe their origin to definite causes, and that the evidence before us justifies the belief that when these causes cease to operate the 'sport' ultimately reverts to the wild type."

It is, of course, true that sports must owe their origin to definite causes; but it is equally true that we know nothing whatever as to the nature of the causes underlying mutation. How, then, are we to know when such causes "cease to operate"? Further, it would be interesting to know what the evidence in favour of the 'reversion' of sports may be. *Chelidonium laciniatum* Miller, perhaps the best authenticated of mutants, has certainly not been observed to revert during the 338 years for which it has been known to science. The other mutants of known date of origin have shown a similar constancy. Indeed, it might be said to be characteristic of true seminal mutants that they do *not* revert.

If I am not mistaken, the only phenomenon which the geneticist would care to call 'reversion,' even by courtesy, is that exemplified by the appearance of a definite proportion of red-flowered plants among the segregates from a cross between an ivory-flowered snapdragon and a white-flowered snapdragon of a particular genetic constitution. In such a case the appearance of the supposedly ancestral type—in this instance the red-flowered plant—is a necessary consequence of the mating of particular gametes, and is quite independent of the incidence of environmental factors. Montagu Drummond.

Botany Department,
University of Glasgow, Mar. 1.

The comments on Dr. Bond's lecture to which Prof. Drummond refers, may be justified perhaps by zoological illustrations even if the botanists are unaware of any causes of mutation and have no evidence of reversion. For example, Müller has shown that when the eggs of normal specimens of Drosophila are subjected to X-ray radiation, they give rise to 'mutations' of the same kind as some of those which turn up in Morgan's cultures. Berndt, in discussing the 'fancy races' of goldfish, admits that the cause of the production of 'mutants' is aquarium conditions. In a word, the general cause of mutations may be described as 'germ-damage' due to bad environmental conditions acting at a critical period of growth. As to reversion, Morgan himself encountered this in some of his extreme mutants and described it as 'mutation backwards.' It can be seen any day in the London squares, where a considerable proportion of our escaped dovecote pigeons are rapidly returning to the ancestral form of *Columba livia*.

The Writer of the Notes.

On Experimental Growth *in situ*.

On the hypothesis of senescence elaborated by Robertson ("Chemical Basis of Growth and Senescence," 1923), adult tissue can only revert to a reproductive phase when the so-called *kern-plasma* relation and nutrient level of its elements has been reduced, and the inhibitory products of previous growth (autocatalysts) have been—and continue to be—removed. But Gye and Barnard have shown that ultramicroscopic organisms occur in (and can be cultivated from) the fluids derived from—at least—some cancerous tissues. Such ultramicroscopic organisms also exhibit specificity. Let Robertson's hypothesis be accepted, then it is a reasonable assumption, which can probably be tested, that these ultramicroscopic organisms may primarily be feeding on the products of autocatalysis in the tissues in which they are found. If, therefore, these organisms could be cultivated in fluids derived from healthy tissues homologous with those from which they were derived, or even in the tissues themselves, partial proof of the assumption would be obtained.

Now Gye and Barnard have actually shown that pathological growth may be produced in some cases by a 'specific factor' plus a 'virus.' But apparently it is not possible to stimulate growth in a tissue by merely injecting into it a culture or extraction containing the pathological organisms. Robertson's hypothesis, however, demands two conditions for resultant growth in adult tissues, namely, (*a*) reduction of the *kern-plasma* relation, which may be effected by various stimuli (chemical, physical, mechanical abrasion or irritation, cutting, or agents causing disruption or decay of cells, etc.), as well as (*b*) removal of the autocatalysts. Thus the mere injection of organisms to remove (presumably) the autocatalysts in a tissue may not be enough to stimulate growth, and reproduce the hyperplasia without the concurrent reduction of the *kern-plasma* relationship.

In order, therefore, to induce unrestricted growth in a tissue *in situ* it is necessary *ex hypothesi* (1) to stimulate the tissue in some way to regenerative activity—thereby ensuring the reduction of the *kern-plasma* ratio; and (2) to add pathological organisms which will remove the autocatalytic products of the stimulated growth, and permit continued growth; such organisms having been derived from a tissue homologous with that in which the new growth is required. It is possible that experiments fulfilling the conditions outlined above may not have been tried, and no excuse is needed for advancing any reasonable suggestion on this important subject.

X.

Postulates of Hydrodynamics.

Of a mass of fluid satisfying the condition of continuity and having a continuous velocity field, the mathematical theory of fluid motion postulates that fluid elements—line, surface, volume—not crossing a surface of discontinuity, of which there may be a finite number, maintain their identity and order of magnitude.

As a dynamical consequence, in a perfect fluid, the forces being restricted to surface pressures and potential body forces, the initial distribution of vorticity is inherent in the volume elements of fluid, and remains so in the subsequent motion.

In particular, if the initial motion is irrotational everywhere (except in the sheets of vorticity), the subsequent motion is irrotational (except in the sheets of vorticity).

Without questioning the correctness of these propositions in the realm of mathematical logic, the present writer has found them a formidable barrier to the understanding of actual fluid motions familiar to the physicist and the engineer, and offers the following physical propositions.

Fluid elements—line, surface, volume—can be effectively subdivided into two or more distinct portions separated by intervening fluid.

A mass of perfect fluid consisting of several distinct parts, each with its own velocity potential, and separated by thin sheets of transition (in mathematical limit, vortex sheets) may be effectively redistributed so that the identity of the irrotational elements of volume falls below the threshold of observability, and new mean elements with an effective finite distribution of vorticity become the objects of physical observation and measurement through the whole or part of the joint mass.

A. R. Low.

The Library, Air Ministry,
Kingsway, W.C.2, Mar. 26.

The Spectrum of Ionised Argon (A II).

For some time the spectrum of ionised argon (A II) has been a subject of investigation in the Amsterdam Laboratory 'Physica.' My analysis of the spectrum of neutral fluorine F I (*Verslagen.*, Amsterdam, June 1926, Dec. 1926. *Zeits. f. Phys.*, **39**, 869; 1926) and the analysis of the spectrum of ionised neon Ne II (*Versl.*, Amsterdam, May 1927. Nature, **119**, 925; 1927. *Zeits. f. Phys.*, **44**, 157; 1927. **46**, 856; 1928) formed preliminary steps for the analysis of the A II spectrum. A great part of the A II lines have now been classified by me. I have found a doublet and a quartet term system. The term structure exhibits a perfect analogy to that of F I and Ne II. The following triplet $4p^4S$-$4s^4P$: (9) 3729,300; (8) 3850,565; (7) 3928,599 involving the deep quartet $4s^4P$ term with the term differences: 844,40 and 515,70, gives the key for the analysis of the spectrum. As examples, the other deep quartet terms are given:

$4p^4P$	: with the term differences :	307,75 and 357,30
$4p^4D$	,, ,,	439,36; 494,57; and 260,32.
$(3)d^4D$	,, ,,	153,98; 149,62; and 107,03.

The complete term table for A II, the lists of classified lines, the new measurements, and the analogy with the spectrum of ionised neon will be published in the *Zeits. f. Phys.*

T. L. de Bruin.

Physical Laboratory, 'Physica,'
University of Amsterdam, Feb. 21.

The Buoyancy of Whales.

Mr. Gray's suggestion (Nature, Mar. 17, p. 421) that whales dying at the surface sometimes float because the air in their lungs is held in by the valves of the blowhole is very interesting, and perhaps helps also in understanding how whales can remain so long under water. There are, however, so many unusual features about whales that one cannot help wondering whether other explanations are not possible. It is, for example, conceivable that whales breathe differently from other mammals, and that the muscular effort they expend in breathing is used not for drawing air into their lungs but for driving it out. On this view the filling of the lungs would be due to the elastic recoil of the thoracic wall and expansion of the cavity following the muscular contraction, and when a whale dies and the muscles relax the lungs would fill with air if the blowhole is above the surface or with water if it is below.

T. H. Taylor.

University of Leeds.

Helium in Deep Diving and Caisson Working.[1]

By Prof. J. H. Hildebrand, University of California,
and Dr. R. R. Sayers and W. P. Yant, United States Bureau of Mines.

In diving and in caisson operations where men are subjected to air pressures above ordinary atmospheric pressure, the amount of air dissolved in the blood stream and body tissues increases. The excess oxygen can be disposed of by the ordinary combustion process, but the excess nitrogen tends to separate in the form of bubbles when the pressure is released. As the amount dissolved is approximately proportional to the pressure, there may be enough separating in the blood stream and tissues of a diver or caisson worker coming up rapidly from a considerable depth to produce 'caisson illness.' This is accompanied by severe bodily pains, and, in more severe cases, unconsciousness or even death.

It is therefore necessary to prolong the time of ascent in deep diving or of decompression in caisson working sufficiently to allow the excess nitrogen to escape from the tissues through the lungs. This period of decompression increases rapidly with the depth or pressure to which the worker has been exposed and with the duration of exposure, and becomes almost prohibitive at depths greater than 200 feet, except in emergencies and for very short exposures. According to present-day diving regulations and practice, it requires but 3 to 8 minutes, depending on the individual diver, to descend to a depth of 200 feet, but after a stay of 45 minutes at the bottom, 2 or more hours would be required to bring the diver to the surface in safety. Mechanical troubles, accidents to the diver, unusually cold water, or stormy weather may make it difficult or impossible to allow such a period, and even at best the proportion of the total time available for work at the bottom rapidly becomes too short to be practical as great depths are approached.

Theoretical studies of the general problem of solubility, begun by the senior writer some years ago, made it evident that the least soluble gas, almost regardless of the solvent, should be helium. As he was familiar with the theory of caisson illness, the idea naturally arose of substituting helium for the nitrogen of air for respiration by divers and caisson workers. Eventually a small amount of helium was obtained from the United States Bureau of Mines through the courtesy of R. B. Moore, former Chief Chemist, with whom the problem had been previously discussed.

Progress was slow, in the absence of suitable equipment, and it became evident that to bring the matter to any practical fruition would require large-scale experiments and access to considerable quantities of helium, of which the United States Government was the only producer. Meanwhile, the sinking of a submarine at a depth that rendered access by divers difficult, suggested that any consideration of personal profit should give way to the prompt working out of the practical problems involved. Accordingly, the senior author wrote in January 1924 to S. C. Lind, then Chief Chemist of the Bureau of Mines, suggesting that the Bureau undertake the necessary experimental work. This suggestion was accepted, and the senior writer was associated with the Bureau as consulting chemist. The work was put into the hands of Dr. R. R. Sayers, Chief Surgeon for the Bureau of Mines, and W. P. Yant, Supervising Chemist, Health Laboratory Section.

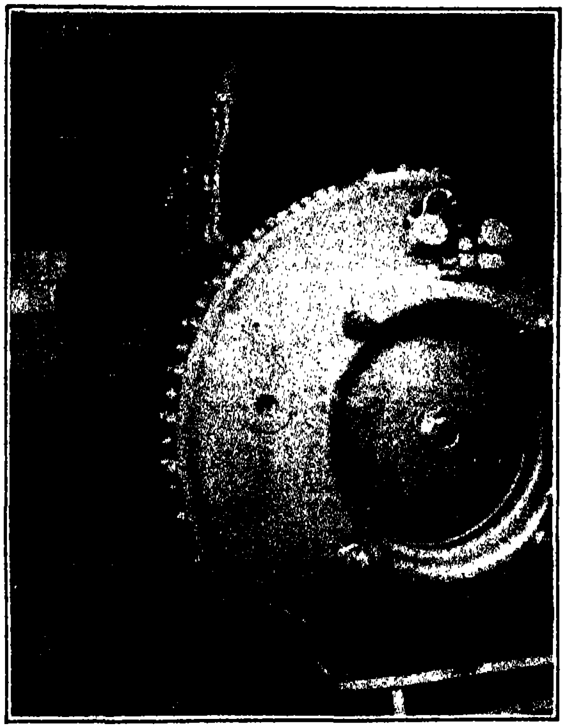

Fig. 1.—Compression chamber used for conducting experiments on men. This was built at the Norfolk Navy Yard and was of 1¾ in. steel and capable of withstanding a working pressure of 600 lb. per sq. in., and a much greater test pressure. Note telephone and electric light connexions above door, and gauges and valves for regulating and indicating pressure. One of the horizontal lines leading from the manifold extends through the reducing valve to the bank of air bottles and the other to a supply of pure oxygen or of helium-oxygen mixture.

As is so often the case, it has since been brought to light that the idea occurred independently to different individuals. On Aug. 15, 1919, an application for a patent was filed, and on Nov. 6, 1923, issued, to C. J. Cooke, of Washington, D.C., for the use of a respirable mixture of oxygen and helium for workers under pressure; and at about the same time Elihu Thomson, it appears, had a similar idea. In a paper, "Helium Production and Uses," by Prof. J. C. McLennan, in Nature of Aug. 19, 1920, is the following statement:

"It has been suggested by Elihu Thomson and

[1] Published by permission of the Director, U.S. Bureau of Mines. (Not subject to copyright.)

others that if divers were supplied with a mixture of oxygen and helium, the rate of expul-

Fig. 2.—Air compressors and apparatus for compressing air into a storage bank consisting of thirty 2-cub. ft. free air capacity cylinders. The air is compressed to approximately 1800 lb. per sq. in., which gives sufficient volume in the bank to fill the large test chamber to a pressure of 100 lb. per sq. in. within two or three minutes. All these cylinders are connected in parallel to a manifold from which the air is released through a reducing valve. One compressor is electrically driven and the other by means of a gasoline engine. This ensures two independent sources of power and an adequate air supply in the event of difficulties being experienced in these experiments, and extended recompression of the men being necessary to allay the occurrence of caisson disease.

sion of carbon dioxide from the lungs might be increased, and the period of submergence as a consequence be considerably lengthened."

As a matter of fact, however, the work at the Bureau of Mines was undertaken and pursued to a considerable fruition before any of those concerned with it became cognizant of the claims of either Mr. Cooke or Dr. Thomson. It may be added also, that if the statement by Prof. McLennan correctly expresses the idea of Dr. Thomson, this was based upon an incorrect assumption, for caisson illness does not depend upon the diffusion of carbon dioxide from the lungs. (For discussion of priority claims see E. Thomson, *Science*, Jan. 14, 1927; J. H. Hildebrand, *Science*, Mar. 15, 1927; and W. P. Yant, *Ind. and Eng. Chem.*, news edition, Mar. 10, 1927.)

The fact remains that the use of helium for deep diving could become practical only after extensive and costly experimentation for the development of a suitable technique. Investigations planned toward this end were initiated by the Bureau of Mines and continued later with the co-operation of the Navy Department. The results of the initial investigations made by the Bureau were published, in part, in its *Reports of Investigations Serial 2670*, February 1925, entitled "Possibilities in the Use of Helium–Oxygen Mixtures as a Mitigation of Caisson Disease," by R. R. Sayers, W. P. Yant, and J. H. Hildebrand. This publication recounts the results of a series of tests with small animals. It was found at the outset that rats could be subjected to a helium-oxygen mixture for 1 hour at a pressure of 20 atmospheres, corresponding to about 600 feet of water, or more than three times the maximum pressure at which extensive diving operations have been conducted; and further, that they could be brought out of this pressure safely in 34 minutes.

It was found important to reduce the proportion of oxygen from 21 per cent. by volume, the proportion in air, to a much smaller proportion, varying from 1·5 to 15 per cent. according to the pressure employed. In most of the studies a pressure of 10 atmospheres was used, with varying periods of exposure, up to

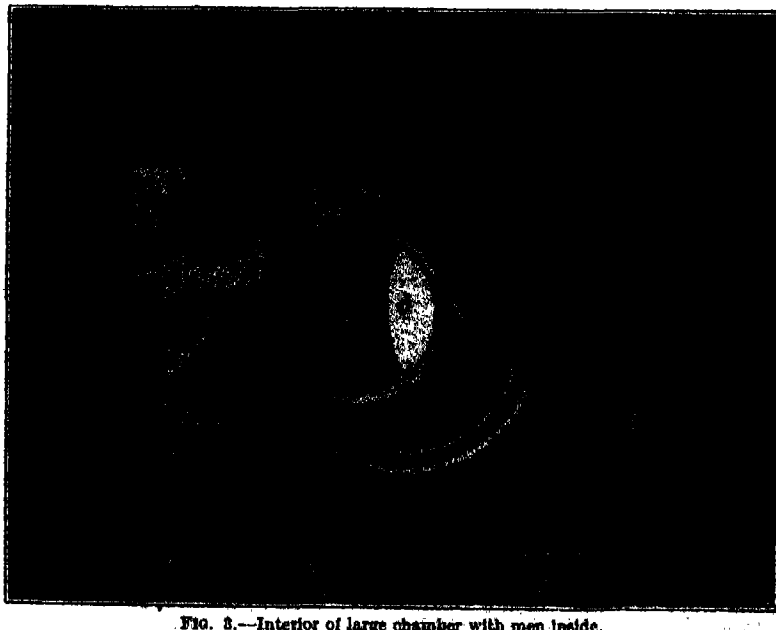

Fig. 3.—Interior of large chamber with men inside.

5 hours. It was found that animals could be brought out from the helium-oxygen mixture

(Continued on p. 591.)

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New Problems in Quantum Theory.

FIFTEEN years have elapsed since Niels Bohr first published a series of papers which were the beginning of a new epoch in the development of the quantum theory. Adopting the atomic model proposed by Rutherford, in which electrons circle round a massive nucleus under the action of a Coulomb force of electric attraction, Bohr gained immediate success in interpreting the spectrum of hydrogen and of ionised helium. For his purpose he was compelled to assume the existence of 'stationary states,' and the emission of monochromatic radiation in the transition between two such states of an atomic system.

In one sense the new method raised as many difficulties as it removed, and to some of the more conservative physicists the account of Bohr's atom read like a fairy tale. Further progress in the interpretation of line spectra was made through the generalisations of Wilson and Sommerfeld, but in spite of the inclusion of a widening circle of facts and the fulfilment of predictions, it came to be realised that a more radical procedure was necessary before a consistent and complete theory could be evolved. In the forward movement few have been more active than Bohr himself. The employment of a spinning electron by Goudsmit and Uhlenbeck removed many discrepancies, and it seems as if some form of magnetic electron is likely to be accepted as a fundamental constituent of an atomic system. The magneton of S. B. McLaren with its quantum of angular momentum may be regarded as the prototype of all such magnetic electrons.

Within the last few years the matrix mechanics of Heisenberg, Born, and Jordan, the quantum algebra of Dirac, and the undulatory mechanics of Schrödinger, have led to remarkable theoretical developments. The new wave mechanics gave rise to the hope that an account of atomic phenomena might be obtained which would not differ essentially from that afforded by the classical theories of electricity and magnetism. Unfortunately, Bohr's statement in the following communication of the principles underlying the description of atomic phenomena gives little, if any, encouragement in this direction.

In classical mechanics it is assumed that the position of a particle (such as an electron) can be determined at a specified instant of time by means of its co-ordinates. As the time varies it is supposed to be possible to trace the path of the particle through space, or to determine its 'world line' in the four-dimensional world. Further, it is assumed that the concept of causality may be applied in considering the effect of the action of external forces. Thus in classical physics we have a causal space-time co-ordination, based on the assumption that the methods or tools of measurement do not affect the phenomena which are observed.

In the new quantum theory the outlook is changed, for any attempt to observe the position or motion of an electron involves illumination by light, and this implies interaction between the electron and the light employed in making the measurement. The position and the path of an electron become vague. Thus there is introduced in the new quantum mechanics an indefiniteness which contrasts with the clear-cut concepts of classical mechanics. Bohr asserts that in any phenomenon which we may attempt to observe there is an essential discontinuity, or rather individuality, which may be symbolised by Planck's constant h. The causal space-time co-ordination of atomic phenomena must on this view be abandoned, and we are left with a somewhat vague statistical description.

The strange conflict which has been waged between the wave theory of light and the light quantum hypothesis has resulted in a remarkable dilemma. But now we have a parallel dilemma, for a material particle manifests some of the attributes of wave motion. Can these apparently contradictory views be reconciled? According to Bohr, the pictures ought to be regarded not as contradictory but as complementary. Radiation in free space is not open to observation, and is a mere abstraction. An isolated material particle likewise can never be observed and is also an abstraction. It is only through their interaction with other systems that the properties of these abstractions can be defined and observed.

It must be confessed that the new quantum mechanics is far from satisfying the requirements of the layman who seeks to clothe his conceptions in figurative language. Indeed, its originators probably hold that such symbolic representation is inherently impossible. It is earnestly to be hoped that this is not their last word on the subject, and that they may yet be successful in expressing the quantum postulate in picturesque form.

The Quantum Postulate and the Recent Development of Atomic Theory.[1]

By Prof. N. Bohr, For. Mem. R.S.

In connexion with the discussion of the physical interpretation of the quantum theoretical methods developed during recent years, I should like to make the following general remarks regarding the principles underlying the description of atomic phenomena, which I hope may help to harmonise the different views, apparently so divergent, concerning this subject.

1. Quantum Postulate and Causality.

The quantum theory is characterised by the acknowledgment of a fundamental limitation in the classical physical ideas when applied to atomic phenomena. The situation thus created is of a peculiar nature, since our interpretation of the experimental material rests essentially upon the classical concepts. Notwithstanding the difficulties which hence are involved in the formulation of the quantum theory, it seems, as we shall see, that its essence may be expressed in the so-called quantum postulate, which attributes to any atomic process an essential discontinuity, or rather individuality, completely foreign to the classical theories and symbolised by Planck's quantum of action.

This postulate implies a renunciation as regards the causal space-time co-ordination of atomic processes. Indeed, our usual description of physical phenomena is based entirely on the idea that the phenomena concerned may be observed without disturbing them appreciably. This appears, for example, clearly in the theory of relativity, which has been so fruitful for the elucidation of the classical theories. As emphasised by Einstein, every observation or measurement ultimately rests on the coincidence of two independent events at the same space-time point. Just these coincidences will not be affected by any differences which the space-time co-ordination of different observers otherwise may exhibit. Now the quantum postulate implies that any observation of atomic phenomena will involve an interaction with the agency of observation not to be neglected. Accordingly, an independent reality in the ordinary physical sense can neither be ascribed to the phenomena nor to the agencies of observation. After all, the concept of observation is in so far arbitrary as it depends upon which objects are included in the system to be observed. Ultimately every observation can of course be reduced to our sense perceptions. The circumstance, however, that in interpreting observations use has always to be made of theoretical notions, entails that for every particular case it is a question of convenience at what point the concept of observation involving the quantum postulate with its inherent 'irrationality' is brought in.

This situation has far-reaching consequences. On one hand, the definition of the state of a physical system, as ordinarily understood, claims the elimination of all external disturbances. But in that case, according to the quantum postulate, any observation will be impossible, and, above all, the concepts of space and time lose their immediate sense. On the other hand, if in order to make observation possible we permit certain interactions with suitable agencies of measurement, not belonging to the system, an unambiguous definition of the state of the system is naturally no longer possible, and there can be no question of causality in the ordinary sense of the word. The very nature of the quantum theory thus forces us to regard the space-time co-ordination and the claim of causality, the union of which characterises the classical theories, as complementary but exclusive features of the description, symbolising the idealisation of observation and definition respectively. Just as the relativity theory has taught us that the convenience of distinguishing sharply between space and time rests solely on the smallness of the velocities ordinarily met with compared to the velocity of light, we learn from the quantum theory that the appropriateness of our usual causal space-time description depends entirely upon the small value of the quantum of action as compared to the actions involved in ordinary sense perceptions. Indeed, in the description of atomic phenomena, the quantum postulate presents us with the task of developing a 'complementarity' theory the consistency of which can be judged only by weighing the possibilities of definition and observation.

This view is already clearly brought out by the much-discussed question of the nature of light and the ultimate constituents of matter. As regards light, its propagation in space and time is adequately expressed by the electromagnetic theory. Especially the interference phenomena *in vacuo* and the optical properties of material media are completely governed by the wave theory superposition principle. Nevertheless, the conservation of energy and momentum during the interaction between radiation and matter, as evident in the photoelectric and Compton effect, finds its adequate expression just in the light quantum idea put forward by Einstein. As is well known, the doubts regarding the validity of the superposition principle on one hand and of the conservation laws on the other, which were suggested by this apparent contradiction, have been definitely disproved through direct experiments. This situation would seem clearly to indicate the impossibility of a causal space-time description of the light phenomena. On one hand, in attempting to trace

[1] The content of this paper is essentially the same as that of a lecture on the present state of the quantum theory delivered on Sept. 16, 1927, at the Volta celebration in Como. For a summary of the theory just previous to the development of the new methods the reader is referred to a lecture of the author, "Atomic Theory and Mechanics," published in this periodical (Nature, 116, 800; 1925). The rapid development which has taken place since has given rise to a considerable number of publications. The present paper is confined to a few references to recent articles which have a special bearing on the subject now under discussion.

the laws of the time-spatial propagation of light according to the quantum postulate, we are confined to statistical considerations. On the other hand, the fulfilment of the claim of causality for the individual light processes, characterised by the quantum of action, entails a renunciation as regards the space-time description. Of course, there can be no question of a quite independent application of the ideas of space and time and of causality. The two views of the nature of light are rather to be considered as different attempts at an interpretation of experimental evidence in which the limitation of the classical concepts is expressed in complementary ways.

The problem of the nature of the constituents of matter presents us with an analogous situation. The individuality of the elementary electrical corpuscles is forced upon us by general evidence. Nevertheless, recent experience, above all the discovery of the selective reflection of electrons from metal crystals, requires the use of the wave theory superposition principle in accordance with the original ideas of L. de Broglie. Just as in the case of light, we have consequently in the question of the nature of matter, so far as we adhere to classical concepts, to face an inevitable dilemma, which has to be regarded as the very expression of experimental evidence. In fact, here again we are not dealing with contradictory but with complementary pictures of the phenomena, which only together offer a natural generalisation of the classical mode of description. In the discussion of these questions, it must be kept in mind that, according to the view taken above, radiation in free space as well as isolated material particles are abstractions, their properties on the quantum theory being definable and observable only through their interaction with other systems. Nevertheless, these abstractions are, as we shall see, indispensable for a description of experience in connexion with our ordinary space-time view.

The difficulties with which a causal space-time description is confronted in the quantum theory, and which have been the subject of repeated discussions, are now placed into the foreground by the recent development of the symbolic methods. An important contribution to the problem of a consistent application of these methods has been made lately by Heisenberg (*Zeitschr. f. Phys.*, **43**, 172; 1927). In particular, he has stressed the peculiar reciprocal uncertainty which affects all measurements of atomic quantities. Before we enter upon his results it will be advantageous to show how the complementary nature of the description appearing in this uncertainty is unavoidable already in an analysis of the most elementary concepts employed in interpreting experience.

2. Quantum of Action and Kinematics.

The fundamental contrast between the quantum of action and the classical concepts is immediately apparent from the simple formulæ which form the common foundation of the theory of light quanta and of the wave theory of material particles. If Planck's constant be denoted by h, as is well known,

$$E\tau = I\lambda = h, \qquad . \quad . \quad . \quad (1)$$

where E and I are energy and momentum respectively, τ and λ the corresponding period of vibration and wave-length. In these formulæ the two notions of light and also of matter enter in sharp contrast. While energy and momentum are associated with the concept of particles, and hence may be characterised according to the classical point of view by definite space-time co-ordinates, the period of vibration and wave-length refer to a plane harmonic wave train of unlimited extent in space and time. Only with the aid of the superposition principle does it become possible to attain a connexion with the ordinary mode of description. Indeed, a limitation of the extent of the wave-fields in space and time can always be regarded as resulting from the interference of a group of elementary harmonic waves. As shown by de Broglie (Thèse, Paris, 1924), the translational velocity of the individuals associated with the waves can be represented by just the so-called group-velocity. Let us denote a plane elementary wave by

$$A \cos 2\pi(\nu t - x\sigma_x - y\sigma_y - z\sigma_z + \delta),$$

where A and δ are constants determining respectively the amplitude and the phase. The quantity $\nu = 1/\tau$ is the frequency, σ_x, σ_y, σ_z the wave numbers in the direction of the co-ordinate axes, which may be regarded as vector components of the wave number $\sigma = 1/\lambda$ in the direction of propagation. While the wave or phase velocity is given by ν/σ, the group-velocity is defined by $d\nu/d\sigma$. Now according to the relativity theory we have for a particle with the velocity v:

$$I = \frac{v}{c^2}E \text{ and } v dI = dE,$$

where c denotes the velocity of light. Hence by equation (1) the phase velocity is c^2/v and the group-velocity v. The circumstance that the former is in general greater than the velocity of light emphasises the symbolic character of these considerations. At the same time, the possibility of identifying the velocity of the particle with the group-velocity indicates the field of application of space-time pictures in the quantum theory. Here the complementary character of the description appears, since the use of wave-groups is necessarily accompanied by a lack of sharpness in the definition of period and wave-length, and hence also in the definition of the corresponding energy and momentum as given by relation (1).

Rigorously speaking, a limited wave-field can only be obtained by the superposition of a manifold of elementary waves corresponding to all values of ν and σ_x, σ_y, σ_z. But the order of magnitude of the mean difference between these values for two elementary waves in the group is given in the most favourable case by the condition

$$\Delta t \Delta\nu = \Delta x \Delta\sigma_x = \Delta y \Delta\sigma_y = \Delta z \Delta\sigma_z = 1,$$

where Δt, Δx, Δy, Δz denote the extension of the wave-field in time and in the directions of space corresponding to the co-ordinate axes. These

relations—well known from the theory of optical instruments, especially from Rayleigh's investigation of the resolving power of spectral apparatus —express the condition that the wave-trains extinguish each other by interference at the space-time boundary of the wave-field. They may be regarded also as signifying that the group as a whole has no phase in the same sense as the elementary waves. From equation (1) we find thus:

$$\Delta t \Delta E = \Delta x \Delta I_x = \Delta y \Delta I_y = \Delta z \Delta I_z = h \quad . \quad (2)$$

as determining the highest possible accuracy in the definition of the energy and momentum of the individuals associated with the wave-field. In general, the conditions for attributing an energy and a momentum value to a wave-field by means of formula (1) are much less favourable. Even if the composition of the wave-group corresponds in the beginning to the relations (2), it will in the course of time be subject to such changes that it becomes less and less suitable for representing an individual. It is this very circumstance which gives rise to the paradoxical character of the problem of the nature of light and of material particles. The limitation in the classical concepts expressed through relation (2) is, besides, closely connected with the limited validity of classical mechanics, which in the wave theory of matter corresponds to the geometrical optics, in which the propagation of waves is depicted through 'rays.' Only in this limit can energy and momentum be unambiguously defined on the basis of space-time pictures. For a general definition of these concepts we are confined to the conservation laws, the rational formulation of which has been a fundamental problem for the symbolical methods to be mentioned below.

In the language of the relativity theory, the content of the relations (2) may be summarised in the statement that according to the quantum theory a general reciprocal relation exists between the maximum sharpness of definition of the space-time and energy-momentum vectors associated with the individuals. This circumstance may be regarded as a simple symbolical expression for the complementary nature of the space-time description and the claims of causality. At the same time, however, the general character of this relation makes it possible to a certain extent to reconcile the conservation laws with the space-time coordination of observations, the idea of a coincidence of well-defined events in a space-time point being replaced by that of unsharply defined individuals within finite space-time regions.

This circumstance permits us to avoid the well-known paradoxes which are encountered in attempting to describe the scattering of radiation by free electrical particles as well as the collision of two such particles. According to the classical concepts, the description of the scattering requires a finite extent of the radiation in space and time, while in the change of the motion of the electron demanded by the quantum postulate one seemingly is dealing with an instantaneous effect taking place at a definite point in space. Just as in the case of radiation, however, it is impossible to define momentum and energy for an electron without considering a finite space-time region. Furthermore, an application of the conservation laws to the process implies that the accuracy of definition of the energy momentum vector is the same for the radiation and the electron. In consequence, according to relation (2), the associated space-time regions can be given the same size for both individuals in interaction.

A similar remark applies to the collision between two material particles, although the significance of the quantum postulate for this phenomenon was disregarded before the necessity of the wave concept was realised. Here this postulate does indeed represent the idea of the individuality of the particles which, transcending the space-time description, meets the claim of causality. While the physical content of the light quantum idea is wholly connected with the conservation theorems for energy and momentum, in the case of the electrical particles the electric charge has to be taken into account in this connexion. It is scarcely necessary to mention that for a more detailed description of the interaction between individuals we cannot restrict ourselves to the facts expressed by formulæ (1) and (2), but must resort to a procedure which allows us to take into account the coupling of the individuals, characterising the interaction in question, where just the importance of the electric charge appears. As we shall see, such a procedure necessitates a further departure from visualisation in the usual sense.

3. Measurements in the Quantum Theory.

In his investigations already mentioned on the consistency of the quantum theoretical methods, Heisenberg has given the relation (2) as an expression for the maximum precision with which the space-time co-ordinates and momentum-energy components of a particle can be measured simultaneously. His view was based on the following consideration: On one hand, the coordinates of a particle can be measured with any desired degree of accuracy by using, for example, an optical instrument, provided radiation of sufficiently short wave-length is used for illumination. According to the quantum theory, however, the scattering of radiation from the object is always connected with a finite change in momentum, which is the larger the smaller the wave-length of the radiation used. The momentum of a particle, on the other hand, can be determined with any desired degree of accuracy by measuring, for example, the Doppler effect of the scattered radiation, provided the wave-length of the radiation is so large that the effect of recoil can be neglected, but then the determination of the space co-ordinates of the particle becomes correspondingly less accurate.

The essence of this consideration is the inevitability of the quantum postulate in the estimation of the possibilities of measurement. A closer investigation of the possibilities of definition would

still seem necessary in order to bring out the general complementary character of the description. Indeed, a discontinuous change of energy and momentum during observation could not prevent us from ascribing accurate values to the space-time co-ordinates, as well as to the momentum-energy components before and after the process. The reciprocal uncertainty which always affects the values of these quantities is, as will be clear from the preceding analysis, essentially an outcome of the limited accuracy with which changes in energy and momentum can be defined, when the wave-fields used for the determination of the space-time co-ordinates of the particle are sufficiently small.

In using an optical instrument for determinations of position, it is necessary to remember that the formation of the image always requires a convergent beam of light. Denoting by λ the wave-length of the radiation used, and by ϵ the so-called numerical aperture, that is, the sine of half the angle of convergence, the resolving power of a microscope is given by the well-known expression $\lambda/2\epsilon$. Even if the object is illuminated by parallel light, so that the momentum h/λ of the incident light quantum is known both as regards magnitude and direction, the finite value of the aperture will prevent an exact knowledge of the recoil accompanying the scattering. Also, even if the momentum of the particle were accurately known before the scattering process, our knowledge of the component of momentum parallel to the focal plane after the observation would be affected by an uncertainty amounting to $2\epsilon h/\lambda$. The product of the least inaccuracies with which the positional co-ordinate and the component of momentum in a definite direction can be ascertained is therefore just given by formula (2). One might perhaps expect that in estimating the accuracy of determining the position, not only the convergence but also the length of the wave-train has to be taken into account, because the particle could change its place during the finite time of illumination. Due to the fact, however, that the exact knowledge of the wave-length is immaterial for the above estimate, it will be realised that for any value of the aperture the wave-train can always be taken so short that a change of position of the particle during the time of observation may be neglected in comparison to the lack of sharpness inherent in the determination of position due to the finite resolving power of the microscope.

In measuring momentum with the aid of the Doppler effect—with due regard to the Compton effect—one will employ a parallel wave-train. For the accuracy, however, with which the change in wave-length of the scattered radiation can be measured the extent of the wave-train in the direction of propagation is essential. If we assume that the directions of the incident and scattered radiation are parallel and opposite respectively to the direction of the position co-ordinate and momentum component to be measured, then $c\lambda/2l$ can be taken as a measure of the accuracy in the determination of the velocity, where l denotes the length of the wave-train. For simplicity, we here have regarded the velocity of light as large compared to the velocity of the particle. If m represents the mass of the particle, then the uncertainty attached to the value of the momentum after observation is $cm\lambda/2l$. In this case the magnitude of the recoil, $2h/\lambda$, is sufficiently well defined in order not to give rise to an appreciable uncertainty in the value of the momentum of the particle after observation. Indeed, the general theory of the Compton effect allows us to compute the momentum components in the direction of the radiation before and after the recoil from the wave-lengths of the incident and scattered radiation. Even if the positional co-ordinates of the particle were accurately known in the beginning, our knowledge of the position after observation nevertheless will be affected by an uncertainty. Indeed, on account of the impossibility of attributing a definite instant to the recoil, we know the mean velocity in the direction of observation during the scattering process only with an accuracy $2h/m\lambda$. The uncertainty in the position after observation hence is $2hl/mc\lambda$. Here, too, the product of the inaccuracies in the measurement of position and momentum is thus given by the general formula (2).

Just as in the case of the determination of position, the time of the process of observation for the determination of momentum may be made as short as is desired if only the wave-length of the radiation used is sufficiently small. The fact that the recoil then gets larger does not, as we have seen, affect the accuracy of measurement. It should further be mentioned, that in referring to the velocity of a particle as we have here done repeatedly, the purpose has only been to obtain a connexion with the ordinary space-time description convenient in this case. As it appears already from the considerations of de Broglie mentioned above, the concept of velocity must always in the quantum theory be handled with caution. It will also be seen that an unambiguous definition of this concept is excluded by the quantum postulate. This is particularly to be remembered when comparing the results of successive observations. Indeed, the position of an individual at two given moments can be measured with any desired degree of accuracy; but if, from such measurements, we would calculate the velocity of the individual in the ordinary way, it must be clearly realised that we are dealing with an abstraction, from which no unambiguous information concerning the previous or future behaviour of the individual can be obtained.

According to the above considerations regarding the possibilities of definition of the properties of individuals, it will obviously make no difference in the discussion of the accuracy of measurements of position and momentum of a particle if collisions with other material particles are considered instead of scattering of radiation. In both cases we see that the uncertainty in question equally affects the description of the agency of measurement and of the object. In fact, this uncertainty cannot be avoided in a description of the behaviour of individuals with respect to a co-ordinate system

fixed in the ordinary way by means of solid bodies and unperturbable clocks. The experimental devices—opening and closing of apertures, etc.—are seen to permit only conclusions regarding the space-time extension of the associated wave-fields.

In tracing observations back to our sensations, once more regard has to be taken to the quantum postulate in connexion with the perception of the agency of observation, be it through its direct action upon the eye or by means of suitable auxiliaries such as photographic plates, Wilson clouds, etc. It is easily seen, however, that the resulting additional statistical element will not influence the uncertainty in the description of the object. It might even be conjectured that the arbitrariness in what is regarded as object and what as agency of observation would open up a possibility of avoiding this uncertainty altogether. In connexion with the measurement of the position of a particle, one might, for example, ask whether the momentum transmitted by the scattering could not be determined by means of the conservation theorem from a measurement of the change of momentum of the microscope—including light source and photographic plate—during the process of observation. A closer investigation shows, however, that such a measurement is impossible, if at the same time one wants to know the position of the microscope with sufficient accuracy. In fact, it follows from the experiences which have found expression in the wave theory of matter, that the position of the centre of gravity of a body and its total momentum can only be defined within the limits of reciprocal accuracy given by relation (2).

Strictly speaking, the idea of observation belongs to the causal space-time way of description. Due to the general character of relation (2), however, this idea can be consistently utilised also in the quantum theory, if only the uncertainty expressed through this relation is taken into account. As remarked by Heisenberg, one may even obtain an instructive illustration to the quantum theoretical description of atomic (microscopic) phenomena by comparing this uncertainty with the uncertainty, due to imperfect measurements, inherently contained in any observation as considered in the ordinary description of natural phenomena. He remarks on that occasion that even in the case of macroscopic phenomena we may say, in a certain sense, that they are created by repeated observations. It must not be forgotten, however, that in the classical theories any succeeding observation permits a prediction of future events with ever-increasing accuracy, because it improves our knowledge of the initial state of the system. According to the quantum theory, just the impossibility of neglecting the interaction with the agency of measurement means that every observation introduces a new uncontrollable element. Indeed, it follows from the above considerations that the measurement of the positional coordinates of a particle is accompanied not only by a finite change in the dynamical variables, but also the fixation of its position means a complete rupture in the causal description of its dynamical behaviour, while the determination of its momentum always implies a gap in the knowledge of its spatial propagation. Just this situation brings out most strikingly the complementary character of the description of atomic phenomena which appears as an inevitable consequence of the contrast between the quantum postulate and the distinction between object and agency of measurement, inherent in our very idea of observation.

4. Correspondence Principle and Matrix Theory.

Hitherto we have only regarded certain general features of the quantum problem. The situation implies, however, that the main stress has to be laid on the formulation of the laws governing the interaction between the objects which we symbolise by the abstractions of isolated particles and radiation. Points of attack for this formulation are presented in the first place by the problem of atomic constitution. As is well known, it has been possible here, by means of an elementary use of classical concepts and in harmony with the quantum postulate, to throw light on essential aspects of experience. For example, the experiments regarding the excitation of spectra by electronic impacts and by radiation are adequately accounted for on the assumption of discrete stationary states and individual transition processes. This is primarily due to the circumstance that in these questions no closer description of the space-time behaviour of the processes is required.

Here the contrast with the ordinary way of description appears strikingly in the circumstance that spectral lines, which on the classical view would be ascribed to the same state of the atom, will, according to the quantum postulate, correspond to separate transition processes, between which the excited atom has a choice. Notwithstanding this contrast, however, a formal connexion with the classical ideas could be obtained in the limit, where the relative difference in the properties of neighbouring stationary states vanishes asymptotically and where in statistical applications the discontinuities may be disregarded. Through this connexion it was possible to a large extent to interpret the regularities of spectra on the basis of our ideas about the structure of the atom.

The aim of regarding the quantum theory as a rational generalisation of the classical theories led to the formulation of the so-called correspondence principle. The utilisation of this principle for the interpretation of spectroscopic results was based on a symbolical application of classical electrodynamics, in which the individual transition processes were each associated with a harmonic in the motion of the atomic particles to be expected according to ordinary mechanics. Except in the limit mentioned, where the relative difference between adjacent stationary states may be neglected, such a fragmentary application of the classical theories could only in certain cases lead to a strictly quantitative description of the phenomena. Especially the connexion developed by

Ladenburg and Kramers between the classical treatment of dispersion and the statistical laws governing the radiative transition processes formulated by Einstein should be mentioned here. Although it was just Kramers' treatment of dispersion that gave important hints for the rational development of correspondence considerations, it is only through the quantum theoretical methods created in the last few years that the general aims laid down in the principle mentioned have obtained an adequate formulation.

As is known, the new development was commenced in a fundamental paper by Heisenberg, where he succeeded in emancipating himself completely from the classical concept of motion by replacing from the very start the ordinary kinematical and mechanical quantities by symbols, which refer directly to the individual processes demanded by the quantum postulate. This was accomplished by substituting for the Fourier development of a classical mechanical quantity a matrix scheme, the elements of which symbolise purely harmonic vibrations and are associated with the possible transitions between stationary states. By requiring that the frequencies ascribed to the elements must always obey the combination principle for spectral lines, Heisenberg could introduce simple rules of calculation for the symbols, which permit a direct quantum theoretical transcription of the fundamental equations of classical mechanics. This ingenious attack on the dynamical problem of atomic theory proved itself from the beginning to be an exceedingly powerful and fertile method for interpreting quantitatively the experimental results. Through the work of Born and Jordan as well as of Dirac, the theory was given a formulation which can compete with classical mechanics as regards generality and consistency. Especially the element characteristic of the quantum theory, Planck's constant, appears explicitly only in the algorithms to which the symbols, the so-called matrices, are subjected. In fact, matrices, which represent canonically conjugated variables in the sense of the Hamiltonian equations, do not obey the commutative law of multiplication, but two such quantities, q and p, have to fulfil the exchange rule

$$pq - qp = \sqrt{-1}\frac{h}{2\pi}. \qquad (3)$$

Indeed, this exchange relation expresses strikingly the symbolical character of the matrix formulation of the quantum theory. The matrix theory has often been called a calculus with directly observable quantities. It must be remembered, however, that the procedure described is limited just to those problems, in which in applying the quantum postulate the space-time description may largely be disregarded, and the question of observation in the proper sense therefore placed in the background.

In pursuing further the correspondence of the quantum laws with classical mechanics, the stress placed on the statistical character of the quantum theoretical description, which is brought in by the quantum postulate, has been of fundamental importance. Here the generalisation of the symbolical method made by Dirac and Jordan represented a great progress by making possible the operation with matrices, which are not arranged according to the stationary states, but where the possible values of any set of variables may appear as indices of the matrix elements. In analogy to the interpretation considered in the original form of the theory of the 'diagonal elements' connected only with a single stationary state, as time averages of the quantity to be represented, the general transformation theory of matrices permits the representation of such averages of a mechanical quantity, in the calculation of which any set of variables characterising the 'state' of the system have given values, while the canonically conjugated variables are allowed to take all possible values. On the basis of the procedure developed by these authors and in close connexion with ideas of Born and Pauli, Heisenberg has in the paper already cited above attempted a closer analysis of the physical content of the quantum theory, especially in view of the apparently paradoxical character of the exchange relation (3). In this connexion he has formulated the relation

$$\Delta q \Delta p \sim h \qquad (4)$$

as the general expression for the maximum accuracy with which two canonically conjugated variables can simultaneously be observed. In this way Heisenberg has been able to elucidate many paradoxes appearing in the application of the quantum postulate, and to a large extent to demonstrate the consistency of the symbolic method. In connexion with the complementary nature of the quantum theoretical description, we must, as already mentioned, constantly keep the possibilities of definition as well as of observation before the mind. For the discussion of just this question the method of wave mechanics developed by Schrödinger has, as we shall see, proved of great help. It permits a general application of the principle of superposition also in the problem of interaction, thus offering an immediate connexion with the above considerations concerning radiation and free particles. Below we shall return to the relation of wave mechanics to the general formulation of the quantum laws by means of the transformation theory of matrices.

5. Wave Mechanics and Quantum Postulate.

Already in his first considerations concerning the wave theory of material particles, de Broglie pointed out that the stationary states of an atom may be visualised as an interference effect of the phase wave associated with a bound electron. It is true that this point of view at first did not, as regards quantitative results, lead beyond the earlier methods of quantum theory, to the development of which Sommerfeld has contributed so essentially. Schrödinger, however, succeeded in developing a wave-theoretical method which has opened up new aspects, and has proved to be of decisive

importance for the great progress in atomic physics during the last years. Indeed, the proper vibrations of the Schrödinger wave equation have been found to furnish a representation of the stationary states of an atom meeting all requirements. The energy of each state is connected with the corresponding period of vibration according to the general quantum relation (1). Furthermore, the number of nodes in the various characteristic vibrations gives a simple interpretation to the concept of quantum number which was already known from the older methods, but at first did not seem to appear in the matrix formulation. In addition, Schrödinger could associate with the solutions of the wave equation a continuous distribution of charge and current, which, if applied to a characteristic vibration, represents the electrostatic and magnetic properties of an atom in the corresponding stationary state. Similarly, the superposition of two characteristic solutions corresponds to a continuous vibrating distribution of electrical charge, which on classical electrodynamics would give rise to an emission of radiation, illustrating instructively the consequences of the quantum postulate and the correspondence requirement regarding the transition process between two stationary states formulated in matrix mechanics. Another application of the method of Schrödinger, important for the further development, has been made by Born in his investigation of the problem of collisions between atoms and free electric particles. In this connexion he succeeded in obtaining a statistical interpretation of the wave functions, allowing a calculation of the probability of the individual transition processes required by the quantum postulate. This includes a wave-mechanical formulation of the adiabatic principle of Ehrenfest, the fertility of which appears strikingly in the promising investigations of Hund on the problem of formation of molecules.

In view of these results, Schrödinger has expressed the hope that the development of the wave theory will eventually remove the irrational element expressed by the quantum postulate and open the way for a complete description of atomic phenomena along the line of the classical theories. In support of this view, Schrödinger, in a recent paper (*Ann. d. Phys.*, **83**, p. 956; 1927), emphasises the fact that the discontinuous exchange of energy between atoms required by the quantum postulate, from the point of view of the wave theory, is replaced by a simple resonance phenomenon. In particular, the idea of individual stationary states would be an illusion and its applicability only an illustration of the resonance mentioned. It must be kept in mind, however, that just in the resonance problem mentioned we are concerned with a closed system which, according to the view presented here, is not accessible to observation. In fact, wave mechanics just as the matrix theory on this view represents a symbolic transcription of the problem of motion of classical mechanics adapted to the requirements of quantum theory and only to be interpreted by an explicit use of the quantum postulate. Indeed, the two formulations of the interaction problem might be said to be complementary in the same sense as the wave and particle idea in the description of the free individuals. The apparent contrast in the utilisation of the energy concept in the two theories is just connected with this difference in the starting-point.

The fundamental difficulties opposing a space-time description of a system of particles in interaction appear at once from the inevitability of the superposition principle in the description of the behaviour of individual particles. Already for a free particle the knowledge of energy and momentum excludes, as we have seen, the exact knowledge of its space-time co-ordinates. This implies that an immediate utilisation of the concept of energy in connexion with the classical idea of the potential energy of the system is excluded. In the Schrödinger wave equation these difficulties are avoided by replacing the classical expression of the Hamiltonian by a differential operator by means of the relation

$$p = \sqrt{-1}\frac{h}{2\pi}\frac{\delta}{\delta q}, \quad . \quad . \quad . \quad (5)$$

where p denotes a generalised component of momentum and q the canonically conjugated variable. Hereby the negative value of the energy is regarded as conjugated to the time. So far, in the wave equation, time and space as well as energy and momentum are utilised in a purely formal way.

The symbolical character of Schrödinger's method appears not only from the circumstance that its simplicity, similarly to that of the matrix theory, depends essentially upon the use of imaginary arithmetic quantities. But above all there can be no question of an immediate connexion with our ordinary conceptions because the 'geometrical' problem represented by the wave equation is associated with the so-called co-ordinate space, the number of dimensions of which is equal to the number of degrees of freedom of the system, and hence in general greater than the number of dimensions of ordinary space. Further, Schrödinger's formulation of the interaction problem, just as the formulation offered by matrix theory, involves a neglect of the finite velocity of propagation of the forces claimed by relativity theory.

On the whole, it would scarcely seem justifiable, in the case of the interaction problem, to demand a visualisation by means of ordinary space-time pictures. In fact, all our knowledge concerning the internal properties of atoms is derived from experiments on their radiation or collision reactions, such that the interpretation of experimental facts ultimately depends on the abstractions of radiation in free space, and free material particles. Hence, our whole space-time view of physical phenomena, as well as the definition of energy and momentum, depends ultimately upon these abstractions. In judging the applications of these auxiliary ideas we should only demand inner consistency, in which connexion special regard has to be paid to the possibilities of definition and observation.

In the characteristic vibrations of Schrödinger's wave equation we have, as mentioned, an adequate representation of the stationary states of an atom allowing an unambiguous definition of the energy of the system by means of the general quantum relation (1). This entails, however, that in the interpretation of observations, a fundamental renunciation regarding the space-time description is unavoidable. In fact, the consistent application of the concept of stationary states excludes, as we shall see, any specification regarding the behaviour of the separate particles in the atom. In problems where a description of this behaviour is essential, we are bound to use the general solution of the wave equation which is obtained by superposition of characteristic solutions. We meet here with a complementarity of the possibilities of definition quite analogous to that which we have considered earlier in connexion with the properties of light and free material particles. Thus, while the definition of energy and momentum of individuals is attached to the idea of a harmonic elementary wave, every space-time feature of the description of phenomena is, as we have seen, based on a consideration of the interferences taking place inside a group of such elementary waves. Also in the present case the agreement between the possibilities of observation and those of definition can be directly shown.

According to the quantum postulate any observation regarding the behaviour of the electron in the atom will be accompanied by a change in the state of the atom. As stressed by Heisenberg, this change will, in the case of atoms in stationary states of low quantum number, consist in general in the ejection of the electron from the atom. A description of the 'orbit' of the electron in the atom with the aid of subsequent observations is hence impossible in such a case. This is connected with the circumstance that from characteristic vibrations with only a few nodes no wave packages can be built up which would even approximately represent the 'motion' of a particle. The complementary nature of the description, however, appears particularly in that the use of observations concerning the behaviour of particles in the atom rests on the possibility of neglecting, during the process of observation, the interaction between the particles, thus regarding them as free. This requires, however, that the duration of the process is short compared with the natural periods of the atom, which again means that the uncertainty in the knowledge of the energy transferred in the process is large compared to the energy differences between neighbouring stationary states.

In judging the possibilities of observation it must, on the whole, be kept in mind that the wave mechanical solutions can be visualised only in so far as they can be described with the aid of the concept of free particles. Here the difference between classical mechanics and the quantum theoretical treatment of the problem of interaction appears most strikingly. In the former such a restriction is unnecessary, because the 'particles' are here endowed with an immediate 'reality,' independently of their being free or bound. This situation is particularly important in connexion with the consistent utilisation of Schrödinger's electric density as a measure of the probability for electrons being present within given space regions of the atom. Remembering the restriction mentioned, this interpretation is seen to be a simple consequence of the assumption that the probability of the presence of a free electron is expressed by the electric density associated with the wave-field in a similar way to that by which the probability of the presence of a light quantum is given by the energy density of the radiation.

As already mentioned, the means for a general consistent utilisation of the classical concepts in the quantum theory have been created through the transformation theory of Dirac and Jordan, by the aid of which Heisenberg has formulated his general uncertainty relation (4). In this theory also the Schrödinger wave equation has obtained an instructive application. In fact, the characteristic solutions of this equation appear as auxiliary functions which define a transformation from matrices with indices representing the energy values of the system to other matrices, the indices of which are the possible values of the space coordinates. It is also of interest in this connexion to mention that Jordan and Klein (*Zeitsch. f. Phys.*, **45**, 751; 1927) have recently arrived at the formulation of the problem of interaction expressed by the Schrödinger wave equation, taking as starting-point the wave representation of individual particles and applying a symbolic method closely related to the deep-going treatment of the radiation problem developed by Dirac from the point of view of the matrix theory, to which we shall return below.

6. Reality of Stationary States.

In the conception of stationary states we are, as mentioned, concerned with a characteristic application of the quantum postulate. By its very nature this conception means a complete renunciation as regards a time description. From the point of view taken here, just this renunciation forms the necessary condition for an unambiguous definition of the energy of the atom. Moreover, the conception of a stationary state involves, strictly speaking, the exclusion of all interactions with individuals not belonging to the system. The fact that such a closed system is associated with a particular energy value may be considered as an immediate expression for the claim of causality contained in the theorem of conservation of energy. This circumstance justifies the assumption of the supra-mechanical stability of the stationary states, according to which the atom, before as well as after an external influence, always will be found in a well-defined state, and which forms the basis for the use of the quantum postulate in problems concerning atomic structure.

In a judgment of the well-known paradoxes which this assumption entails for the description of collision and radiation reactions, it is essential to consider the limitations of the possibilities of

definition of the reacting free individuals, which is expressed by relation (2). In fact, if the definition of the energy of the reacting individuals is to be accurate to such a degree as to entitle us to speak of conservation of energy during the reaction, it is necessary, according to this relation, to co-ordinate to the reaction a time interval long compared to the vibration period associated with the transition process, and connected with the energy difference between the stationary states according to relation (1). This is particularly to be remembered when considering the passage of swiftly moving particles through an atom. According to the ordinary kinematics, the effective duration of such a passage would be very small as compared with the natural periods of the atom, and it seemed impossible to reconcile the principle of conservation of energy with the assumption of the stability of stationary states (cf. *Zeits. f. Phys.*, **34**, 142; 1925). In the wave representation, however, the time of reaction is immediately connected with the accuracy of the knowledge of the energy of the colliding particle, and hence there can never be the possibility of a contradiction with the law of conservation. In connexion with the discussion of paradoxes of the kind mentioned, Campbell (*Phil. Mag.*, i. 1106; 1926) suggested the view that the conception of time itself may be essentially statistical in nature. From the view advanced here, according to which the foundation of space-time description is offered by the abstraction of free individuals, a fundamental distinction between time and space, however, would seem to be excluded by the relativity requirement. The singular position of the time in problems concerned with stationary states is, as we have seen, due to the special nature of such problems.

The application of the conception of stationary states demands that in any observation, say by means of collision or radiation reactions, permitting a distinction between different stationary states, we are entitled to disregard the previous history of the atom. The fact that the symbolical quantum theory methods ascribe a particular phase to each stationary state the value of which depends upon the previous history of the atom, would for the first moment seem to contradict the very idea of stationary states. As soon as we are really concerned with a time problem, however, the consideration of a strictly closed system is excluded. The use of simply harmonic proper vibrations in the interpretation of observations means, therefore, only a suitable idealisation which in a more rigorous discussion must always be replaced by a group of harmonic vibrations, distributed over a finite frequency interval. Now, as already mentioned, it is a general consequence of the superposition principle that it has no sense to co-ordinate a phase value to the group as a whole, in the same manner as may be done for each elementary wave constituting the group.

This inobservability of the phase, well known from the theory of optical instruments, is brought out in a particularly simple manner in a discussion of the Stern-Gerlach experiment, so important for the investigation of the properties of single atoms. As pointed out by Heisenberg, atoms with different orientation in the field may only be separated if the deviation of the beam is larger than the diffraction at the slit of the de Broglie waves representing the translational motion of the atoms. This condition means, as a simple calculation shows, that the product of the time of passage of the atom through the field, and the uncertainty due to the finite width of the beam of its energy in the field, is at least equal to the quantum of action. This result was considered by Heisenberg as a support of relation (2) as regards the reciprocal uncertainties of energy and time values. It would seem, however, that here we are not simply dealing with a measurement of the energy of the atom at a given time. But since the period of the proper vibrations of the atom in the field is connected with the total energy by relation (1), we realise that the condition for separability mentioned just means the loss of the phase. This circumstance removes also the apparent contradictions, arising in certain problems concerning the coherence of resonance radiation, which have been discussed frequently, and were also considered by Heisenberg.

To consider an atom as a closed system, as we have done above, means to neglect the spontaneous emission of radiation which even in the absence of external influences puts an upper limit to the lifetime of the stationary states. The fact that this neglect is justified in many applications is connected with the circumstance that the coupling between the atom and the radiation field, which is to be expected on classical electrodynamics, is in general very small compared to the coupling between the particles in the atom. It is, in fact, possible in a description of the state of an atom to a considerable extent to neglect the reaction of radiation, thus disregarding the unsharpness in the energy values connected with the lifetime of the stationary states according to relation (2) (cf. *Proc. Camb. Phil. Soc.*, 1924 (Supplement), or *Zeits. f. Phys.*, **13**, 117; 1923). This is the reason why it is possible to draw conclusions concerning the properties of radiation by using classical electrodynamics.

The treatment of the radiation problem by the new quantum theoretical methods meant to begin with just a quantitative formulation of this correspondence consideration. This was the very starting-point of the original considerations of Heisenberg. It may also be mentioned that an instructive analysis of Schrödinger's treatment of the radiation phenomena from the point of view of the correspondence principle has been recently given by Klein (*Zeits. f. Phys.*, **41**, 707; 1927). In the more rigorous form of the theory developed by Dirac (*Proc. Roy. Soc.*, A, vol. 114, p. 243; 1927) the radiation field itself is included in the closed system under consideration. Thus it became possible in a rational way to take account of the individual character of radiation demanded by the quantum theory and to build up a dispersion theory, in which the final width of the spectral lines is taken into consideration.

The renunciation regarding space-time pictures characterising this treatment would seem to offer a striking indication of the complementary character of the quantum theory. This is particularly to be borne in mind in judging the radical departure from the causal description of Nature met with in radiation phenomena, to which we have referred above in connexion with the excitation of spectra.

In view of the asymptotic connexion of atomic properties with classical electrodynamics, demanded by the correspondence principle, the reciprocal exclusion of the conception of stationary states and the description of the behaviour of individual particles in the atom might be regarded as a difficulty. In fact, the connexion in question means that in the limit of large quantum numbers where the relative difference between adjacent stationary states vanishes asymptotically, mechanical pictures of electronic motion may be rationally utilised. It must be emphasised, however, that this connexion cannot be regarded as a gradual transition towards classical theory in the sense that the quantum postulate would lose its significance for high quantum numbers. On the contrary, the conclusions obtained from the correspondence principle with the aid of classical pictures depend just upon the assumptions that the conception of stationary states and of individual transition processes are maintained even in this limit.

This question offers a particularly instructive example for the application of the new methods. As shown by Schrödinger (*Naturwiss.*, **14**, 664 ; 1926), it is possible, in the limit mentioned, by superposition of proper vibrations to construct wave groups small in comparison to the 'size' of the atom, the propagation of which indefinitely approaches the classical picture of moving material particles, if the quantum numbers are chosen sufficiently large. In the special case of a simple harmonic vibrator, he was able to show that such wave groups will keep together even for any length of time, and will oscillate to and fro in a manner corresponding to the classical picture of the motion. This circumstance Schrödinger has regarded as a support of his hope of constructing a pure wave theory without referring to the quantum postulate. As emphasised by Heisenberg, the simplicity of the case of the oscillator, however, is exceptional and intimately connected with the harmonic nature of the corresponding classical motion. Nor is there in this example any possibility for an asymptotical approach towards the problem of free particles. In general, the wave group will gradually spread over the whole region of the atom, and the 'motion' of a bound electron can only be followed during a number of periods, which is of the order of magnitude of the quantum numbers associated with the proper vibrations. This question has been more closely investigated in a recent paper by Darwin (*Proc. Roy. Soc.*, A, vol. 117, 258 ; 1927), which contains a number of instructive examples of the behaviour of wave groups. From the viewpoint of the matrix theory a treatment of analogous problems has been carried out by Kennard (*Zeits. f. Phys.*, **47**, 326 ; 1927).

Here again we meet with the contrast between the wave theory superposition principle and the assumption of the individuality of particles with which we have been concerned already in the case of free particles. At the same time the asymptotical connexion with the classical theory, to which a distinction between free and bound particles is unknown, offers the possibility of a particularly simple illustration of the above considerations regarding the consistent utilisation of the concept of stationary states. As we have seen, the identification of a stationary state by means of collision or radiation reactions implies a gap in the time description, which is at least of the order of magnitude of the periods associated with transitions between stationary states. Now, in the limit of high quantum numbers these periods may be interpreted as periods of revolution. Thus we see at once that no causal connexion can be obtained between observations leading to the fixation of a stationary state and earlier observations on the behaviour of the separate particles in the atom.

Summarising, it might be said that the concepts of stationary states and individual transition processes within their proper field of application possess just as much or as little 'reality' as the very idea of individual particles. In both cases we are concerned with a demand of causality complementary to the space-time description, the adequate application of which is limited only by the restricted possibilities of definition and of observation.

7. The Problem of the Elementary Particles.

When due regard is taken of the complementary feature required by the quantum postulate, it seems, in fact, possible with the aid of the symbolic methods to build up a consistent theory of atomic phenomena, which may be considered as a rational generalisation of the causal space-time description of classical physics. This view does not mean, however, that classical electron theory may be regarded simply as the limiting case of a vanishing quantum of action. Indeed, the connexion of the latter theory with experience is based on assumptions which can scarcely be separated from the group of problems of the quantum theory. A hint in this direction was already given by the well-known difficulties met with in the attempts to account for the individuality of ultimate electrical particles on general mechanical and electrodynamical principles. In this respect also the general relativity theory of gravitation has not fulfilled expectations. A satisfactory solution of the problems touched upon would seem to be possible only by means of a rational quantum-theoretical transcription of the general field theory, in which the ultimate quantum of electricity has found its natural position as an expression of the feature of individuality characterising the quantum theory. Recently Klein (*Zeits. f. Phys.*, **46**, 188 ; 1927) has directed attention to the possibility of connecting this problem with the five-dimensional unified

representation of electromagnetism and gravitation proposed by Kaluza. In fact, the conservation of electricity appears in this theory as an analogue to the conservation theorems for energy and momentum. Just as these concepts are complementary to the space-time description, the appropriateness of the ordinary four-dimensional description as well as its symbolical utilisation in the quantum theory would, as Klein emphasises, seem to depend essentially on the circumstance that in this description electricity always appears in well-defined units, the conjugated fifth dimension being as a consequence not open to observation.

Quite apart from these unsolved deep-going problems, the classical electron theory up to the present time has been the guide for a further development of the correspondence description in connexion with the idea first advanced by Compton that the ultimate electrical particles, besides their mass and charge, are endowed with a magnetic moment due to an angular momentum determined by the quantum of action. This assumption, introduced with striking success by Goudsmit and Uhlenbeck into the discussion of the origin of the anomalous Zeeman effect, has proved most fruitful in connexion with the new methods, as shown especially by Heisenberg and Jordan. One might say, indeed, that the hypothesis of the magnetic electron, together with the resonance problem elucidated by Heisenberg (*Zeits. f. Phys.*, **41**, 239; 1927), which occurs in the quantum-theoretical description of the behaviour of atoms with several electrons, have brought the correspondence interpretation of the spectral laws and the periodic system to a certain degree of completion. The principles underlying this attack have even made it possible to draw conclusions regarding the properties of atomic nuclei. Thus Dennison (*Proc. Roy. Soc.*, A, vol. 115, 483; 1927), in connexion with ideas of Heisenberg and Hund, has succeeded recently in a very interesting way in showing how the explanation of the specific heat of hydrogen, hitherto beset with difficulties, can be harmonised with the assumption that the proton is endowed with a moment of momentum of the same magnitude as that of the electron. Due to its larger mass, however, a magnetic moment much smaller than that of the electron must be associated with the proton.

The insufficiency of the methods hitherto developed as concerns the problem of the elementary particles appears in the questions just mentioned from the fact that they do not allow of an unambiguous explanation of the difference in the behaviour of the electric elementary particles and the 'individuals' symbolised through the conception of light quanta expressed in the so-called exclusion principle formulated by Pauli. In fact, we meet in this principle, so important for the problem of atomic structure as well as for the recent development of statistical theories, with one among several possibilities, each of which fulfils the correspondence requirement. Moreover, the difficulty of satisfying the relativity requirement in quantum theory appears in a particularly striking light in connexion with the problem of the magnetic electron. Indeed, it seemed not possible to bring the promising attempts made by Darwin and Pauli in generalising the new methods to cover this problem naturally, in connexion with the relativity kinematical consideration of Thomas so fundamental for the interpretation of experimental results. Quite recently, however, Dirac (*Proc. of the Roy. Soc.*, A, **117**, 610; 1928) has been able successfully to attack the problem of the magnetic electron through a new ingenious extension of the symbolical method and so to satisfy the relativity requirement without abandoning the agreement with spectral evidence. In this attack not only the imaginary complex quantities appearing in the earlier procedures are involved, but his fundamental equations themselves contain quantities of a still higher degree of complexity, that are represented by matrices.

Already the formulation of the relativity argument implies essentially the union of the space-time co-ordination and the demand of causality characterising the classical theories. In the adaptation of the relativity requirement to the quantum postulate we must therefore be prepared to meet with a renunciation as to visualisation in the ordinary sense going still further than in the formulation of the quantum laws considered here. Indeed, we find ourselves here on the very path taken by Einstein of adapting our modes of perception borrowed from the sensations to the gradually deepening knowledge of the laws of Nature. The hindrances met with on this path originate above all in the fact that, so to say, every word in the language refers to our ordinary perception. In the quantum theory we meet this difficulty at once in the question of the inevitability of the feature of irrationality characterising the quantum postulate. I hope, however, that the idea of complementarity is suited to characterise the situation, which bears a deep-going analogy to the general difficulty in the formation of human ideas, inherent in the distinction between subject and object.

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safely in so short a time as 4 to 7 minutes, whereas animals brought from a nitrogen-oxygen mixture in 26 minutes or more became paralysed, and many died at once or within a few days. These general conclusions were confirmed in a large number of experiments.

It was interesting to find that the advantage of the helium was considerably greater than was expected on the basis of its smaller solubility. Helium diffuses more rapidly than nitrogen on account of its smaller molecules, which move nearly three times as fast. Hence, not only is less helium dissolved in the blood stream, but also it can escape into the lungs with much greater rapidity during decompression.

Large-scale experiments with men are now in progress under the direction of the Navy Department. The apparatus in use is partly shown in the accompanying illustrations. Considerable time has been spent upon the revision of the decompression tables in order to have an authoritative basis for further work with helium.

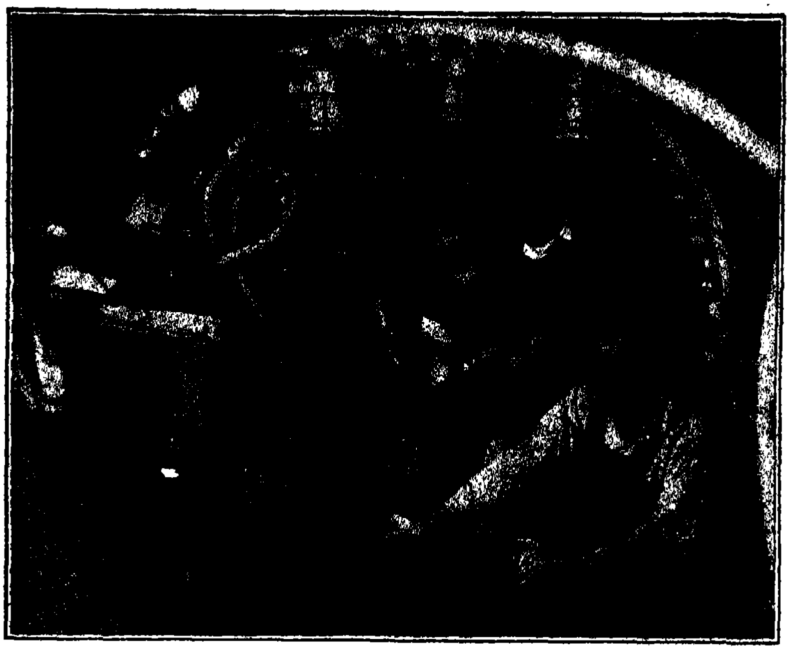

FIG. 4.—Interior of main compartment with test apparatus. Note electric lights, pressure gauge, control valve, hatches for closing windows in event of fracture of windows, and small tending lock at rear. This tending lock is operated similarly to the man lock, and is provided for passing in and out apparatus, food, etc. In connexion with the regulating valves, it should be stated that there are controls inside the chamber as well as outside, but the attendant on the outside can prohibit the use of the inside controls by closing off certain valves. This is done in order to prevent a man whose judgment may be impaired from releasing the pressure at a time or at a rate which is not safe. The oxygen breathing apparatus hanging to the wood support is used for administering helium. This is supplied from an external cylinder through a high pressure line and the man breathes helium from the bag, but at the same time has an air pressure surrounding his body. This obviates the necessity of filling the tank with that gas and conserves the supply of helium.

On Oct. 4, 1927, United States Patent 1,644,363 was issued to W. P. Yant, R. R. Sayers, and J. H. Hildebrand. Under the terms of this patent, persons under compression are supplied with a mixture for respiration consisting mainly of oxygen and nitrogen and containing a lower percentage of oxygen than air, and while under decompression with a gas comprising mainly oxygen and helium.

The Frequency of Rain over the British Isles.

By Dr. JOHN GLASSPOOLE.

THE perennial interest in the chances of good weather in our short English summer is quickened by the advance of spring. While the weather map is the vade-mecum of the forecaster of to-morrow's rain, it cannot help us to arrange our holidays in advance. We can, however, derive a great deal of information from a study of the accumulated statistics of the past.

Rainfall is measured at 9 A.M. at some 4000 stations in the British Isles, the smallest amount recorded being 0·01 inch. A day with 0·01 inch or more is defined as a rain-day. Although the rain-day includes many days with too little rain to be of practical importance, it is only such statistics which are available for any length of time. In considering the frequency of rain over the British Isles, it is necessary, therefore, to consider first of all the distribution of the number of rain-days, and to supplement this information by statistics from the limited number of stations for which more detailed observations are available.

Although a station with a relatively large annual rainfall is usually one with a large number of rain-days, the two quantities do not vary in the same proportion.[1] In the first place, the variations of the number of rain-days over the British Isles are much less than the corresponding variations of rainfall. In other words, both the variations of average monthly and annual values from place to place, and also the variations of average monthly values at one place, are much more uniform in the case of rain-days. The second difference is that, even at stations with the same rainfall, the average number of rain-days increases from the south-east to the north-west of the British Isles. Both these differences can be illustrated from the map reproduced as Fig. 1, which shows the distribution of the average number of rain-days during the six

[1] The question is dealt with in two recent papers: "The Distribution over the British Isles in Time and Space of the Average Number of Days with Rain." "British Rainfall, 1926," pp. 260-279, and "The Distribution over the British Isles of the Average Number of Days with Rain during each Month of the Year," *Q.J.R. Meteor. Soc.*, 54; 1928.

summer months, April to September (a period of 183 days).

The range of the number of rain-days on the map is from 65 in the neighbourhood of the Thames Estuary to just above 120 in parts of the western Highlands of Scotland. The corresponding range in the summer rainfall is from 9 inches at Shoeburyness to 45 inches in the western Highlands, so that while in the latter locality during the summer rain-days are only twice as frequent as in the former, the rainfall is five times as much. Even a comparison of the values on the map for areas at about sea-level indicates that there is a persistent increase in the frequency of rain-days from the south-east to north-west. In the south-east, therefore, there is a much greater chance of long spells of dry weather. In fact, all records of rainless calendar months have occurred in the south-eastern half of the British Isles. Such occurrences are rare; but small areas in February 1891, July 1911, April 1912, June 1921, and June 1925 were free from rain.

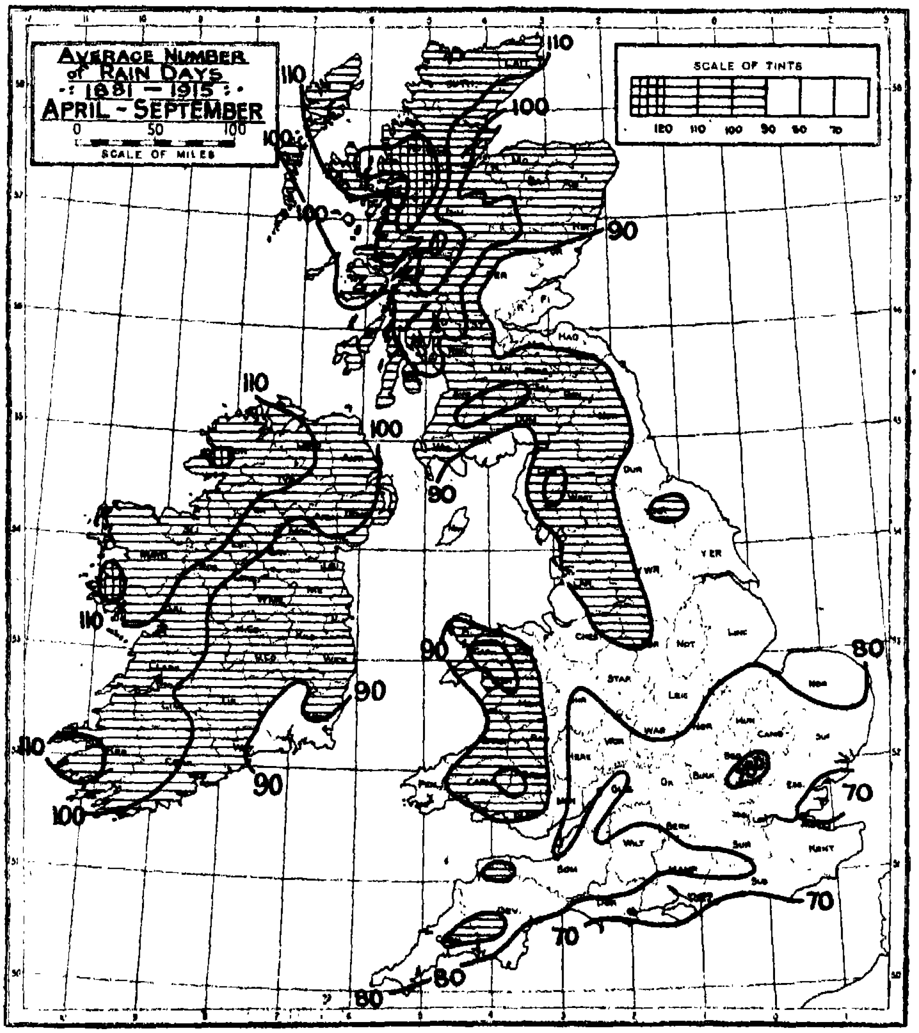

FIG. 1.—Average number of rain-days during the summer.

The main characteristics of the variations in the number of rain-days from month to month are apparent from the general values for the whole country. These are set out below, together with the corresponding values of the rainfall.

The table shows that there are in general 20 more days with rain in the winter than in the summer six months, this being the case nearly everywhere in the British Isles. The three months April, May, and June are the driest months of the year and the months of fewest rain-days, while December gives the maximum value in each column. The subsidiary maximum in August, associated with relatively intense convection rains, is well marked. Of the summer months, May and June are therefore on the average more favourable for holiday makers, both on account of the greater frequency of rainless days and the smaller amount of rain. The mean rainfall per rain-day over the British Isles generally is 0·20 inch, and some conception of this amount is afforded by considering it as the quantity which would fall during 3½ hours of continuous rain, the rate of rain being the average for London. In this connexion it may be of interest to recall that on the average rain falls in London for 1·2 out of 24 hours.

Some indication of the risks of a wet day is afforded by a consideration of the frequency of occurrence of days with specified amounts of rain. At Camden Square (London), with 25 inches a year, 0·01 inch or more falls on 163 days, of which 75 occur in the summer. There are, on the average, 40 days a year with 0·20 inch or more, 9 days with 0·50 inch or more, and only one day with 1 inch or more. The heaviest daily falls are about evenly divided between the intense thunderstorm rains of the summer months and the more persistent and more widespread rains of the winter. Of the two most remarkable falls on record at Camden Square,

in one so much as 3·28 inches fell in two intense downpours, giving in all a duration of only one

The General Number of Rain-days and Rainfall over the British Isles, 1881 to 1915.

	Rain-days.	Rainfall.
		in.
January	19	3·78
February	17	3·26
March	18	3·22
April	15	2·52
May	15	2·61
June	14	2·64
July	16	3·25
August	17	3·88
September	15	3·09
October	19	4·25
November	19	4·19
December	20	4·72
Year	204	41·41

hour, while in the other about the same quantity (actually 3·43 inches) was spread over 3 days with continuous rain for 58 hours. The mean values for the individual months show that the distribution during the year is fairly uniform. The greatest contrast in the frequency of falls of 0·20 inch or more is afforded by the spring and autumn. In each of the former months there are usually two or three such falls, while in the latter there are four or perhaps five.

As the number of rain-days increases towards the north-west, it is obvious that of two stations with the same average annual rainfall the one to the north-west will in general record the greater frequency of days with small amounts. Further, as the variations in the number of rain-days from place to place are smaller than the variations in the actual rainfall, the frequency of days with large amounts will be greater at the wetter of two stations. Some indication of the extent of the increase due to both these factors is afforded by setting out statistics for Glasgow alongside those already given for London.

Average Values, London and Glasgow.

	London.	Glasgow.
Annual rainfall (inches)	25	37
Rain-days in year	163	212
,, ,, summer	75	99
Days with 0·20 in. or more during year	40	66
Days with 0·50 in. or more during year	9	12
Days with 1·00 in. or more during year	1	2

The differences which occur at stations in the same locality but with widely different rainfall are illustrated by a comparison of the daily falls made at Ben Nevis Observatory and those made at Fort William at the foot of the mountain, and only about 4 miles away in a horizontal direction. The mean values are set out below:

Mean Annual Number of Days, 1885–1903.

Station. Altitude (feet). Average Annual Rainfall (inches).	Ben Nevis. 4405. 159.	Fort William. 31. 78.
	days.	days.
0·01 in. or more	263	244
0·50 in. or more	106	52
1 in. or more	53	15

Although the total rainfall at Ben Nevis is twice that at Fort William, the number of rain-days is practically the same. Rain falls, however, much more heavily on Ben Nevis, so that the number of days with larger amounts is much greater. At Fort William the 52 days with 0·50 inch or more contribute 62 per cent. of the rainfall, and at Ben Nevis the 106 days contribute as much as 82 per cent. of the total rainfall.

Another important consideration is whether more rain falls during the day than at night.

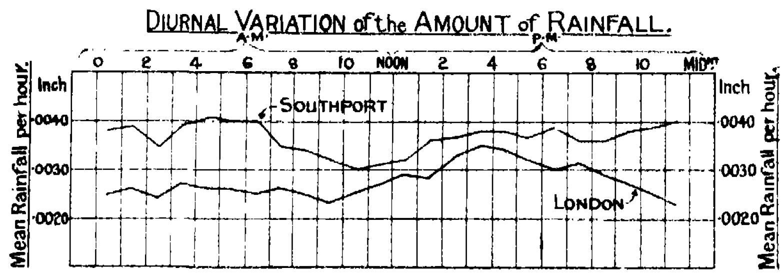

Fig. 2.—Comparison of mean hour values of rainfall.

Precise information from the traces of recording instruments covering a long period has been published at various times for some thirteen stations. Actually the total amount of rain during the day and night at these stations (that is, dividing the day at 6 A.M. and 6 P.M.) is practically identical. The proportion during the day varies at the individual stations from 52 per cent. to 48 per cent. of the total rain. More rain falls at night at stations in the west, for example, Valentia (in the west of Ireland), Falmouth, Southport, Glasgow, and Bidston (in Cheshire), while the inland stations and those to the east give more during the day. At Camden Square (London) there is a slight excess of rain in the day, and this holds good throughout the summer, but there is a reversal of these conditions in the winter, when the rain is greater at night.

Holiday resorts along the west coasts have therefore a slight natural advantage during the summer over those along the well-advertised 'dry east coast.' The actual mean hourly amounts are shown in the diagram for two typical stations, London and Southport, with 52 and 48 per cent. of the total rain in the day respectively. At the former there

is a definite maximum in the afternoon, with a minimum between 9 and 10 in the morning, typical of inland stations, and a subsidiary maximum of midnight. At Southport, the early morning maximum usually found at coast stations is well marked, while there is a subsidiary maximum in the late afternoon. As recording rain-gauges are comparatively rare, and as the generalisations set out in the diagram alone involve more than half a million tabulations, it is not surprising that the complete story of the diurnal variation of rainfall has not yet been written.

Obituary.

Prof. Antonio Abetti.

On Feb. 20 there passed away at Arcetri, Florence, aged eighty-two years, after a short illness, Prof. Antonio Abetti, the *doyen* of Italian astronomers. Born at Gorizia, in Frioul, in 1846, he took his degree in mathematics at the University of Padua in 1867, and at once entered the astronomical observatory of that city, rendered famous, like that of Pisa and Florence, by Galileo Galilei. As assistant to Prof. Santini, then director, he was one of the Italian astronomical party of 1874 for observing the transit of Venus in India. After Santini's death, he collaborated at Padua with Prof. Lorenzoni and went to Florence in 1893 as director of the Arcetri Observatory, the reorganisation of which, begun by Donati, he completed, raising it, as the Institute of Astrophysics, to one of the most important in Italy. He remounted Amici's famous equatorial and did important work in the study of the minor planets or asteroids, on which he published numerous papers.

On reaching the age limit in 1921, Abetti retired and was succeeded by his son, Prof. Giorgio Abetti, who, trained at Arcetri and under Prof. G. E. Hale at the Mount Wilson Observatory, California, installed at Arcetri the 'Galilei Sun Tower' as an Italian replica of the Mount Wilson Tower. The Arcetri Astrophysical Tower and Institute were described by the present writer in *Engineering* of April 30, 1926. Prof. Antonio Abetti kept up his interest in the institute until a few days before his death. In 1901 he delivered at the opening of the Royal University of Florence an important inaugural address on "Galileo in Arcetri." His son and successor, Prof. Giorgio Abetti, was a member of the astrophysical section of the De Filippi Expedition, 1913–14, to Trans-Himalaya, the Karakoram, and Chinese Turkestan.

C. Du Riche Preller.

We regret to announce the following deaths:

Prof. Launcelot Harrison, Challis professor of zoology in the University of Sydney since 1922 and president of the Linnean Society of New South Wales, on Feb. 20.

M. Félix Henneguy, professor of comparative embryology at the Collège de France, Paris, since 1900, and president for five years of the Société de Biologie, aged seventy-seven years.

Dr. J. M. Hulth, principal librarian of the Royal University Library, Upsala, known for his "Bibliographia Linnæana," of which the first volume was published in 1907, on Mar. 29, aged sixty-two years.

Mr. G. P. Miln, for more than forty years honorary secretary of the Chester Society of Natural Science, Literature, and Art, and a trustee of the National Institute of Agricultural Botany, on Feb. 14, aged sixty-six years.

News and Views.

The announcement in the House of Lords on Mar. 29 of the names of the committee on motor spirit containing lead tetraethyl will doubtless serve to quiet somewhat the public controversy over the possible dangers of this spirit. The committee includes distinguished representatives from the fields of medicine, physiology, and chemistry, whose names and reputations are such as to carry the greatest possible weight with the public. The report of the committee will be awaited with interest and confidence. The following are the terms of reference: "To inquire into the possible dangers to health resulting from the use of motor spirit containing lead tetraethyl or similar lead-containing compounds, and to report what precautions, if any, are desirable for the protection of the public or of individuals in connection with the use or handling of such motor spirit."

It is a matter of regret that in the discussion of ethyl petrol, both in the Press and in the House of Lords, incorrect and misleading statements have been issued through lack of correct information. Thus such statements that the *use* of the spirit (instead of sale) is prohibited in New York City and in the Holland Tunnel under the Hudson River are entirely incorrect; while the reference to deaths by poisoning with lead tetraethyl in the United States in 1924 are misleading, since these fatalities occurred in the experimental manufacture of lead tetraethyl and had nothing to do with the use of the substance in motor spirit. On the contrary, there was read in the House of Lords a letter from the Surgeon General of the United States to the British Ministry of Health, stating that "notwithstanding the late publicity given to the investigations and the general use of the substance all over the United States and Canada, no instance of lead poisoning has been reported in the lay or medical press or to any of our Federal or State Authorities." Final decision, of course, rests with the Government committee, but while awaiting its report, it would appear that the above letter should at least lessen the fears of the extreme alarmists.

A committee including the names of the leading physiologists of Great Britain, and also two from the United States, has been formed to issue an appeal for funds to commemorate the work of those great

partners in physiology, Bayliss and Starling. This partnership lasted for about thirty years and was fruitful beyond measure for physiology and its applications to medicine; in addition, it has made the name of University College, London, known throughout the world. Their written works are monuments to their industry and learning, but it is felt that a further memorial, in the form of a studentship in physiology, is necessary, and in this form would have been approved by Bayliss and Starling themselves. It is proposed, therefore, to create a Bayliss and Starling studentship at University College, open to any graduate in science or medicine, for a year or more of such training in physiology and biochemistry as would fit him for research. A small part of the funds collected may be devoted to a simple memorial tablet in the entrance hall of the Institute of Physiology at University College. Subscriptions should be sent to Prof. Lovatt Evans, Institute of Physiology, University College, Gower Street, London, W.C.1.

Dr. A. W. Hill, Director of the Royal Botanic Gardens, Kew, attended the annual meeting of the New Zealand Institute on Jan. 26 last, when he was elected an honorary member. In replying to the president's welcome, Dr. Hill thanked the Board for the honour conferred upon him, and remarked that he noticed among the roll of names of honorary members that of Mr. E. Meyrick, his old teacher at Marlborough College, who had been instrumental in directing his studies into the channel of nature study, and had been a source of much inspiration to him. He remarked that New Zealand possesses a remarkable flora, and promised that he would do his best while in the Dominion to further the idea of the establishment of a National Botanic Garden. In this direction he thought it might be advisable to have one section in Auckland and another in Dunedin, with a director to link the two together as a national institution, and thus to avoid any possible jealousies as had occurred in other countries. In the course of his tour of New Zealand, Dr. Hill climbed Aleck's Knob, in the glacier region, which has not previously been explored by a botanist. This necessitated a climb of 4200 feet, but the array of alpine plants on the meadow at the top repaid the exertion expended in the climb. The plants there were in striking contrast to anything available to European botanists. All the flowers were pure white. Beside the Ourisias, *Ranunculus Lyalli* and *Hebe (Veronica) macrantha*, there were Lilaepsis and *Caltha novæ-zealandica*, on which Dr. Hill is working in England. The size of these plants on their native heath surprised Dr. Hill, especially the large Celmisias, and he was also much interested in the native hybrid plants.

Warm tribute was paid by Dr. Hill to Dr. L. Cockayne, of the State Forest Service of New Zealand, for his work on natural plant hybrids. Dr. Cockayne was awarded the Mueller Medal for research work in New Zealand over a period of twenty-five years, at the meeting of the Australasian Association for the Advancement of Science, held at Hobart (Tasmania) in January last. The Royal Society of London recently allotted Dr. Cockayne £100 for research work on hybridisation, and on the flora and vegetation of New Zealand. Other scientific workers who have lately visited New Zealand include Dr. J. P. Lotsy, the Dutch botanist, who toured the country in 1925. It will be remembered that Dr. Lotsy, at the Leeds meeting of the British Association last year, discussed New Zealand plants and their hybrids. Dr. O. Olsen, of Oslo, has also visited New Zealand recently, and found during his visit of three months a fertile field for botanical, geological, and ornithological study, where 20 per cent. of the geological specimens are unknown to science. Yet another, Dr. G. Einar Du Rietz, of the University of Upsala, toured New Zealand, and was, by courtesy of the Government, afforded an opportunity of making a voyage round the islands (some uninhabited) south of New Zealand by the steamer that makes the rounds supplying lighthouses and replenishing depots for castaways by shipwreck. He expressed the belief that the high-mountain flora of New Zealand is the best subject in the world for study, and that the country is well suited for the establishment of original botanical species.

The concluding section of "The Oxford English Dictionary" is announced for publication on April 19. It is an event of capital importance for English scholarship and indirectly a matter of moment to all the world. English is the richest language man has ever framed, and the most widely used. The effect of the War has been to extend its vogue, and, as the two great English-speaking communities—the British Empire and the United States—are also the most powerful nations, it is inevitable that the use of English will spread still further in future. Another consideration makes the publication of this work of special importance at the present moment. English is the official language of India and also its accepted medium of higher education. In China, too, English is much the most familiar of European tongues. We may therefore look for a continued extension of some form of English throughout both those countries, which between them contain nearly half the human race; and, if English is to be used, it is essential that it retain some recognisable connexion with correct English as built up and spoken in the land of its birth. This cannot be done by means of English teachers, who are a diminishing quantity in India and still fewer in China. A standard and comprehensive work is therefore of the first importance, from which other and smaller books may be drawn for those who cannot enjoy the monumental original.

Fifty guineas is a 'long' price, and beyond any but fair-sized town libraries and large schools, yet it is not out of proportion to what has been expended on the production of the work. The Oxford Press alone has spent £300,000, and this takes no account of the unpaid labour on which the book was based. All the collectors of the original references were volunteers, scattered over Great Britain and elsewhere. Work of this sort has been going on for nearly seventy years since the dictionary was first thought of by the

Philological Society. In 1884 the Oxford University Press assumed the responsibility, after Sir John Murray had met the Delegates of the Press in 1878 and become charged with the editorship. It is as much a monument of his zeal, industry, and organising powers as it is of the English language itself. Already supplements are beginning to appear, containing words, many of them dealing with science and technology, which have won the rights of citizenship since the work began. Of these supplements, at least the first will be furnished gratis to purchasers of the whole book.

THE recently issued *Annual Report* of the British Research Association for the Woollen and Worsted Industries provides concrete evidence of the increasing attention which the fundamental scientific principles underlying the wool textile industry are receiving both in Great Britain and overseas. In an article on "Research in the Textile Industry," which appeared in NATURE of Nov. 19 last, attention was directed to the fundamental problem of the textile industry, namely, a complete knowledge of the properties of the wool fibre, and a definite measure of the 'quality' of the fibre. The importance of this matter, not only to Great Britain, but also to wool growers in the dominions overseas, has been recognised and, as a result, the Under-Secretary for the Colonies has approved the recommendation of the Empire Marketing Board that a grant should be made for the prosecution of research on the problems connected with the standardisation of raw wool. This research will be undertaken jointly by the Research Association and by the Animal Breeding Research Department of the University of Edinburgh. Other important activities of the Research Association include the determination of standard tests for fastness of dyestuffs, particularly with a view to the prescription of standard tests for fastness to light, washing, and perspiration. An investigation into the determination of a suitable branding substance for sheep is in progress, but the final results are not yet available. The Association is availing itself on a very considerable scale of the existing research facilities in the universities and similar institutions. A mass attack of this kind on the many problems of the textile industry should ensure real progress in the application of science to that industry.

IN our issue of June 11, 1927, p. 864, reference was made to a small booklet published by Mr. E. A. Chapman, 69 Hayter Road, London, S.W.2, on certain so-called "Mystery Pearl Shells" which were in his possession. Various opinions had been expressed as to the origin of these shells, and Prof. Dakin, who examined them at our request, concluded that they had been cleverly cut from large pearl shells. In any event, however, their history (they came from Ireland) was left unexplained. At the request of Mr. Chapman another booklet has been written, and has been published by him in explanation of the previous one. It bears the title, "A Short History of a Notable Irish Family," and is by P. C. Gallagher (formerly of University College, Dublin). The pamphlet, which is very beautifully illustrated, suggests that the shells, which appear to have been heirlooms, were handed down in the O'Donnell family from a certain Hugh Roe O'Donnell, a brilliant figure, chieftain of Tirconnail and King of Donegal in the time of Elizabeth. We are not in a position to comment upon the historical details involving the O'Donnell family, but it is quite conceivable that the shells came originally from a Spanish source, as the booklet suggests, and that they were presented long years ago (possibly by some wrecked member of a Spanish ship) to this Irish family. It seems curious that others are not known to exist, unless these were the only result of some capable carver's whim. If they are shells of some real species, one would expect still more to find specimens in some of the world's museums. The whole matter is surprising.

AUTOMATIC operation of electrical equipment has in several cases made it possible to dispense, at least for a certain period, with human agency entirely. For example, lights on buoys are sometimes operated by a selenium cell, the flow of current through which is regulated by the light falling on it. When darkness comes the alteration in the resistance of the cell, and consequently of the current, switches on the light, and when daylight breaks, switches it off. Similarly, the action of some fire alarms depends on smoke affecting the amount of light falling on the cell. According to a recent *Daily Science News Bulletin*, issued by Science Service of Washington, a somewhat analogous automatic control was used recently to unveil a portrait of George Washington. All that was necessary to perform the operation was to telephone a certain signal. The apparatus used, called a televox, depends upon a device that only responds when a sound of a definite maintained frequency is made. The televox is tuned to a certain note produced either by a tuning-fork or a whistle. When this note is sounded, the movable armature of an electromagnet makes a contact which completes a local circuit. The current in this local circuit may start a motor, turn on or off a light, or do any similar operation. By having several instruments, each with its relay, a complicated mechanical operation can be gone through by sending a series of different notes which may, if desired, be so chosen that they form a tune. Experiments have been made for many years on controlling motor-cars and aeroplanes by radio waves. The televox system, however, is to control by sound.

THE London School of Hygiene and Tropical Medicine has placed an order with Messrs. R. and J. Beck, Ltd., for more than two hundred microscopes for use in the new laboratories now in course of construction in Gower Street. The order has been given on the recommendation of a small committee which has had the matter under consideration for some time, in consultation with the Department of Applied Optics, National Institute for Medical Research. The type of microscope selected embodies certain features that have been evolved to meet the needs of the heads of departments at the School. The base is of rigid construction, with points of support

sufficiently wide spread to ensure stability in any position. The foot is of the type now being produced by Messrs. Beck, combining the advantages of the horse-shoe or Continental model with the so-called English foot. The stage is of the completely built-in mechanical type with travel of $1\frac{1}{2}$ in + 1 in., the entire top plate of the stage forming the moving part. On the stage a slide-holder of new design is provided, as suggested by Prof. Topley, in which the slide is firmly held without springs. The fine adjustment is of the double lever pattern, operated by milled heads on either side. The body is 2 in. in diameter and is provided with an adjustable graduated draw-tube. The sub-stage is actuated by rack and pinion, and all sub-stage appliances are carried on Akehurst slides. Thus the interchange of illuminating systems is both easy and accurate. The optical equipment is ample for all bacteriological requirements, and the objectives are to be coloured externally so as to enable them to be recognised at sight. Messrs. Beck have agreed that certain rigid tests shall be applied to the whole equipment before delivery is accepted.

WE have received a copy of the "Descriptive Account and Catalogue of the Home Office Industrial Museum and Exhibits," recently published by H.M. Stationery Office. In the introduction it is explained that the Museum, which is situated in Horseferry Road, Westminster, is intended to serve as a permanent exhibition of methods, arrangements, and appliances for promoting the safety, health, and welfare of industrial workers. The exhibition is the first of its kind in Great Britain, though others exist in Berlin, Munich, Milan, Amsterdam, and other cities abroad. The exhibits may be classified under three main headings. The safety section contains actual machines, plants, and appliances as they would be installed in a factory. Many actual protective devices are shown, but a wider range is exhibited by the aid of models and photographs. In the health section the exhibits include photographs illustrating the prevention of various industrial diseases (lead poisoning, silicosis, dermatitis, etc.), charts indicating the incidence of such diseases, 'cautionary notices' as issued by the Home Office, etc. Two sections are devoted specially to ventilation and lighting—the latter including an excellent series of cabinets illustrating fundamental principles. The welfare section contains rooms fitted up to serve as ambulance rooms, rest rooms, and canteens, and first-aid equipment, protective clothing, etc., are shown. The catalogue contains a detailed account of all exhibits, with illustrations. Various sections, such as machine tools, drilling and milling machines, and machinery used in the textile and printing industries, in bakehouses, etc., are dealt with in turn. Finally, reference may be made to the nature of the building, which in itself serves as a useful exhibit, special attention having been devoted to the ventilation, lighting, and other essentials to health and safety.

THE Easter conference of the Society for Experimental Biology took place at Oxford on Mar. 23 and 24. By kind invitation of Prof. E. S. Goodrich and Prof. A. G. Tansley, meetings were held in the Zoological and Botanical Laboratories. At the first session, among many interesting papers, Mr. G. R. de Beer gave an account of his experiments on the development of the nervous system in Anura, and a paper by Dr. T. A. Stephenson on the nature of 'physiological' species was followed by a lively discussion. Discussions of considerable interest also took place during the second session, particularly after a paper by Mr. P. A. Buxton on the physical factors which determined the behaviour of the mosquito. In a paper by Captain G. C. C. Damant on the secretion of gases in the bladders of seaweeds, the remarkable fact appeared that nitrogen as well as oxygen was secreted into the bladders under a considerable pressure. The last session was occupied chiefly with discussions of the nature of oxidation in living cells and carbohydrate metabolism in various groups of the animal kingdom. The chairman, Dr. D. Keilin, gave an account of the polyphenol oxidase and cytochrome system in cells.

A USEFUL pamphlet on "Rats and how to kill them" has been compiled by Mr. A. Moore Hogarth (London: John Bale, Sons and Danielsson, Ltd., 6*d*. net). It reprints the Rats and Mice (Destruction) Act of 1919, and gives full instructions for trapping, poisoning, fumigating, or otherwise destroying rats. These instructions are practical and ought to increase the effectiveness of the anti-rat campaign. But it can scarcely be said that all the author's suggestions are practical: he advocates that rat-catchers should be taught, amongst much else, elementary pathology; that zoological laboratories in the universities should devote part of their time to the economics of the rat; and that elementary school children should be instructed in rat life-history and the "toxicity of the various raticides in common use." He speaks of the barn owl as if it were the only ratter of its kind, of the pine-marten as if he did not know that it was almost extinct, and of the ferret as if it were a wild creature. With more reason he advocates an international codification of rat laws, a synchronised rat campaign in Britain twice a year, and local bye-laws to encourage rat-proofing. He states that the cost of feeding British rats per annum would pay for 1,864,235,290 bottles of Bass—a less offer in kind should attract a record army of Pied Pipers.

SIR JOHN RUSSELL, Director of the Rothamsted Experimental Station, has been elected an honorary member of the New Zealand Institute.

PROF. G. ELLIOT SMITH will deliver the Huxley Memorial Lecture at the Royal College of Science, South Kensington, on Friday, May 4. His subject will be "Conversion in Science."

IT is announced in *Science* that the Charles P. Daly Gold Medal of the American Geographical Society of New York has been presented to Prof. Alois Musil, of the Charles' University, Prague, for his explorations in northern Arabia and Mesopotamia and his historical researches relating to this part of the world.

Dr. E. F. Armstrong, managing director of the British Dyestuffs Corporation, Ltd.; Dr. J. B. McEwen, Principal of the Royal Academy of Music; and Prof. R. W. Seton-Watson, Masaryk professor of Central European history in the University of London, have been elected members of the Athenæum, under the provisions of Rule II. of the Club, which empowers the annual election by the Committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public service."

In April of last year the eighth annual meeting of the American Geophysical Union was held, like its predecessors, at Washington. The transactions of the Union at this meeting have been issued as a *Bulletin of the National Research Council* (No. 61, pp. 295). The Union met usually in six sections, but one resolution passed in general assembly may be noted: since it appears that, in future, reports of much of the seismological work done in Japan will be published in Japanese only, the National Research Council was requested to provide (1) for the translation into English of such reports as are selected for the purpose by the American Geophysical Union, and (2) that mimeographed copies of the translations be distributed under suitable financial arrangements. The reports and papers dealt with in the sectional meetings include many of great interest. Three general symposia were held, one on climatic control, another on the sun's ultra-violet light and the ozone content of the earth's atmosphere, and a third on correlations of various radio phenomena with solar and terrestrial magnetic and electric activities.

Applications are invited for the following appointments, on or before the dates mentioned:—A secretary of University College Hospital Medical School—The Dean, University College Hospital Medical School, University Street, W.C.1 (April 18). A technical officer at the Royal Aircraft Establishment, South Farnborough, to assist in design and experimental development work in connexion with aerial beacons and aerodrome illumination generally—A.271, The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (April 21). A professor of mechanical engineering in the Engineering College of the Benares Hindu University—Box P4360, 33 Norfolk Street, Strand, W.C.2 (April 30). An assistant lecturer in physics at the University College of the South-West of England, Exeter—The Registrar. A mathematical master, able to teach elementary physics and chemistry, at the Prince of Wales' Royal Indian Military College, Dehra Dun, U.P., India—The Secretary, Military Department, India Office, S.W.1. A junior assistant chemist under the Directorate of Explosives Research of the Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18.

Our Astronomical Column.

Search for a Planet outside Neptune.—Ever since the discovery of Neptune by the perturbations that it produced on Uranus, attempts have been made to extend the method to still more remote regions. Prof. W. H. Pickering is one of those who have attacked this problem; in his research he examined the observations of Saturn, Uranus, and Neptune, and noted discordances between prediction and observation. His latest paper on the subject is in *Popular Astronomy* for March. He notes that if Adams and Le Verrier had used Saturn as well as Uranus in their calculations, they would have had material for making a better estimate of the distance and period of the perturbing planet; the reason being that conjunctions of the unknown planet with Saturn occurred every 36 years, so that the observations covered several conjunctions.

Prof. Pickering gives the shape that the curve of residuals should follow about the time of conjunction of each planet with an external perturbing one. He finds some evidence of conjunction of the unknown with Neptune about 1906, with Uranus about 1841, with Saturn about 1850, 1885, 1917. He finally assigns to the unknown the same period as Neptune, 164·8 years, but a more eccentric orbit. He makes aphelion passage about the year 1891, in longitude 72°. The present position of the planet is given as R.A. 8 h. 51 m., N. Decl. 16½°; mass about half that of the earth, magnitude 12. When in opposition it would retrograde at the rate of 4″ or 5″ per hour, sufficient to show a short trail on photographic plates. Whether the planet is there or not, the investigation seems sufficiently ingenious to be worthy of notice.

Spectroscopic Parallaxes of 125 *B*-type Stars.—Mr. D. L. Edwards has been engaged for some years in deducing spectroscopic parallaxes of *B*-type stars at the Norman Lockyer Observatory. *Mon. Not. R.A.S.* for January contain his fifth paper on the subject. The research is much more difficult than in the case of stars of late type. Two methods are employed: (1) photometric measures of the intensities of certain hydrogen and helium lines by means of a wedge; (2) classification based on spectral type and line character. Standard stars of well-determined parallax were observed in order to check the curves used for converting measures into absolute magnitudes. The magnitudes of the stars in this paper range from 0·6 (Achernar) to 6·9. The absolute magnitudes range from − 3·4 (α Camelopardalis) to + 0·1 (ν Cassiopeia). The largest parallaxes are Regulus 0·060″ and Achernar 0·040″.

Minimum of ε Aurigæ.—This star, of spectral type *F5p*, the light of which varies between 3·3 and 4·1, is now approaching minimum, which is predicted to last about 700 days. It is an appropriate time for publishing an elaborate study of its spectrum, which Miss Cecilia H. Payne does in *Harvard Bulletin 855*, basing it on five plates, ranging in date from 1890 until 1927; last year's plate was standardised by comparison with the hydrogen lines in the spectrum of Vega, and it served to calibrate the other four. A list is given of the wave-length, origin, and intensity of about 170 lines. Certain iron lines are found to be suitable for the determination of absolute magnitude. The following absolute magnitudes of stars of this type are given: Procyon 3·1, α Persei − 1·3, *b* Velorum − 2·5, ι Scorpii − 2·8, ε Aurigæ − 4·0. This last star is therefore a supergiant at a distance of more than six hundred light-years. Miss Payne notes that search should be made during minimum for possible spectral changes.

Research Items.

DUALISM IN AFRICAN RELIGIONS.—In *Ancient Egypt*, pt. 4, 1927, Mr. G. W. B. Huntingford contributes some further notes on the dualism which can be observed in the various forms of African religions. In the Nilo-Hamitic group the good and evil gods are manifestations of the elements. The Galla, in addition to their god *Wak*, believe that there are two kinds of sunshine, *adu* the white, which destroys, and *biftu* (from *bifti*, colour), the good, which gives life. *Adu* is from the same stem as *adi*, a fabulous being white in colour, apparently a kind of Ἔμπουσα. The black and red gods of the Masai are the heavens in fine weather and in storm, or rather in dry and wet weather. The Nandi do not distinguish the good and bad thunder by colour. The Hottentot beliefs are contrasted. According to Kolben, they have two good deities and one bad, the "God of all Gods," the moon, and the "Father of all Mischief." The Galla, Masai, and Nandi pairs of gods are additional to their supreme god and do not come within their ceremonial system. The beliefs in good and evil forces in opposition may be divided into three groups: (1) Where the forces are the elements and subordinate to the chief deity, as among Galla, Masai, and Nandi; (2) where the forces are spirits, as among the Baganda, Azande, and Lugwari; and (3) where the worship is that of a trinity, the third member of which is evil, as among the Hottentots. It would appear, therefore, that dualism in East Africa is not limited to tribes of Hamitic speech as has been thought. The fact that the same colours appear as attributes of good and evil in other parts of Africa is perhaps a coincidence; though the opposition of red and black which appears on the Gold Coast is singular. Among the Galla the unlucky colour is white.

THE CART TRACKS OF MALTA.—Following closely on Miss Murray's communication to *Man* (see NATURE, Feb. 25, p. 297), Prof. Zammit has published in *Antiquity* for March a study of the cart-tracks of Malta, illustrated by a number of excellent air photographs. His conclusions as to the origin, purpose, and date of these ruts or deep grooves on the limestone, which are of such frequent occurrence in the island, are the result of a long and exhaustive examination. There can be little doubt that they were made by a wheeled vehicle—strong, heavy carts with wooden wheels without metal tyres. The sharp curves preclude the idea of a sledge with runners. They are triangular in section, and can easily be distinguished from the grooves, rectangular in section, made by the modern metal-tyred wheel. Further, it must be concluded that human power was used for traction, as the ancient ways show no sign of being cut up in the way in which modern tracks have been cut up by the hooves of animals. It is also probable that the tracks were started by human labour and deepened later by use. There are definite signs that they were first carefully laid. In only one case does a pair of tracks appear to enter the sea, namely, at the Bay of St. George at Birzebuggia, where they probably appear on the other side of the bay now covered with silt and field soil. There is nothing to suggest the existence of these tracks when the island was connected with the continent, quite independently of the fact that the islands could not have been inhabited by an industrial population at the end of the Ice Age. Nor are they so late as the Roman occupation. Further, they are earlier than the rock-cut tombs of the Phœnician occupation, one of which cuts right across one of the cart tracks. As they do not go near the megalithic monuments they were not used for carting stone for these buildings. They were used by the energetic neolithic population for carting earth for their terrace cultivation made necessary by the bare character of the high lands and for carrying water to the ships of a busy maritime traffic in harbours near which were no springs.

PREPARATIONS OF VITAMINS A AND D.—We have received from Messrs. The British Drug Houses Ltd., London, N.1, samples of their "Radiostoleum" capsules. The oil in these gelatin capsules contains vitamins A and D: the latter is manufactured by irradiation of ergosterol, and together with a vitamin A concentrate is supplied in solution in a tasteless vegetable oil. No cod-liver oil is used in the preparation of this product. The vitamin A and D content is standardised by animal feeding tests and is twenty times that of the finest cod-liver oil: and in the case of vitamin A, the physiological assays are checked by a chemical test. 'Radiostoleum' may be used in all conditions in which cod-liver oil has hitherto been administered. It is supplied in capsules, in boxes of 50, and also in solution, in bottles containing half a fluid ounce.

THE NATURAL HISTORY OF THE HAKE.—In *Min. Agric. Fish., Fishery Invest.*, Ser. 2, vol. 10, No. 2, 1927, Mr. C. F. Hickling gives an account of the food and feeding of the hake, and of the periodic changes in the hake fishery. This paper is of especial interest, as it is based on observations made and experience gained during fourteen months of sea-time on commercial trawlers, and is illustrated to a considerable extent by statistical data supplied by the Ministry's Statistical Section. From a study of the weekly figures of landing of hake at Cardiff during the years 1922–25, it appears that from the fifth to the ninth full moons of the year there is a regular fluctuation in the landings, such that more fish is landed at full moon than at new moon. Mr. Hickling suggests that this is the result of a monthly period of activity in the reproductive organs of the fish. There is also a daily change in the abundance of hake on the sea-bottom. Long experience has taught skippers that there is so little hake on the sea-bottom during the hours of darkness that it is rarely worth while to trawl at night, especially when the hours of darkness are long, as in winter. This apparent nightly migration vertically from the sea bottom is believed by the author to be due to a 'sleep rhythm' in the fish, which is inactive by day but active by night. In support of this theory, it is pointed out that (*a*) it can be shown that the hake feeds at night, but apparently not during the day, and (*b*) the surface methods of catching hake, which are most successful at night, depend upon the hake seizing a hook or becoming entangled in stationary trammel-nets, whereas the method of catching hake on the bottom, which is most successful by day, depends upon the hake being swept along passively into a trawl which may be moving very slowly relatively to the hake's own presumed speed of locomotion.

LEECHES ON FISHES.—Mr. David H. Thompson ("An Epidemic of Leeches on Fishes in Rock River," State of Illinois Department of Registration and Education. Division of the Natural History Survey. Bulletin, vol. 17, art. 3, 1927) describes an epidemic of leeches in the fish *Ictiobus cyprinella*, the so-called 'red-mouth buffalo.' In the winter of 1925–26 almost every fish of this species in Rock River, near Rockford, Illinois, was infested by the leech *Pisciola*

punctata Verrill, from one to fifty on each fish. This leech was rare, and for two years of continuous work on the river during the handling of fish, had not been seen. It appeared quite suddenly in February when the river was covered with ice, and continued throughout March until the temperature was a few degrees above freezing-point over a stretch of twenty miles. By the end of April none was to be seen. The leeches were so numerous that the bottom of the boat in which had been a few hundred pounds of fishes was almost completely covered with them. The next winter at the same time, although several fishes were infested, the numbers were not nearly so great as to cause an epidemic. After the leeches had left their hosts they were found among water plants, where they apparently leave their egg cocoons. The young leeches attach themselves to the fishes, at first feeding on mucus, later on blood, and grow to maturity very quickly in the cold winter months. The leech is said not to harm its host, but in this case they were certainly harmful, as is shown by the large marks left on the fishes in the places of attachment, and also by the fact that the fishes with many leeches were so thin that they were quite unfit for food. This is the first time that this leech has appeared in sufficient quantities to affect the market, and no reason can be brought forward for its presence in such enormous numbers.

STARCH AND CAMBIAL ACTIVITY IN THE WOODY TWIG.—Swarbrick has recently directed attention to the complexity of the problems associated with the appearance and disappearance of starch in the woody twig (*Journal of Pomology and Horticultural Science*, **6**, 296-312; 1928). Curtis has previously drawn conclusions as to the necessity of phloem for translocation from the retention of the starch in a region of the stem isolated between two rings made down to the cambium (*American Journal of Botany*, **7**, 101-124; 1920). Swarbrick now shows that the retention of this starch depends upon the absence of buds in the region lying between the rings and is associated with the absence of cambial activity under these conditions. If buds are present, then cambial activity is initiated in this region and the starch quickly disappears. Experience with disbudded twigs, upon which an occasional adventitious bud regenerates, shows that, whilst a limited amount of cambial activity and xylem formation is found below this bud and nowhere else on the twig, starch hydrolysis begins below this bud and then continues throughout all the tissues of the twig below this bud. In this case starch disappearance seems rather dependent upon cambial activity than the latter upon the food reserves, and both seem to be connected with the initiation of bud development.

WOOD-PULP IN AUSTRALIA.—When ground wood or mechanical pulp was first introduced, the paper industry received considerable impetus in countries where soft wood was easily obtained, and the later development of the sulphite process, or the chemical conversion of wood to pulp, brought about an even greater expansion. In Australia, however, the industry has developed slowly, for owing to the absence of suitable indigenous material, nearly all the pulp has had to be imported. Experiments have been carried out (*Australian Journal of the Council for Scientific and Industrial Research*, vol. 1) with the view of utilising indigenous eucalypts, etc., in order to establish the industry on an independent footing. It has been found that by employing certain modifications of the soda process a pulp suitable for the important type of papers classed as 'book and fine printings' can be produced from the eucalypts. The quick-growing candlenut *Aleurites moluccana* is also promising, but since the pulp is bleached with some difficulty, it is recommended for use in the manufacture of brown paper. There seems little prospect of being able to utilise the indigenous grasses or sedges. With regard to other methods of pulping, the sulphate process has hitherto been considered uneconomic in Australia, but it is of great importance in the production of strong (kraft) pulp. Laboratory and mill trials, however, have shown that it can be successfully used with exotic conifers such as *Pinus insignis*, the results comparing favourably with the pulp from spruce or firs, for which the climate is unsuitable. The possibility of producing a long-fibred sulphite pulp is still under investigation. It is hoped that in this case also *Pinus insignis* will prove suitable, or that the process can be so modified as to allow of its use, in the event of which the paper industry in Australia would be almost self-contained. Further, trials are in progress regarding the manufacture of newsprint from short-fibred eucalypts instead of from the longer fibred spruce and fir. Under special grinding conditions, immature eucalypts have yielded very promising results on a laboratory scale, a paper stronger than the standard newsprint being obtained.

ARCTIC ICE IN 1927.—The *Annual Report* by the Danish Meteorological Office on the state of the ice in Arctic Seas in 1927 has recently been published. In the Barents Sea the most noteworthy features were the congestion of ice off the entrance to the White Sea from March until May, and the open sea up to Franz Josef Land in September. The west coast of Novaya Zemlya was clear in July, and the Kara Sea was almost clear in August and quite clear in September. Around Spitsbergen there was much less ice than usual, except in October and November, when a broad belt of pack lay off the west coast. Bear Island, however, was not clear of ice from the autumn of 1926 until the end of May. On the east coast of Greenland the belt of ice seems, on the whole, to have been wider than usual, but the coasts of Iceland were free throughout the year. In Davis Strait there was less ice than usual, and on the Newfoundland Banks the ice season was short and had ended entirely by August. In Baffin Bay and the channels of the Canadian Arctic Archipelago, ice was scarcer than in most years. Davis Strait was almost clear in July, but Wrangel Island was not approachable until August. The report is furnished with the usual ice distribution charts for the spring and summer months.

THE TASMANIAN TEKTITES.—Sir Edgeworth David, Dr. H. S. Summers, and Mr. G. A. Ampt have made a very valuable study of the remarkable variety of tektite known as Darwin Glass (*Proc. Roy. Soc. Victoria*, vol. 39, pp. 167-190; 1927). The mode of occurrence in what are probably outwash gravels from a Pleistocene ice sheet suggests that a 'hailstorm' of small meteorites fell on the ice, which transported the fragments to the margin. It is shown that the schonite of Sweden, the moldavites of Moldau, the billitonites of Banca, Billiton, and Borneo, the australites of Australia, and the Darwin glass of Tasmania, all occur close to a single great circle. By means of variation diagrams, the genetic relationship between the various tektites is convincingly brought out, and a comparison of the graphs with those for the common acid igneous rocks indicates that the latter are quite distinct in composition. Two fresh analyses of Darwin glass are recorded; they show 86-87 per cent. of SiO_2. Such a percentage is higher than that for any analysed australite, but is approached by some of the moldavites. Various hypotheses of the origin of tektites

—artificial, volcanic, fulguritic, dust fusion by lightning, etc.—are discussed, and by a process of elimination the conclusion is reached that the mysterious fragments are of meteoritic origin.

MAGNETIC MEASUREMENTS.—The September and December (1927) quarterly issues of *Terrestrial Magnetism and Electricity* have recently appeared together under one cover (103 pp.). The principal article is one on earth-resistivity measurements in the copper country, Michigan, by W. J. Rooney, in which interesting details are given of the survey, which proved very successful in locating bodies of copper ore, as tested in cases where direct data obtained by boring were available. The conditions under which magnetic methods of prospecting for underground discontinuities are likely to be of service are discussed. The journal contains also many reports, reviews, and short articles, one of the latter being on magnetic observations made in Spitsbergen in 1927 by a Cambridge expedition, while others deal with questions of computation. In an article by D. Stenquist on the diurnal variation of the normal earth-current in southern Sweden, attention is directed to the fact that in his memoir " Étude des courants telluriques," 1925 (see also NATURE, Feb. 18, p. 242), the values given on pp. 21-23 of that paper are ten times too great.

DEVELOPMENT OF NATURAL GAS.—On Mar. 13, Col. S. J. M. Auld discussed before the Institution of Petroleum Technologists some of the more complex problems affecting natural gas exploitation. Facilities for utilising the gas produced either simultaneously with oil at the well-head, or afterwards by evolution by reduced pressure, vary to some extent with the environment of the field, *e.g.* climatic conditions, and in many limestone fields, such as parts of Texas, Mexico, and Persia, the matter is complicated by the presence of hydrogen sulphide, sometimes exceeding 10 per cent. by volume. The author dealt with a type of gas-oil separator designed for high gas-oil ratios, most proprietary types being more suited to conditions of low gas-oil ratios. The measurement of quantity of gas released was next considered, various standard equations coming up for critical analysis and comment. Equally important is the duration of gas production and, as pointed out, accurate estimates of reserves are always problems of great difficulty; much depends on the gas-oil system involved, and on the degree to which calculations based on gas laws are applicable in particular cases. An interesting section of the paper dealt with the use of highly sulphurous gas as a fuel which, contrary to expectation, results in no serious trouble with modern boilers equipped with efficient methods of firing. It was also shown by experimental data that the active charcoal recovery process is inapplicable to sulphurous gases; in view of recent interest abroad in the possible use of solid adsorbents for gas extraction and gasoline stripping from such extracted gas, this conclusion is not without significance. The author also discussed many of the conditions affecting the oil absorption process for gasoline extraction, and urged the importance of efficient operation depending on knowledge and application of the gas laws.

METEOROLOGICAL INSTRUMENTS.—The latest instrumental catalogue (No. 548) of Messrs. C. F. Casella and Co., Ltd., gives particulars of a wide range of meteorological instruments. We notice that the various types of cup anemometer do not include any with three instead of four cups, nor is there a cup instrument designed to give direct readings of velocity instead of the number of miles of air that have passed the instrument since its erection. The advantages of having only three cups have been proved experimentally by J. Patterson of the University of Toronto, who published his results about two years ago (*Trans. R. Soc. Canada*, Third Series, vol. 20, Sec. 3; 1926), and the *Meteorological Magazine* for September last contains a photograph of such an anemometer adapted for direct reading by the incorporation of a Stewart magnetic speedometer. It is to be hoped that an instrument of this kind will appear in the next catalogue. Accurate thermometry continues to be an expensive matter. It is, however, possible to purchase an outfit of thermometers — maximum, minimum, 'wet and dry'—with a rain gauge, and with a screen that should give good results if properly mounted, for £7. This outfit is designed for schools. A very handy pocket set, with maximum and minimum, as originally designed for Dr. Livingstone, costs £2 10s., and should continue to be in demand among explorers and mountaineers.

NEW SYNTHESIS OF NICOTINE.—The synthesis of an alkaloid generally involves the closing of a ring system containing a nitrogen atom. In the classical synthesis of nicotine, the molecule of which consists of a pyridine ring and an *N*-methylpyrrolidine ring linked together in the β-position to the former and the α to the latter, Pictet employed comparatively violent means to obtain the second ring system attached in the desired manner to the pyridine ring. The new and simple synthesis described in the February issue of the *Berichte* (vol. 61, p. 327) by E. Späth and H. Bretschneider, of the University of Vienna, is therefore very welcome. Prof. Späth employs the novel method of starting with both nitrogen ring systems already formed, in the shape of ethyl nicotinate and *N*-methylpyrrolidone. These compounds are condensed together under the influence of sodium ethoxide, and a ketone is obtained in which the two ring systems are separated by the carbon atom of the ketone group. There is a second ketone group present in the pyrrolidone ring, and by treatment of the compound with hydrochloric acid this group is removed as carbon dioxide. This opens the ring, which is, however, closed again by converting the first –CO– group into –CH(OH)– and thence into –CHI–, for removal of hydrogen iodide now draws the bridge carbon atom into the *N*-methylpyrrolidine ring to replace the carbon atom which had been lost, and (racemic) nicotine is at once obtained. The yields in the synthesis are good, that of the initial condensation being 70 per cent., that of the ring opening 37·5 per cent., and that of the complete ring closure to give nicotine 31 per cent.

RÔLE OF COPPER SULPHATE IN THE DEACON PROCESS.—The work of Hensgen and others has shown that many metal sulphates are decomposed by dry hydrogen chloride gas with the formation of chlorides and liberation of sulphuric acid. If this is the case, it would appear that when the Deacon process is started with copper sulphate as a catalyst, the mechanism is the same as when copper chloride is used. Experiments to test this view have been made by R. A. Beebe and D. B. Summers and are described in the January issue of the *Journal of the American Chemical Society*. Hydrogen chloride, both in the pure state and mixed with oxygen, was passed over pure anhydrous copper sulphate heated to 450° C. (the temperature used in the Deacon process) and the liberated sulphuric acid determined. In each case the sulphate was completely decomposed after several hours, and copper chloride, $CuCl_2$, or oxychloride, $CuO . CuCl_2$, remained. The use of copper sulphate initially in place of cupric chloride does not, therefore, seem to complicate the mechanism of the Deacon process.

Injury by Fire and Bark-beetle Attack.

ABOUT a quarter of a century has elapsed since bark-beetle infestations following fires in coniferous forests came under serious consideration outside European countries. The ideas and opinions then expressed, based admittedly on investigations which still had to stand the test of future corroboration, were at first treated with more or less open scorn by the professional forester both in the United States and in India, the two countries where attention was first paid to the matter. In the former country the commercial lumberer also regarded the scientific worker as a faddist. Of recent years, opinions have undergone a drastic change in both countries, and the present position and opinions held on this important subject are due to the patient work of the entomologist. In India, owing to the difference in climate in the plains, the matter is not confined to the coniferous forests of the mountainous regions, but has to be considered in its relation to the forests of broad-leaved deciduous species. The problem here, however, save perhaps in the native States, has not been complicated during the period alluded to above by the operations of the lumberer and his felling methods in the forest.

Recently two small but important monographs have been issued in the United States. The first, entitled "Preliminary Studies on the Relation of Fire Injury to Bark-Beetle Attack in Western Yellow Pine (*Pinus ponderosa*)," by Messrs. J. M. Miller and J. E. Patterson (*Journal of Agricultural Research*, Washington, April 1927), and the second, "The Relation of Highway Slash to Infestations by the Western Pine Beetle in Standing Timber," by J. E. Patterson (*U.S. Dept. of Agric.*, June 1927). The latter paper has a closer connexion with the danger of infestation from slash in the neighbouring standing forest than with previous damage by fire.

The literature available on the effect of fire in the pine forests of the Pacific slope region is considerable. One phase, the effect of bark-beetle infestations following the fires, has previously received scant treatment. It has been generally recognised that there is a direct relation between fire injury and later insect damage on burned-over areas. Two types of loss are involved—destruction of the marketable value of fire-killed trees by wood-boring insects, and the actual killing by bark beetles of trees that survived the fire. Such damage follows as a result of the sporadic local increase of bark-beetle population within the fire area, which can be explained only by the assumption that numbers of beetles fly into the area from the surrounding forest. The authors hazard the following hypothesis: "Because of fire injury certain trees become especially attractive to the beetles. The physiological basis of this attraction is but vaguely understood. The odour of fire-scorched foliage and cambium may be an attractive influence, or the insects themselves may possess an instinctive ability to select those trees in which sap resistance has been weakened by fire injury, but whatever the influence, it is evidently a very strong one of determining the behaviour of Dendroctonus beetles." The explanation would seem to rather lie in the unerring instinct possessed by the bark beetles, and one may add to these many species of the longicorns and buprestids, which leads them to choose out trees the vitality of which for whatever reason is impaired for the time being. For example, these groups of beetles exhibit the same instinct in infesting wind-blown or snow-broken trees. The heavy windfalls which occurred near Gerardmer in the Vosges in the late autumn of 1903, to quote but one European example, were followed by a heavy concentration of bark beetles on the wind-blown trees the following year. So serious was this attack that a considerable area of forest had to be felled before it was stamped out.

The various aspects of the inter-relation of fire and insect damage raise many questions that are pertinent to the protection of pine forests. The authors set themselves the following questions: What type, and what degree of fire injury make trees attractive to bark beetles? Are such trees capable of recovery if not attacked by insects? Do bark beetles 'breed up' in fire areas, increasing their numbers to an epidemic status, and then become aggressive in uninjured trees in and around burned areas? As they correctly state, the answers to these questions, of extreme importance to the forester, can only be obtained by a careful study on the ground.

The monograph by Messrs. Miller and Patterson is a most valuable piece of work and merits the careful study by all interested in this matter. Briefly, the authors' conclusions are as follows: Forest fires of sufficient severity to scorch the bark and foliage of yellow pine trees produce types of injury which make certain trees especially attractive to the Western pine beetle. Many trees which have been only moderately injured by the fire and are apparently capable of recovering, are attacked and killed by the beetles after a fire of this character. The attraction of fire-injured trees often causes a concentration of beetles within a burned area which lasts for one or two seasons following the fire. This attraction may extend for a distance of two or three miles from the burn. The concentration of bark-beetle attacks in fire-injured trees within a burned area does not develop into an epidemic condition. The loss from bark-beetle attacks in trees not injured by the fire either within the area of the burn or in the surrounding forest is not materially increased as a result of this concentration. Trees which have been defoliated by the fire are not favourable breeding places for the beetles, the resultant mortality amongst the latter, owing to the abnormally moist condition of the inner bark, being high. Finally, the authors' studies show that fires can be of but little benefit in reducing beetle losses through killing the beetles unless the fires are sufficiently severe to kill the trees. They add, in conclusion, "bark beetles supplement and increase timber losses initiated by forest fires, while fires have but little influence in permanently increasing the losses caused by bark beetles."

The second brochure here under review, by Mr. Patterson alone, deals with the inter-relation of slash (lop and top, etc., of trees) and insects, especially bark beetles and borers. In the United States three types of slash are recognised, and the definition is not without its value in Great Britain, namely, logging slash, the waste left in bulk on the ground after logging; line slash resulting from clearing roads, power lines and telephone lines (occurring in narrow strips); and wind-blown slash, *i.e.* wind-blown or snow-broken trees left unremoved. Both foresters and lumbermen have come to recognise, for the matter has been widely discussed, that if only to minimise the danger of fires originating in the slash and spreading into valuable standing forest, its disposal is advisable. The problem is further complicated by insect infestation, the green material being in the condition most suited to the beetles for oviposition.

The study undertaken by Mr. Patterson was to determine definitely whether the insect infestation of the slash threatened the value of adjacent standing

timber, the species investigated being in line slash of the Western yellow pine in Southern Oregon. The following are the conclusions arrived at. The line slash of this species is very attractive to the bark beetle (*Dendroctonus brevicornis*). The attack in the slash is not so heavy as in mature standing timber. The broods developing in slash are characterised by abnormal mortality (64 per cent. increase of beetles as compared with 135 per cent. in adjacent standing timber). Bark beetles from the surrounding standing timber are attracted to the slash at the time of attack, and a temporary concentration of infestation occurs in its immediate vicinity. Normal distribution of the infestation is resumed within the year. The concentration in the slash and the resulting beetles therefrom have little influence on infestations in the surrounding forests. Concluding, the author considers that the infestation of line slash by this beetle is not a serious menace to neighbouring mature timber, and may be disregarded when the problem of slash disposal is under consideration.

These two monographs merit the consideration of those interested in these matters. They exhibit a praiseworthy amount of careful research and experiment, undertaken in the forest, yielding results of practical utility.

Fisheries and their Products.

THE twentieth meeting of the Conseil Permanent International pour l'Exploration de la Mer took place in May 1927 at Stockholm. The report[1] marks the twenty-fifth anniversary of the foundation of the Council, which, mainly through the efforts of Sir John Murray, Prof. Cleve, Dr. Otto Petterson, and Dr. Fridtjof Nansen, owed its existence to the initiative of the late King Oscar II. of Sweden, who summoned in 1889 at Stockholm the first of the two conferences leading up to the foundation of the Council in 1902. The programme of international exploration had for its object the study of the hydrography and biology of the North Atlantic, North Sea, and Baltic, including statistical and industrial problems. With the recent inclusion of Italy, the Mediterranean is now added and fifteen countries are involved.

During the twenty-five years in which the Council has been in existence much work has been done, but most of the problems are so large that they need many years to show any results. Even now, however, in the infancy of the researches, definite results and promises of important results are seen. Direct research on fishes (especially food fishes, but also others indirectly related), with particular reference to their life histories, migrations, fluctuations, food, and environment, come first, and side by side the hydrography and plankton work with bottom sampling. At the same time statistical investigations, comparisons of various nets and methods of fishing, as well as research into the over-fishing of certain areas, are in progress, whilst the work on the whale fisheries is planned to fit in with that of the *Discovery* Expedition.

The hydrographers, continually active in all the countries concerned, maintain regular observations on temperatures and salinities, with special studies of currents and ice conditions. Plankton work in connexion with hydrography and its relation to fish food is undertaken in most of the countries, bottom sampling chiefly in the southern North Sea area. The most important fishes investigated are herring, cod, haddock, and plaice. A large amount has been done on the herring, in the North Sea, particularly the young stages (the main problems of its life history now being known), with regard to races, migrations, and fluctuations. Great Britain, France, Denmark, Norway, Sweden, Germany, and Poland all help in the herring work. The north-eastern area is mainly responsible for the cod. This includes sending specialists on board trawlers for the study of statistics, age, and food. A result of this is found in the comparison of fish from the coast of Finmarken and from the White Sea, showing that they belong to a common stock. Research on the haddock, chiefly in the southern North Sea area, has resulted in important work, carried on at Aberdeen, on age determinations; whilst the plaice, also in this area and in the north-western area, has been investigated particularly in Denmark and the Baltic. It is reported that there is a very large increase in the Baltic fishery in the last few years, and the red tunny has appeared in numbers in the North Sea in connexion with the herrings. Work on salmon and sea trout, together with the study of river pollution, is also being carried on.

The general conclusions to be drawn from this report are that the main facts relating to the spawning areas, life histories, food, age, and migrations of the most important food fishes (especially plaice and haddock, and to a less extent, herring and cod) are now known, and there is a general knowledge of hydrographical data, plankton distribution and bottom communities, especially in the North Sea, all of which form a foundation on which to carry on the enormous amount of detailed work still to be done. The statement of the North Sea Combined Committee that "there are certain features in the life histories of our most important commercial fishes . . . which are still obscure," whilst suggesting special attention to these, only voices the opinion of the Council as a whole, when recommending continuance of the existing programme in all areas and in all sections rather than beginning work on new lines.

A large amount of important and interesting information dealing with sea fisheries and suggestions for their improvement, with regard especially to those products which largely enter into the food of the people of the British Isles, has been published in a recent report of the Imperial Economic Committee on Marketing and Preparing for Market of Foodstuffs produced within the Empire.[2]

The main fishing grounds are almost wholly confined to water of less than 200 fathoms depth, situated in all parts of the Empire, but the North Atlantic and the North Pacific are the only two parts of the world where the fishing industries have been developed on a large scale, the North Atlantic being the most important. There is no evidence pointing to a shortage in the total fish supplies of the world, although the amount of fish on the fishing grounds may vary and some of them may have been over-fished. There are many valuable grounds at present only partially worked, because they are difficult of access and the present methods of preserving are not suitable for prolonged sea voyages. Nevertheless, the tendency is to go farther and farther afield.

In the British Isles, the demand is chiefly for 'white fish,' that is to say, such fish as cod, whiting, and sole, as distinct from 'pelagic' fish such as herring and mackerel, the two divisions representing fish of different habit and therefore requiring an

[1] Conseil Permanent International pour l'Exploration de la Mer, *Rapports et Procès-Verbaux des Réunions*, vol. 45. (Copenhague: Andr. Fred. Høst et fils, 1927.)

[2] "The Report of the Imperial Economic Committee on Marketing and Preparing for Market of Foodstuffs produced within the Empire." Fifth Report: Fish. (London: His Majesty's Stationery Office, 1927.)

entirely different method of catching, resulting in two almost separate trades. Since the War there has been a marked change in the demand for white fish rather than for herring, and the herring trade is faced by a loss of markets both at home and abroad, whilst there is a very large and increasing market for white fish, and almost all that is landed in Great Britain is consumed locally. To meet this demand the vessels must make longer voyages, which necessitate better methods of preservation.

The storage of fish after landing is most important, as at present the fish must be sold directly it is brought in, hence the great fluctuations in the quantities marketed and high prices. If it could be stored in 'live condition' more regular prices could be obtained. High prices limit consumption. This is particularly noticeable in affecting the British market of fresh and refrigerated fish caught off the Newfoundland and Canadian coasts, and discourages this branch of inter-Imperial trade. It follows that anything that will stabilise wholesale prices must have a healthy effect on the trade—the first essential is a better method of preservation at an economic cost. With better methods of preservation a larger consumption would be probable, and it is suggested that economy would be affected if the public were trained to buy filleted fish rather than whole, all the waste parts then being disposed of at headquarters; also that an improved and different method of curing herring would probably reinstate it as a favourite fish.

With regard to by-products, the most important are fish oils, especially cod-liver oil, and fish meals. The British and Newfoundland cod-liver oil is probably superior to foreign oil in essential vitamin content, but at present further research is needed as to methods of refinement. Fish meals are extremely valuable for feeding live stock and should be more fully used.

The recommendations of the Committee are wholly on the industrial side, the most important being that research should be instituted with the view of preserving fish from the moment when it has been caught to the moment when it reaches the consumer. This should be based on two central stations, one in Great Britain and one in Canada, a specially constructed vessel or 'factory ship' being established on which the most essential preliminary parts of the oil and meal industries could be carried on at sea. Other recommendations include the services of a biochemist to determine the scientific problems of economic importance attached to the preservation and curing of herrings, researches into the causes of variation of vitamin content in cod-liver oil and into refining methods, so that the full vitamin content may be retained, and further use of fish meal. With regard to the extension of tropical fisheries, the favourable position of the Malay Government for this purpose is suggested.

University and Educational Intelligence.

Cambridge.—Mr. W. C. D. Dampier-Whetham, Trinity College, has been appointed by the University a member of the Council of the National Institute of Agricultural Botany. E. J. H. Corner, Sidney Sussex College, has been appointed Frank Smart student in botany, and W. L. Edge, Trinity College, has been awarded the Allen Scholarship.

St. Andrews.—The Senatus Academicus has resolved to confer the honorary degree of LL.D. upon Prof. E. P. Cathcart, Gardiner professor of physiological chemistry in the University of Glasgow, and upon Prof. William Darrach, Dean of the Medical School, Columbia University, New York.

An election of Beit Memorial Junior Fellows for medical research will take place in July. The annual value of the fellowships is £400 each, and the usual tenure is for three years. Applications, in writing, should be sent to Sir James K. Fowler, Honorary Secretary, Beit Memorial Fellowships for Medical Research, 35 Clarges Street, W.1.

Applications are invited for a Busk studentship in aeronautics for 1928–29, to be awarded towards the beginning of next July. This studentship, established in memory of E. T. Busk, who lost his life in 1914 while flying an experimental aeroplane, is awarded to provide opportunity for whole-time research on stability problems in aeronautics, and is open to British subjects of less than twenty-five years of age. Applications must reach Prof. B. Melvill Jones, Engineering Laboratory, Cambridge, before May 12 next.

The Prince of Wales' Royal Indian Military College, Dehra Dun (United Provinces), was established in 1921 for the education of Indian boys in preparation for entry into the Royal Military College, Sandhurst, and eventually for a military career as officers. The number of pupils is at present seventy, and further expansion is contemplated. The normal age of entry is 11-13 years, and the standard at entry that of the higher primary school. The course extends over six years. The College is controlled by the Army authorities under the Government of India, and the staff includes a Commandant (Lieutenant-Colonel, Indian Army), a headmaster, and five assistant masters. Applications are now being invited for an assistant master, well qualified in mathematics and able to teach elementary physics and chemistry. Candidates must be public school men, preferably with an honours degree and experience of teaching in public schools. They should normally be from 23 to 30 years of age, and good at games. Unmarried men are preferred. Particulars of the pay, leave, and pension can be obtained from the Secretary, Military Department, India Office, S.W.1.

From the Universities Bureau of the British Empire we have received a list of "Students from other Countries in the Universities and University Colleges of Great Britain and Ireland: Session 1927–28." The total number is 4875, which is 6 per cent. greater than the total number given in the corresponding list for the session 1926–27. The number of students from each of the countries contributing substantially to this increase is as follows, the increase per cent. on the preceding year's figures being given in brackets: Egypt 384 (14), Canada and Newfoundland 183 (17), United States 487 (9), India, Burma, and Ceylon 1501 (10), France 61 (45), Germany 121 (30), Switzerland 60 (54), Australia 234 (20). Of considerable interest for comparison with these statistics is a tabular statement, published on p. 864 of the American Council on Education's new handbook, "American Universities and Colleges" (Charles Scribner's Sons, 1928), giving the number of foreign students in the colleges and universities of the United States during the past five years. The total number for the last year of the series (1925-26) is 5806, the countries chiefly contributing to this total being China (1317), Japan and Korea (808), Canada (733), Philippines (571), Russia (515), South American States (244), British Isles 310 (England 202, Scotland 52, Ireland 49, Wales 7), Mexico 188, Porto Rico 183, India, Burma, and Ceylon 182, Hawaii 141, British West Indies 125, Germany 124, Italy 117. Germany shows a steady increase during the five years—49, 63, 79, 121, 124; South Africa a decrease—146, 137, 97, 76, 63.

Calendar of Customs and Festivals.

April 15.

LOW OR WHITE SUNDAY.—Said by a seventeenth-century writer to be so called because in the primitive Church neophytes baptised and clothed in white garments at Easter Eve put off their white clothes on this day and were admonished to remember that they were made *low* as little children of Almighty God such as ought to retain in their lives and manners the memory of the Paschal feasts they had accomplished. An alternative was that it was the lowest or latest day for satisfying the Easter obligations.

In the Highlands of Scotland, 'Old Men's Easter' was a repetition of the Easter feast if on a lesser scale. In the Greek Church its popular observance is a continuation of the Easter festivity. In Macedonia on Easter Tuesday the people repair to the open country where the girls dance, in more or less ceremonial dances, and the youths amuse themselves with contests in shooting at a mark, wrestling, jumping, running, and the throwing of heavy stones. On the following Sunday, known as St. Thomas's Day, a similar celebration, but on a more elaborate scale, takes place. Prizes are given for the principal events—for running and wrestling a kid or a lamb, the winners in these events being acclaimed and marching off with their prizes over their shoulders to the accompaniment of shouts and the firing of guns.

It is evident that in the popular observances throughout Lent and at Easter we are dealing with festivals connected with both seed-time and the advent of spring which took place originally on no fixed date, but were observed at different times in different localities, or perhaps even on various occasions within the same community.

That the two classes of festival are not necessarily coincident or immediately consecutive appears in the popular religion of India. The Holi festival in veneration of fire and lights is a spring fertility festival celebrated in northern India in the month of Phālgun (February-March). Fire is lighted on the night of the full moon, fuel being taken from all the villagers for the purpose, or a tree is set on fire. Processions are made round the fire, men and women jump through the fire, and offerings are thrown into the flames. Foul obscenities of act and word are used, and sometimes there is a procession of a mock king—an Easter ceremonial which survived in Cornwall at Lostwithiel, but as a solemn observance. In contrast, the agricultural new year begins with a festival in later April, which is a time of great solemnity. Both plough and seed are consecrated, small portions of the latter being sowed ceremonially; and cutting the first sods in ploughing or digging—evidently an act of peril—are performed by a holy man. Among the Nagas the transplanting of the first five rice plants is done by the village priest, and a libation made. Such a solemn rite is almost necessarily made the occasion for mourning lost relations. Omens are taken of the coming harvest, and ceremonial contests such as mock fights or tug of war between the women and girls on one side and the men and boys of the village on the other, promote fertility or foretell the harvest.

Among the Malabars, in the earlier half of April, but usually between April 10 and April 14, the vernal equinox is celebrated, marking the agricultural new year. The first thing seen on Vishu day is an omen of fortune for the whole year, judicious prearrangement usually securing a desirable object. Presents of money are made to the junior members of the family and the servants. The spade furrow is laid and an offering made to the elephant god. The Chāl is the most important of these agricultural ceremonials, though not now often observed. It demanded the services of a professional astrologer to fix the propitious time and place for cutting the first furrow. A new ploughshare was fitted and a handful of seed was thrown ceremonially into the first furrow. A coconut was cut on the ploughshare to foretell the character of the harvest, in accordance with the direction of the cut and the part at which the nut was divided. The actual seed is not sown until May.

April 17.

ST. PETER GONZALEZ OR ST. ELMO: *b.* in the town of Astorga in Spain, 1190, *d.* 1240. He accompanied King Ferdinand in the expeditions against the Moors and was present at the capture of Cordoba. Afterwards he went on evangelical missions among the degraded peasantry and among sailors. He is especially associated with the protection of the latter. In art he is represented as holding a blue candle, and the confraternities of St. Elmo carry blue candles in their processions. This is in reference to the corposant (*corpo santo*), the blue electric discharge which in the Mediterranean appears on the tops of masts of ships under certain conditions of weather, and is taken to ensure the safety of the ship.

Virtues have been added to St. Elmo to which he is not entitled in making him responsible for this light, for the belief is much older. Several other saints have had the protective light assigned to their province—St. Anselm of Lucca or St. Erasmus, names of which, it is suggested, St. Elmo or St. Telmo may be corruptions. Frequently the saint is duplicated, hence St. Cosmas and St. Damian or St. Crispin and St. Crispian, the last-named pair being especially connected with the protection of sailors and ships in the English Channel, and more particularly in Kent, owing to the proximity of the Goodwin Sands. St. Nicholas is also popular there for the same reason. The twin cult, and its association with maritime activities, however, antedates Christianity. The Dioscuri and other pairs of brothers, such as Romulus and Remus, from whom the name St. Elmo may really be derived by amalgamation, were specially connected with navigation and the protection of sailors as part of a great protective cult.

April 21.

ST. MAELRUBIUS OR MAELRUBHA, a member of the Clan Cinel-Eoghain of Co. Londonderry and a descendant of the famous Niall of the Nine Hostages. He passed over to Scotland, becoming a zealous apostle among the Picts and founding the church of Aporcrossan or Applecross in A.D. 672 or 673. He was patron saint of all the coast from Applecross to Loch Broom. His cult has evidently subsumed a number of local cults, and his name appears in a number of varying forms. Partly for this reason his festival has been identified with others occurring later in the year. His relation to paganism is suggested by his association with a well on Inis Maree noted for the cure of insanity, and by his patronage of several fairs in August and September. For neglect of his festival in August at harvest-time men's houses were burnt, while those of the men who observed it were preserved. The saint's influence has not waned. When the present manse at Applecross was building, the builder was warned in a dream to desist from using a fragment of the saint's tombstone. Later he was thrown from the scaffolding and his skull fractured on this very stone.

Societies and Academies.

London.

Geological Society, Mar. 21.—**F. B. A. Welch**: The geological structure of the Central Mendips. The Central Mendips comprise a rectangular area measuring roughly 80 square miles, lying between Shepton Mallet and Cheddar on the east and west respectively. As a whole, the Mendips consist of a west-north-westerly to east-south-easterly ridge, the structure being that of four periclines arranged *en échelon*. The cores of these periclines are of Old Red Sandstone age, with the Carboniferous Limestone Series succeeding. The Central Mendips include the North Hill, the Pen Hill, and part if the Beacon Hill periclines. Of these, North Hill and Pen Hill are more or less anticlinal in structure; but the Pen Hill pericline has been much disturbed by extensive earth movements. A large syncline, which extends from Cheddar to Wells, has been thrust from the south against the southern limb of the North Hill pericline, while at one point a ' window ' occurs in this syncline, revealing beds of the main hill-mass beneath the thrust. Parallel to this thrust, at Ebbor, a second great thrust is developed, isolated remnants of which are seen in the small hills north of Wells. Earth movements seem to have been directed mainly from the south, at first producing the ridge with periclines *en échelon*, and separated one from the other by normal synclines. Pressure continued, and appears to have been greatest in the Pen Hill region, where overfolding was developed. Finally overthrusting resulted, and large blocks of beds, bounded by extensive north-and-south faults, formed at the time of the thrusting, were driven northwards.

Paris.

Academy of Sciences, Mar. 5.—**G. Ferrié**: The operation of world longitudes (October-November, 1926). An account of work done by the international committee. Fifty-two stations belonging to thirty nations took part in the work, and forty-five of these have already sent to the president accounts of their observations. Twenty-two of these have furnished data bearing on the fundamental triangle, Algiers—Li Ka Wei—San Diego, for which results are given.—**C. Sauvageau**: The development of two Asperococcus.—**Luigi Fantappié**: The calculation of matrices.—**S. Stoïlow**: A class of continued transformations with limited variation.—**Henri Cartan**: A theorem of M. A. Bloch, and questions of unicity in the theory of meromorph functions.—**G. Vranceanu**: Completely stable periodic solutions.—**Jacques Mesnager**: The theory of equilibrium of heavy massifs submitted to pressures from below and its bearing on the stability of barrages.—**Mesnager**: Remarks on the preceding communication.—**Henri Mémery**: An important recrudescence of sunspots on Feb. 2, 1928.—**Marcel Dufour**: The refraction of the astigmatic pencil. The third equation of Sturm.—**M. Ponte**: The various spectra of mercury. Details of the spectrum obtained in a tube fitted with a single electrode and submitted to high frequency discharge with very short wavelength (about 12 metres).—**W. Kopaczewski**: The buffer action of the serum in relation with immunity.—**Jacques Bardet** and **Arakel Tchakirian**: The preparation and properties of some germanous salts. Two direct methods are given, one based on the reduction of germanic salts by zinc and sulphuric acid, the other by reduction with hypophosphorous acid in hydrochloric acid solution. Germanous oxide is soluble with difficulty in solutions of sulphuric or hydrochloric acid, and after filtering and rapidly drying, is stable at the ordinary temperature.—**G. Allard**: The determination of the crystalline network of microcrystalline substances by means of radiograms taken with powders. The method described is general, and is not, like Hull's method, limited to substances crystallising in the cubic, quadratic, hexagonal and rhombohedric systems.—**Henri Termier**: A hypothesis concerning the Permian and Trias of Morocco.—**Marcel Martz**: The anomalies of the androecium in a hybrid of the genus Digitalis.—**A. Jullien**: The significance of the eosinophil granulations of the blood cells of *Sepia officinalis*.—**Maurice Caullery** and **Mlle. Marguerite Comas**: The determination of sex in a nematode (*Paramermis contorta*), a parasite of the larvae of Chironomus. From determinations of the number and sex of parasites present on single worms, it was found that the sex depends largely on the number of parasites on each worm, and hence is probably a question of nutrition.—**Charles Pérez**: The evolution of the apparatus for attaching the abdomen to the thorax in decapods (Dromia, Homola).—**Angel Establier y Costa**: Hyperallantoinuria in artificially produced polyuria and diabetes in man. In all the cases examined the polyuria was accompanied by a large increase in the amount of allantoin excreted.—**Marcel Duval, Paul Portier**, and **Mlle. A. Courtois**: The presence of large quantities of amino-acids in insects. Analyses of seven different species showed a very high proportion of amino-acids, ranging from 13 to 36 times the amounts present in the blood of mammals.—**C. Levaditi** and **T. E. Anderson**: The neurotropism of *Spirochæta Duttoni*. From experiments on mice inoculated with *Sp. Duttoni*, the brain was found to be virulent long after the blood was sterile. No typical spirochæte could be detected in the brain in these cases. As in the experiments described by Nicolle, Levaditi, Sanchis-Bayarri, and Schoen, the parasites appear to undergo a cycle of evolution, one of the phases of which is invisible and non-filtrable.—**S. Nicolau**: The histo-pathological modifications of the suprarenal capsules and the salivary glands of rabbits killed by experimental enzootic encephalomyelitis (Borna's disease).—**V. Chorine**: The influence of the hydrogen ion concentration of the culture medium on the virulence of the Coccobacillus of the Pyralis of maize.

Rome.

Royal National Academy of the Lincei, Dec. 18.—**G. Armellini**: Measurement of double stars.—**S. Baglioni**: (1) Action of quinine, eserine, pilocarpine, digitonine, sparteine, and atropine on the nervous centres. Experimental investigations on a preparation of *Bufo vulgaris*. None of the poisons named, when applied locally to the dorsal or ventral face of the posterior intumescence of this preparation, causes increase in the excitability or tetanic or clonic convulsions. An apparent exception occurs with digitonine applied to the dorsal face, this resulting, after the lapse of some hours, in tetanic reflexes similar to those produced by strychnine; such action is, however, almost certainly due to a decomposition product of digitalin which has an action resembling that of picrotoxin. (2) Physiological doctrine of the action of poisons exciting the nervous centres. Consideration of the available experimental data seems to justify the enunciation of the following general theory: All poisons acting selectively by enhancing the excitability of the central co-ordinating elements of the posterior corna of the spinal medulla, cause the abnormal increase in the reflex activity which culminates in the typical tetanic convulsions of central origin (strychnine type), whereas those which act selectively by raising the excitability of the central

elements of the anterior corna (motor neurones) cause increase in the reflex excitability, resulting finally in clonic convulsions of central origin (phenol type). This selective action of different poisons is, moreover, a proof that the neurones of the posterior corna and of the anterior corna are endowed with specifically different functional properties.—**F. Tricomi**: The equation $y\partial^2 z/\partial x^2 + \partial^2 z/\partial y^2 = 0$.—**U. Crudeli**: The elementary geodesic displacement.—**G. Sansone**: The apiristic resolution of the biquadratic congruences.—**Giuseppe Scorza**: Partial minima and maxima for functions of several variables.—**V. Hlavatý**: Complements to the theorem of reduction of orthogonal differential systems.—**G. Krall**: Variation of the field in the equations of elastic motion.—**D. Graffi**: Magnetic induction. A mathematical treatment is given for the problem of magnetic induction for ferromagnetic bodies in the case when the variations in time of the electromagnetic field are so small that the phenomena accompanying such variations may be neglected.—**E. Fermi**: A statistical method for the determination of certain properties of the atom (1). A process is described for calculating statistically the distribution of the electrons round the nucleus. The results obtained render it possible, first, to calculate the energy necessary to ionise the atom completely, that is, to strip it of electrons, and secondly, to determine the variation in potential at different distances from the nucleus and hence to ascertain the electric field in which the electrons of the atoms occur.—**L. De Caro**: The production of lactic acid and of phosphoric acid in 'rigor from thawing.' Quantitative experiments made by Fletcher on the production of lactic acid in striated mammalian muscle subjected to low temperatures showed that, during the freezing of the muscle, there takes place no formation of lactic acid, but some change which disposes it to a more rapid formation of the acid when thawing begins. The results of the author's experiments on muscle from the frog, toad, and dog show that the production of phosphoric acid in the muscle at low temperatures follows a course parallel to that of lactic acid and that this behaviour remains unchanged even after the suppression of the morphological structure of the muscular tissue. 'Rigor from thawing' is accompanied by the same chemical changes as are encountered in the other normal or experimental forms of muscular contraction.—**Camillo Artom**: Effects of cooling the spinal ganglia.—**N. Passerini and P. Galli**: Experiments on the action of the sodium chloride contained in irrigation water on certain plants. Under the conditions of pot tests, various annual and perennial plants exhibit for some time marked tolerance towards moderately concentrated sodium chloride solutions, but, owing to the rapid evaporation of the liquid and to consequent accumulation of salt in the soil, even dilute solutions result ultimately in death or damage to the plants. Although such accumulation of salt is not to be feared in the open ground, it is not advisable to employ, for irrigation, water containing more than 1 part of combined chlorine per 1000. For the spontaneous growths of established meadow-land or for arable land with permeable subsoil, this limit may be increased to 2 or, in some instances, 3 parts per 1000.

VIENNA.

Academy of Sciences, Jan. 19.—W. Figdor: The influence of light on the form of *Bowiea volubilis* and the increase and structure of its bulbs. Both in the light and in the dark, the main and the side axes show opposite tendencies as to growth in length. —**K. Menger**: Notes on theory of dimensions (4). The dimensions of irreducible continua.

Jan. 26.—**A. Franke and E. Gigerl**: Researches on the formation of benzal in glycols.—**A. Franke and R. Stern**: Glycol from methylethylacetaldehyde and benzaldehyde.—**F. Schweda**: Calculation of the transversal end frame of open bridges.—**K. Menger**: Metrical researches: (1) Theory of convexity, (2) Euclidean metric, (3) n-dimensional metric.—**A. Methlagl**: Trombidioses in Austrian alpine countries. Various species of Trombicula are reported.—**L. Lämmermayr**: Further contributions to the flora of magnesite and serpentine soils.—**A. Kieslinger**: Geology and petrology of the Kor Alps. (5) Marble outcrops in the region of the map sheet Deutschlandsberg-Wolfsberg.

Official Publications Received.

BRITISH.

The British Mycological Society Transactions. Edited by Carleton Rea and J. Ramsbottom. Vol. 13, Parts 1 and 2. Pp. 144+7 plates. (Cambridge: At the University Press.) 15*s*.

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1111 (Ae. 285): A General Theory of the Autogyro. By H. Glauert. (T. 2359: T. 2418.) Pp. 30+5 plates. 1*s*. 6*d*. net. No. 1117 (Ae. 290): Scale Effect on Three Aerofoils at Low Levels of LV, R.A.F. 32, Göttingen 483, and Göttingen 410, with 2 per cent. Centre Line Camber. By F. B. Bradfield. (T. 2512.) Pp. 6+4 plates. 6*d*. net. (London: H.M. Stationery Office.)

Transactions of the Royal Society of Edinburgh. Vol. 55, Part 3, No. 24: The Life-History and Cytology of *Reticularia Lycoperdon* Bull. By Dr. Malcolm Wilson and Elsie J. Cadman. Pp. 555-608+6 plates. 9*s*. Vol. 55, Part 3, No. 26: A Comparative Study of the Stem Structure of the Genus Clematis, with special reference to Anatomical Changes introduced by Vegetative Propagation. By Dr. Edith Philip Smith. Pp. 648-664+2 plates. 3*s*. 6*d*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Proceedings of the University of Durham Philosophical Society. Vol. 7, Part 4, 1926–1927. Pp. 161-260. (Newcastle-on-Tyne.) 5*s*.

Imperial Agricultural Research Conference, 1927. Report and Summary of Proceedings. Pp. iv+249. (London: H.M. Stationery Office.) 1*s*. net.

Report of the Marlborough College Natural History Society for the Year ending Christmas, 1927. (No. 76.) Pp. 94+4 plates. (Marlborough.) 3*s*.; to Non-Members, 5*s*.

University of London: University College. Report of the University College Committee (February 1927–February 1928), with Financial Statements (for the Session 1926–27), and other Documents, for Presentation to the Senate. Pp. 191. (London: Taylor and Francis.)

The National Physical Laboratory. Report for the Year 1927. Pp. vi+264. (London: H.M. Stationery Office.) 7*s*. 6*d*. net.

A Problem of Empire Suffering: being the Annual Report for 1927 of the British Empire Leprosy Relief Association. Pp. 46. (London.)

List of Council and Fellows of the Royal Society of Edinburgh, October 1927. Pp. 26. (Edinburgh.)

List of the Geological Society of London, March 1928. Pp. 74. (London.)

Agricultural Progress: the Journal of the Agricultural Education Association. Vol. 5, 1928. Pp. 145. (London: Ernest Benn, Ltd.) 5*s*. net.

Proceedings of the Royal Society of Edinburgh, Session 1927–1928. Vol. 48, Part 1, No. 3: On Fourier Constants. By E. T. Copson. Pp. 15-19. 6*d*. Vol. 48, Part 1, No. 4: An X-ray Examination of Saturated Dicarboxylic Acids and Amides of the Fatty Acid Series. By Dr. Edward Henderson. Pp. 20-27. 9*d*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Kitts-Nevis, 1926–27. Pp. iv+80. (Trinidad, B.W.I.) 6*d*.

University of Bristol: Department of Agriculture and Horticulture. Bulletin No. 2: Sugar Beet Trials, 1927, and Report of Sugar Beet Conference, February 1928. By A. W. Ling and C. W. Linley. Pp. 55. Bristol.)

Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 15, No. 1: Studies in Khandesh Cotton, Part i. By S. H. Prayag. Pp. iii+49+8 plates. (Calcutta: Government of India Central Publication Branch.) 1.4 rupees; 2*s*. 3*d*.

The Tea Quarterly: the Journal of the Tea Research Institute of Ceylon. Edited by T. Petch. Vol. 1, Part 1, February. Pp. 26. (Nuwara Eliya.)

Journal of the Chemical Society: containing Papers communicated to the Society. March. Pp. iv+529-751+x. (London: Gurney and Jackson.)

FOREIGN.

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 32: Statistics of City School Systems, 1925–1926. Pp. 185. (Washington, D.C.: Government Printing Office.) 30 cents.

Travaux de la Section de Géodésie de l'Union Géodésique et Géophysique Internationale. Tome 4: Rapports généraux établis à l'occasion de la deuxième assemblée générale, 24 septembre–8 octobre 1924. Pp. vi+58+4 planches+79+11+8+33+53+3+4+4+11. (Paris.)

Rapport annuel sur l'état de l'Observatoire de Paris pour l'année 1926 présenté au Conseil dans la séance du 12 mars 1927. Par B. Baillaud. Pp. 20. (Paris.)

Publikace Pražské Státní Hvězdárny: Publications de l'Observatoire National de Prague. No. 5: The Maps of the Boundaries of the Constellations in the Galactic System of Co-ordinates. By Otto Seydl. Pp. 2+2 maps. (Prague.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 569: Generator for Audio Currents of Adjustable Frequency with Piezo-Electric Stabilization. By August Hund. Pp. 681-687+2 plates. 10 cents. Scientific Papers of the Bureau of Standards, No. 570: Thermal Expansion of Alloys of the 'Stainless Iron' Type. By Peter Hidnert and W. T. Sweeney. Pp. 689-647. 10 cents. (Washington, D.C.: Government Printing Office.)

United States Department of Agriculture. Technical Bulletin No. 25: Experiments for the Control of the European Red Mite and other Fruit-Tree Mites. By E. J. Newcomer and M. A. Yothers. Pp. 34. 10 cents. Technical Bulletin No. 42: Life History of the Codling Moth in Delaware. By E. R. Selkregg and E. H. Siegler. Pp. 61. 15 cents. (Washington, D.C.: Government Printing Office.)

Boletim meteorologico: observações meteorologicas feitas no Observatorio do Instituto Central, do Rio de Janeiro e estações das rêdes federal e cooperativas. Anno 1922. Pp. viii+191. (Rio de Janeiro: Ministerio da Agricultura, Industria e Commercio.)

United States Department of Agriculture. Technical Bulletin No. 34: The Fall Army Worm. By Philip Luginbill. Pp. 92. (Washington, D.C.: Government Printing Office.) 25 cents.

Catalogues.

The Cambridge Bulletin. No. 59, March. Pp. 31+8 plates. (Cambridge: At the University Press.)

A Catalogue of Books published by Bowes and Bowes. (Catalogue No. 442.) Pp. 8. (Cambridge: Bowes and Bowes.)

Mr. Murray's Quarterly List. April. Pp. 32. (London: John Murray.)

Diary of Societies.

SATURDAY, April 14.

Institute of British Foundrymen (Lancashire Branch) (at College of Technology, Manchester), at 4.—J. Hogg: A Foundry Problem.—W. Holland: Refractories.

Institute of British Foundrymen (West Riding of Yorkshire Branch) (at Technical College, Bradford), at 6.—W. H. Poole: What has Science done for the Foundry?

Institute of British Foundrymen (Lancashire Branch—Junior Section) (Annual General Meeting), at 7.—C. F. Brereton: Some Observations on Metallurgical Practice in the U.S.A.

Hull Association of Engineers (at Municipal Technical College, Hull), at 7.15.—L. Rowland: Rubber as a Shock Absorber.

MONDAY, April 16.

Victoria Institute (at Central Buildings, Westminster), at 4.30.—Rev. Charles Boutflower: Sennacherib's Invasion of Judah 701 B.C.

Institution of Electrical Engineers (Informal Meeting), at 7.—E. H. Shaughnessy and others: Discussion on Wireless Reception.

Institution of Electrical Engineers (Mersey and North Wales (Liverpool) Centre) (at University, Liverpool), at 7.—Annual General Meeting.

Ceramic Society (at North Staffordshire Technical College, Stoke-on-Trent), at 7.30.—W. E. Box: The Recent Development of Special Electro-magnetic Separators and Applications of Interest to the General Pottery Trade.—Dr. G. Martin: Researches on the Theory of Fine Grinding, Parts 9, 10, and 11.

Railway Club (25 Tothill Street, S.W.1), at 7.30.—R. M. Bazley: South American Railways.

Royal Society of Arts, at 8.—A. G. Huntley: Applied Architectural Acoustics (Dr. Mann Lectures) (I.).

Chemical Industry Club.

TUESDAY, April 17.

Electrical Association for Women (at Institution of Electrical Engineers), at 11.15 A.M.—Annual General Meeting.

Royal Statistical Society (at Royal Society of Arts), at 5.15.

Royal Society of Medicine, at 5.30.—General Meeting.

Institution of Petroleum Technologists (at Royal Society of Arts), at 5.30.

Zoological Society of London, at 5.30.—J. H. Lloyd: Abnormalities of *Rana temporaria*, chiefly relating to the Vascular System.—Dr. J. G. Myers: Morphology of the Cicadidæ (Homoptera).—Dr. H. G. Jackson: The Morphology of the Isopod Head. Part II. The Terrestrial Isopods.

Institution of Civil Engineers, at 6.—C. P. Taylor and Dr. O. Faber: Deep-water Jetty at Bevan's Cement-Works, Northfleet.

London Natural History Society (at Winchester House, E.C.), at 6.30.—C. L. Collenette: Mothing in the Tropics (Bacot Memorial Meeting).

Royal Photographic Society of Great Britain (Scientific and Technical Group), at 7.—Dr. D. A. Spencer: Photographic Applications of Diazo Compounds.—H. H. Horton and O. Bloch: A Mechanical Developing Appliance for Sensitometric Work.

Society of Glass Technology (at University, Sheffield), at 7.30.—W. Butterworth, sen.: Stained Glass of the Renaissance Period.

Royal Anthropological Institute, at 8.30.—Rev. F. R. Bishop: Native Life in the Mandated Territory of New Guinea.

WEDNESDAY, April 18.

Research Association of British Paint, Colour, and Varnish Manufacturers (at Paint Research Station, Waldegrave Road, Teddington), at 2.30.—R. A. Coolahan: Cellulose Lacquers, illustrated by a film entitled Modern Lacquers.

Society of Glass Technology (at University, Sheffield) (Annual General Meeting), at 2.30.—(Ordinary Meeting), at 3.—Dr. S. English, Prof. W. E. S. Turner, and F. Winks: Some New Facts arising from a Study of the Casing of Colourless by Coloured Glass.—A. Cousen, H. W. Howes, and F. Winks: The Control and Distribution of Temperature in Lehrs.

Electrical Association for Women (at Institution of Electrical Engineers), at 3.—Capt. P. P. Eckersley: Technical Problems of Broadcasting.

Royal Meteorological Society, at 5.—C. K. M. Douglas: Some Alpine Cloud Forms.—N. K. Johnson: A Strong Wind of small Gustiness.—T. N. Hoblyn: A Statistical Analysis of the Daily Observations of the Maximum and Minimum Thermometers at Rothamsted.

Geological Society of London, at 5.30.—Dr. G. H. Mitchell: The Succession and Structure of the Borrowdale Volcanic Series in Troutbeck, Kentmere, and Long Sleddale (Westmorland).—L. J. Chubb: The Geology of the Marquesas Islands (Central Pacific).

Institute of Metals (Swansea Local Section) (at Thomas' Café, Swansea), at 7.—Annual General Meeting.

Institution of Electrical Engineers (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—D. B. Hoseason: Squirrel-Cage Induction Motors.

Royal Microscopical Society, at 7.30.—Dr. K. F. Bělař: The Separation of Protoplasm in the *Myxomycete Didymium* by Stimuli.—B. R. Johnson: Some Introductory Experiments dealing with a Quantitative Method of Determining the Resolving Power of Microscope Objectives.

Royal Society of Arts, at 8.—A. C. Bossom: American Architecture.

Folk-Lore Society (at University College), at 8.—W. J. Perry: The Dramatic Element in Ritual.

Electroplaters' and Depositors' Technical Society (at Northampton Polytechnic Institute), at 8.15.—G. B. Hogaboom: Effect of Carbonates in a Silver Solution.

Institute of Brewing (Burton-on-Trent Section) (at Queen's Hotel, Burton-on-Trent).—C. F. Wade: Fuel Economy.

Institute of Chemistry (London Section).

THURSDAY, April 19.

Institution of Mining and Metallurgy (at Geological Society), at 5.30.

Institution of Electrical Engineers, at 6.—Sir Oliver Lodge: The Revolution in Physics (Kelvin Lecture).

Royal Photographic Society of Great Britain (Colour Group, Informal Meeting), at 7.—F. T. Hollyer: Some Aspects of Colour Printing.

Royal Society of Medicine (Neurology Section) (Clinical Meeting at West End Hospital for Diseases of the Nervous System), at 8.

British Institute of Radiology, at 8.30.—C. Wainwright: The Coolidge Cathode-Ray Tube and its Applications.—J. E. Schall: Lantern Slide Projection of Stereoscopic Radiograms.

Institution of Civil Engineers (Birmingham and District Association) (Annual General Meeting) (at 6 Corporation Street, Birmingham).—R. A. Robertson: The Sandfields Filters of the South Staffordshire Waterworks Company.

Institution of Mechanical Engineers (Bradford Branch).—Prof. G. F. Charnock: Mechanical Transmission of Power.

FRIDAY, April 20.

Royal Astronomical Society (Geophysical Discussion), at 4.30.—Dr. de Graaf Hunter, A. R. Hinks, Sir Gerald Lenox-Conyngham, Capt. G. T. McCaw, and H. L. P. Jolly: Some Applications of the Geoid. Chairman, Sir Charles Close.

Institution of Mechanical Engineers, at 6.—Dr. H. J. Gough and A. J. Murphy: The Causes of Failure of Wrought-Iron Chains and Cable.—Third Report of the Wire Ropes Research Committee.

North-East Coast Institution of Engineers and Shipbuilders (at Mining Institute, Newcastle-upon-Tyne), at 6.—Dr. S. H. Long: W/T Direction Finding for Marine Purposes.

Royal Photographic Society of Great Britain (Pictorial Group, Informal Meeting), at 7.—A. Cocking: The Development of Cut Film.

Junior Institution of Engineers, at 7.30.—Re-Exhibition of Slides and Discussion on Paper by W. M. Hurrell on An Outline of the Distribution of Petroleum.

Society of Chemical Industry (Chemical Engineering Group) (jointly with Birmingham Section), at 7.30.—Dr. C. M. Walter: The Heat Treatment of Ferrous Metals.

Royal Society of Medicine (Obstetrics Section), at 8.—R. H. Paramore: Eclampsia and its Treatment: an Experience with Spinal Anæsthesia in one case.—Prof. W. Blair Bell: The Malignant Functions of the Chorionic Epithelium.

Royal Institution of Great Britain, at 9.—Col. Sir Henry G. Lyons: Heirlooms of Industry in the Science Museum.

Society of Dyers and Colourists (Manchester Section).—Annual Meeting.

SATURDAY, April 21.

North of England Institute of Mining and Mechanical Engineers (Newcastle-upon-Tyne), at 2.30.

CONFERENCE.

April 13-16.

Geographical Association (at Oxford).

April 14.—Sir Halford Mackinder: The British Empire in Relation to the Geography of the World (Lecture).

April 16.—Col. C. H. D. Ryder: Surveys from Air Photographs (Lecture).—Dr. L. Dudley Stamp and others: Discussion on Practical Steps in Regional Survey Work and Local Studies.

SATURDAY, APRIL 21, 1928.

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Problems in Human Nutrition.

IN the acquirement of knowledge by the experimental method, with the attention to minute detail which accurate and successful work demands, it is sometimes useful to pause a while and raise the eyes from the task in hand, and to take a general survey of the field—what has already been accomplished and what still remains to be done. Some reflections on problems in nutrition are suggested by perusal of the thirteenth annual report of the Medical Research Council, more especially as one chapter of our knowledge of the elusive, but extremely important, accessory food factors appears closed, even though the next may be already partly written. The discovery that ergosterol is the precursor of vitamin D, and is converted into it on irradiation by ultra-violet light or by exposure to sunlight, has already been referred to in these columns (NATURE, vol. 120, p. 955 ; 1927) : it is now possible for the first time to produce a vitamin from a pure chemical compound in the laboratory or even in the factory, so that an ample supply should be readily available for all.

Advances made, however, in one branch of nutritional studies, striking though they are, should not lead us to forget the importance of the other elements of the diet, the salts, the proteins, fats, and carbohydrates, or even the water. All constituents of the diet are worthy of study : scientific knowledge of them is of especial importance to a country which imports the major portion of its food supply. Thus it is known that proteins differ in their 'biological value'; that is, animals can maintain nitrogenous equilibrium on smaller quantities of some proteins, usually of animal origin, than of others which are usually derived from vegetable sources. What is both the most suitable and also the most economical source or sources of protein for human dietaries? Again, it is possible for human beings to live on much smaller quantities of protein than are usually consumed, but it is doubtful if this minimum is also the optimum. Another problem of extreme importance is the relationship which the different constituents of the diet should have to one another. Thus the quantity of vitamin B must bear a certain ratio to the amount of protein present : and vitamin A can only exert its full effect on growth in the presence of vitamin D.

The practical application of some of our recently acquired knowledge is mentioned in the Medical Research Council's report and has also been

referred to in Nature (vol. 120, p. 440; 1927) by O. Rosenheim and T. A. Webster. The supply of milk fat is inadequate for the minimal needs of our population, partly owing to the greater cost of animal fats as compared with vegetable. The chief sources of vitamins A and D have so far been animal fats: in this respect vegetable fat products cannot replace animal. Heretofore, the richest known supplement has been cod-liver oil, but its unpleasant flavour has made it more of a medicine than a dietary supplement to most people. Vitamin D can now be supplied by irradiation of ergosterol, and vitamin A has been found to be present in large amounts in the livers of herbivorous animals, from which it can be easily extracted together with the fat. The supply of liver, fresh or frozen, should be sufficient to meet the requirements of our population for vitamin A; and the fat has the advantage that it is without the unpleasant flavour of the fish oils, so that it can be easily added to vegetable fats or other articles of the diet.

A knowledge of correct nutrition has also a direct bearing on certain medical problems and the prevention of disease. It is only necessary to mention that inadequate intake, relative or absolute, of the appropriate vitamins, is the ultimate cause of scurvy, rickets, beriberi, and pellagra, and probably plays an important part in the initiation of dental decay. It is impossible to say what light future advances in nutritional problems may throw upon certain aspects of preventive medicine.

Much of our knowledge on this subject has been derived from animal experiments: the conclusions drawn can frequently be applied directly to mankind. But it must not be forgotten that results so obtained have another aspect and may throw light on problems facing those who have to breed and maintain animal stock. In the case of the domestic animals, the problem comes back to human nutrition again, in the fattening of stock or in the production of milk of high nutritive value.

Many questions, both of general scientific and practical interest, still await investigation and solution. The nature of the change that occurs in ergosterol under the influence of light, leading to the formation of vitamin D, the further change resulting in the destruction of the vitamin when the irradiation is long continued, and the wavelengths which are the most active in producing these effects, are still undecided. The solution of these questions has a practical bearing on the optimum conditions for effecting the transformation. Of more academic interest, perhaps, are such problems as the source of the vitamin D which is found in the liver of the cod, or the reason for the absence of this vitamin from mammalian liver. Leigh Clare has shown that the diatom *Nitzschia closterium* contains none of it, so that presumably the cod obtains it from the plankton and smaller fish it consumes, since it is unlikely to be exposed to enough light to synthesise it for itself (*Biochem. Jour.*, vol. 21, p 368; 1927). Again, the body fat of fish is usually free from vitamin A, though it contains vitamin D, but the body oil of eels is rich in both these vitamins; thus does scientific investigation confirm man's empirical selection of certain of his articles of diet. The prospects of the improvement in human well-being which may be expected to result from better knowledge of the influence of diet in the prevention of disease or ill-health make research work on nutrition and its application of prime importance and worthy of generous support from the State and the public.

Czechoslovakian Cytology.

Structure and Development of the "Living Matter." By Prof. F. Vejdovský. (Published with the Assistance of the Ministry of Education of the Czechoslovak Republic.) Pp. vii + 360 + 24 plates. (Prague: Royal Bohemian Society of Sciences; Fr. Řivnáč; London: James Smith, 1926–7.) 147*s.*

THIS volume is one of the largest contributions to cytology published by a single author in recent years. It is written in fairly good English, though in certain more technical parts the translator has not got the equivalent English terminology. Prof. Vejdovský's publications go back at least to 1888, when he brought out his first study on the "Reifung, Befruchtung und Furchung" of the Rynchelmis egg. He is to be congratulated on being at work forty years after.

There are six chapters devoted respectively to the spermatogenesis of the crayfish, the development of the cleavage spindle of Ascaris, and of Rhynchelmis, the structure and development of the somatic cells of Angiospermous plants, the spermatogenesis of the rock kangaroo, and finally a general discussion of the cell constituents. The book contains 360 pages, and the plates are nearly all in colour.

It should be said at once that Prof. Vejdovský's cytology has much in common with that of the celebrated German cytologist F. Meves—perhaps with not so much of the latter's remarkable powers of observation, for Meves, within the limits of his technique, never made a mistake. Prof. Vejdovský

makes many mistakes, and he is a little querulous with those whose views do not coincide with his own. In justice to Prof. Vejdovský, it should, however, be mentioned that the book was meant for publication before the War. As he himself says, he took two years reading up the periodicals he could not get during or just after the War. He has endeavoured to superimpose the results of his reading on his own pre-War cytological views.

The book serves to throw into relief the extensive advances both in microscopical technique and general cytology made by non-continental workers in recent years. Prof. Vejdovský has not kept abreast with modern advances, and in some ways one even feels that he has not learnt what he might have done from the work of Jan Hirschler, F. Meves, and Duesberg, whose publications must have been accessible to him before he went to press.

F. Meves was, in his later years, dominated by the idea that the cytoplasmic inclusions are bearers of the hereditary factors of the cytoplasm. This view is not acceptable nowadays, except in a very moderate form, but Meves's theory never injured his powers of observation. Prof. Vejdovský, on the other hand, allows his theories to lead him into misinterpretations of descriptive cytology.

The book is dominated by two theories—that the acrosome of mammalian spermatogenesis is derived from 'nuclear liquid,' and that the Golgi bodies are a 'mitotic apparatus.' Now there is probably no field in cytology which has been more thoroughly searched than that of the formation of the mammalian sperm from the spermatid. Benda, Niessing, Lenhossék, Hermann, Meves, Moore, Walker, Brown, Duesberg, Papanicolaou, and Stockard, and Woodger and the reviewer, to mention only a few workers, have brought out papers on this subject. In recent years, work by Schütz, Bowen, Voinov, Hyman, and the reviewer has been brought into line with the results of the workers on mammalian spermatogenesis, and confirmed by work in lower vertebrates and invertebrates. Yet Prof. Vejdovský attempts to show that the acrosome is formed as a sort of coagulum from "Karyochyme or nuclear liquid" poured out of the nucleus on to the region of the "mitotic apparatus" (Golgi apparatus). This view is at variance with the careful observations of past and present cytologists. The author has failed to study the spermatocyte and spermatid stages properly, and it is regrettable that he should have devoted so much space to this undoubtedly mistaken interpretation. Perhaps if Prof. Vejdovský had chosen an insect or a mollusc instead of a crayfish for his study of invertebrate spermatogenesis, his views would have changed.

Before the War, and when he was nearly ready to publish his book, Prof. Vejdovský had found the Golgi bodies both in supravitally stained cells and in prepared sections. He was impressed by the fact that in much of his material these bodies hovered near the asters during mitosis. Not being aware of the newer homology of the Golgi apparatus of nerve cells with these bodies, he considered them to be a 'mitotic apparatus.' This quite natural mistake vitiates much that is good in his accounts of mitosis. We cannot definitely claim that the Golgi bodies in these cases do not contribute in some way to the amphiaster, but we do know that the amphiaster can form without Golgi bodies stuck on it, and the idea that the Golgi apparatus is a 'mitotic apparatus' is unacceptable. It seems a pity that Prof. Vejdovský has not familiarised himself with recent work on dictyokinesis, such as that of Ludford, Bowen, Da Fano, *et alia*.

Prof. Vejdovský has observed both mitochondria and Golgi bodies *intra vitam*. There is much in his work of importance to the younger men, and his observations on plant cells should be taken into consideration by those who are now investigating plant tissues so successfully.

The original coloured drawings of Prof. Vejdovský are very beautiful, yet it is interesting to note that the three methods which are most used by modern workers, modified Kopsch, Da Fano, and chrome-osmium hæmatoxylin, all give 'black and white' preparations, and the necessity for coloured plates to illustrate cytological articles is no longer so apparent.

Zoologists who may be interested in cytology are advised to procure Prof. Vejdovský's most interesting publication. J. Brontë Gatenby.

Acoustics of Buildings.

The Acoustics of Buildings. By Dr. A. H. Davis and Dr. G. W. C. Kaye. Pp. ix + 216 + 22 plates. (London: G. Bell and Sons, Ltd., 1927.) 15*s*. net.

The high standard of care in preparation and the wealth of illustration which are such notable features of Royal Institution lectures are paralleled in this volume, which is based on the Tyndall lectures of 1926. The account of the lectures already given in Nature (vol. 99, pp. 603-606) indicates the scope of the book.

The subject is full of fascinating problems, for so much is demanded of a public auditorium. In

many towns the same hall has to be used for speech, chamber music, or a full symphony orchestra and choir. When we realise the minute amount of energy in a human voice, it seems remarkable that a speech in a large hall can be heard at all. R. L. Jones has calculated that if a million persons were to talk steadily, and the energy of their voices were to be converted into heat, they would have to talk for an hour and a half to produce enough heat to make a cup of tea (even if they were all politicians)! The minute amount of energy is, however, compensated for by the remarkable sensitivity of the ear, which can hear a sound of amplitude equal to the wavelength of a penetrating X-ray. Then again the smooth rigid parts of the walls of a hall act as better reflectors of sound than do the best mirrors for light. If, however, these reflecting parts are too far away, the time lag between the direct and reflected ray will cause confusion, and the reflecting power has to be reduced.

The book admirably illustrates that the subject has reached a stage when an architect submitting to experts at, say, our National Physical Laboratory, plans and details of materials for a proposed hall, could be given trustworthy particulars of its acoustics. The principles and necessary details are so clearly set out that he might even make the necessary calculations himself. It should be added that the mere act of consulting experts will not, however, lead to the production of a satisfactory hall if their advice is not followed. This may seem a facetious remark, but it is based upon the reputed facts of a recent famous case when a hall was found, when built, to be quite unsuited for speech, although experts had been consulted.

Whilst prevention is better than cure, the correction of acoustical defects is now so well understood that the acoustics of a faulty hall can always be improved, and in many cases the defects can be entirely removed. One method which will make *no* appreciable difference is in use in our largest auditorium, the Royal Albert Hall in London. Across the ceiling is draped some half-dozen lengths of ordinary wide-mesh wire netting, no doubt a relic of darker ages. This eyesore should be removed out of consideration for the feelings of musical scientists who visit this monument of defective acoustic design.

The use of draping or porous acoustic plaster for rendering hospital wards less reverberant would no doubt be unhygienic. In this and similar cases, such as in typewriting rooms or underground tube railways, the initial generation of sound should be reduced by suitable insulation of the vibrating objects.

The book is admirably produced, and the authors have succeeded in giving all necessary quantitative details in such form that they can be readily understood and applied, even by those with only an elementary knowledge of acoustics. Although there is no bibliography, adequate references are given in the text. W. H. GEORGE.

A Revised Physical Chemistry.

Outlines of Theoretical Chemistry. By Dr. Frederick H. German. Fourth edition, revised and partly rewritten. Pp. xiii + 728. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1927.) 18*s.* 6*d.* net.

THE principal value of a review of a new edition of a well-known book is to inform the reader of the review of the features in which the new edition differs from the old. In the present instance the author claims: "a fuller treatment of limiting densities and vapour pressures; a brief description of the latest and most accurate method of measuring heats of vaporisation; a more comprehensive treatment of crystal structure and the methods of X-ray analysis; an enlargement of the section treating of the absorption of light and its bearing on chemical constitution; a thorough revision of the chapter on the elementary principles of thermodynamics; a more discriminating treatment of the phenomena of osmosis; the inclusion of the concepts of fugacity and activity in connexion with the subject of vapour pressures of dilute solutions; a fuller discussion of the theories of emulsification and gel formation; an enlargement of the sections devoted to adsorption and the methods of preparation of colloids; a more detailed account of the theories of catalysis; the treatment of the more important practical applications of conductance and electrometric methods in separate sections in the respective chapters devoted to electrical conductance and electromotive force; the simplification of the treatment of hydrolysis; the adoption of a uniform and consistent system for the representation of galvanic cells, thereby connecting their polarity with the direction of current-flow; a fuller treatment of both the hydrogen electrode and oxidation and reduction cells; the rearrangement and enlargement of the chapter on electrolysis and polarisation; a brief presentation of the quantum theory together with its application to

the principle of photochemical equivalence; an outline of Baly's fascinating and suggestive researches in the field of photosynthesis; and lastly, the complete revision of the chapter on atomic structure."

There can be little doubt that further changes will have to be made in the near future when the author has considered in fuller detail how far he intends to maintain his hold upon Arrhenius's theory of reversible ionisation and how far he proposes to admit the later theory of complete ionisation, since it is obviously unsatisfactory to devote a large part of one chapter to expounding one view and a considerable part of another chapter to demolishing the foundations on which that view rests. The optical sections of the book will also require revision, in order to conform to the modern physical view that absorption of light of given frequency does not depend on a vibratory oscillation of given frequency in the molecule, but on the possibility of some form of activation in which quanta of energy of suitable magnitude are taken up.

These two points serve to illustrate the difficulty that is experienced by every writer of books on physical chemistry in this transition period, and they are particularly acute when a book of well-established merit falls due for revision. The author has not spared himself in the work of revision, and, if further changes have to be made in the near future, this will only be a further proof of the vitality of the subject which he expounds with no mean skill.

Our Bookshelf.

Allen's Commercial Organic Analysis. Vol. 5: *Tannins, Writing Inks, Stamping, Typing and Marking Inks, Printing Inks, Amines and Ammonium Bases, Analysis of Leather, Colouring Matters of Natural Origin, Colouring Substances in Foods, Benzene and its Homologues, Aniline and its Allies, Naphthylamines, Pyridine, Quinoline, and Acridine Bases.* By the Editors and the following Contributors: M. Nierenstein, C. Ainsworth Mitchell, John B. Tuttle, H. E. Cox, A. E. Caunce, W. M. Gardner, Walter E. Mathewson, J. Bennett Hill, A. B. Davis, Fifth edition, revised and in part rewritten. Editors: Samuel S. Sadtler, Dr. Elbert C. Lathrop, C. Ainsworth Mitchell. Pp. xii + 700. (London: J. and A. Churchill, 1927.) 30*s.* net.

In the period of sixteen years since the publication of the corresponding volume in the fourth edition of "Allen's Commercial Organic Analysis," there has been a considerable advance in our knowledge of practically all the sections under review. In spite of the enormous amount of data to be included on a great number of subjects in a limited space, the editors have presented a readable and connected book. They have avoided the temptation of presenting their material in the usual dull dictionary form now so common in many comprehensive treatises on specialised branches of science.

Benzene and its homologues have been introduced as a first step on the road to coal-tar dyes, and are considered before dealing with amines and other dye intermediates. As natural dye colours are used largely as foundation material for the after treatment with coal-tar colours, they are included in this volume. Tannin materials and inks are considered in conjunction with natural colours which are rich in tannin products. Nearly one-third of the whole volume deals with the subject of tannin, and the qualitative and quantitative examination of tannin materials is treated exhaustively. The constitution of acacatechin, as set forth by Nierenstein, is given, and while it is stated that this is not in agreement with the views of Freudenberg, it is left to the reader to look up the original papers, to which references are given, to examine the points of difference.

Much of the material in the sections on amines and ammonium bases, benzene and its homologues aniline, naphthylamine, etc., will be found in general text-books on organic chemistry. If this material was restricted, more place might be given to the more specialised sections on natural colouring matters, inks, and leather analysis.

The volume shows signs of careful editing, and only a small number of errors have been noted. The standard of the previous volumes has been maintained generally, and the subject index has been greatly improved. J. REILLY.

(1) *Manual of British Birds.* By H. Saunders. Third edition, revised and enlarged by Dr. William Eagle Clarke. Pp. viii + 834. (London and Edinburgh: Gurney and Jackson, 1927.) 30*s.* net.

(2) *The Birds of the Island of Bute.* By J. M. McWilliam. Pp. 128 + 8 plates. (London: H. F. and G. Witherby, 1927.) 8*s.* 6*d.* net.

(1) CLOSE field observation and keen discrimination of racial differences have brought the number of British birds from 384 to 500 since the second edition of this famous "Manual" appeared twenty-eight years ago. Fortunately, the bulk of the third edition has not kept pace with the increase, for although all the additions are described and many are illustrated, the editor has properly distinguished between rare visitors and regular British birds by allotting less space to each of the former. The essential plan is as in earlier editions: the occurrence in Britain, characteristic appearance, nesting habits, and migrations of each species are set out in a description which, with an illustration in woodcut or half-tone, occupies roughly two pages.

Great care has evidently been taken in compiling the accounts of occurrences and breeding in the British Isles, one of the most useful features in

the book, since records are brought down to the year of publication. Its compactness in a single volume, its accurate, full and readable descriptions, and its definitive illustrations of every species, make this the most suitable of British bird books for the ordinary ornithologist and naturalist.

(2) Island faunas offer many points of interest to the naturalist, and although the viability of birds discounts the significance of many species, there remains a substratum of 'residenters' which illustrate, more clearly than can be done on the mainland, the history of the fauna. Mr. McWilliam fully appreciates this significance, and in his historical introduction and remarks about several species, points out how the island of Bute has suffered a gradual reduction. In all, 168 species have been recorded from this limited area, and a general survey shows that the avifauna is closely comparable with that of the mainland, although island life has sometimes impressed new habits. Thus of rooks, jackdaws, and starlings, it is noted that they make daily migrations to the mainland over the Firth of Clyde, setting out in the morning and returning at dusk, notwithstanding that Bute itself apparently contains abundance of suitable feeding ground. It is estimated that in the autumn the sixty square miles of the island may contain as many as 400,000 birds.

A Treatise on the British Freshwater Algæ, in which are included all the Pigmented Protophyta hitherto found in British Freshwaters. By the late Prof. G. S. West. New and revised edition, in great part rewritten by Prof. F. E. Fritsch. Pp. xviii + 534. (Cambridge: At the University Press, 1927.) 21*s.* net.

More than twenty years have elapsed since the late G. S. West published his "British Freshwater Algæ." The edition was soon exhausted, and the lack of a similar volume has since been acutely realised. Prof. Fritsch has, therefore, done botanists in general a very real service in undertaking a revision of the earlier work. He has successfully tried to retain the character of the original volume, but the vast increase in every branch of our knowledge of the algæ has necessitated the addition of an enormous mass of material, and the result is an entirely new work, which has gained also an added personality.

Point is given to the general treatment of algal morphology in the emphasis laid on the development of parallel stages of morphological complexity in widely separated groups, a useful chart being given in illustration. The chief changes in arrangement occur in the Isokontæ. The Cladophorales and Sphæropleales are now removed from the Siphonales and grouped with Ulothricales, presumably on account of their metabolic similarity. The treatment of the Chlorococcales follows that of Brunnthaler in distinguishing Autosporinæ and Zoosporinæ. A considerable number of flagellate forms are added, these being grouped along with the appropriate coccoid and filamentous forms. The Peridineæ are also now included. No freshwater Phæophyceæ are recognised, the forms which were formerly described here having been more suitably transferred to the Chrysophyceæ.

The figures include one, at least, of every genus. Generic keys are given, and indications of the characters of at least the commoner species, while the valuable indications as to habitat have been retained and amplified. The book will be of great value not only to the algologist, but also to the teaching botanist, the student, and the amateur naturalist.

W. H. P.

Foremanship Training. By Lieut.-Col. Hugo Diemer. Pp. viii + 230. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1927.) 12*s.* 6*d.* net.

The *flair* for business which is so typical of Americans is peculiarly noticeable in their methodical consideration of the problem, how to get the most effect out of men and materials. This does not imply that the American seeks to take advantage of his fellow-citizens; it is rather that he desires to use human effort (as he strives to use mechanical effort) to the last ounce of advantage, so that the end in view may be achieved in the most practically economical way. Col. Hugo Diemer's treatise upon foremanship training considers one—and a very important—aspect of this urge for maximum effect. In a series of fourteen chapters he discusses that responsible cog in the machine, the foreman, with the view of making evident the necessity for training him so as to be, in fact, something more than a mere part of a machine—to be a man with intelligent general grasp of the whole of the work involved, and having a human faculty for bringing out what is best in the employés over whom he has to exercise a measure of control. The author drives home his arguments with a skill that is beyond dispute.

P. L. M.

A Book of Words: Selections from Speeches and Addresses delivered between 1906 and 1927. By Rudyard Kipling. Pp. vii + 299. (London: Macmillan and Co., Ltd., 1928.) 7*s.* 6*d.* net.

The addresses which compose the "Book of Words" were delivered in many lands to varied audiences through a period covering almost a quarter of a century. Occasional speeches, however, especially when delivered in lighter vein, only have value outside the circumstances in which they are made when they contain, hidden it may be by phraseology peculiar to the occasion, ideas of general interest. Such, in a measure, are these speeches. Almost every conceivable theme is touched upon from "The Spirit of the Navy" to the "Virtue of France," from "Independence" to the "Handicaps of Letters." Here and there, at greater length, occur other types of topics such as the contribution of prehistoric man to modern military practice and naval science, in which imagination and a kindly regard for half truths have resulted in charming narratives. The delight of the book is in the reading.

Letters to the Editor.

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Lecture Experiments on the Hydrogen Ion Concentration Changes in the Rusting of Iron.

FOR the rusting of iron, oxygen, water, and a trace of acid are required. In the process oxygen is used up, also a certain amount of water, but the acid may be said to act as a catalyst. It is, in fact, regenerated when the ferrous salt first formed is oxidised to the ferric state, as was shown previously (*Trans. Faraday Soc.*, **18**, 310-317; 1923). This is at once evident when we consider that, on making solutions of ferric or ferrous salts less acid, ferric hydroxide is first precipitated, at *p*H 3·5 to 5·5, and ferrous hydroxide comes down later, at *p*H 5·1 and onwards, a trace being still in solution at *p*H 7·6. Oxidation, therefore, must result in a liberation of acid, accounted for by the ferric being hydrolysed to a greater extent than the ferrous salt.

The reaction may be demonstrated as follows: Adding four drops of 0·04 per cent. brom phenol blue to each 10 c.c. of a dilute solution of a ferric salt, the yellowish colour of the indicator denotes acidity equivalent to *p*H 3·2 or less, namely, equivalent to a solution at least as acid. A similar solution of ferrous sulphate gives a purple colour with this indicator and can accordingly be no more acid than *p*H 4·2. It is in reality at about *p*H 4·8. On standing for some days the change to the ferric condition is accompanied by a change in reaction, as shown by the indicator. For lecture demonstration, however, it may be brought about instantaneously. By adding a few crystals of 'hyperol' to distilled water, a solution of hydrogen peroxide may be prepared which is no more acid than *p*H 5·6. It is accordingly alkaline towards the indicator mentioned and gives with it a good purple colour, as does also the freshly prepared ferrous solution. On mixing these two alkaline solutions, the result is a solution acid to the indicator, namely, at about *p*H 3·2, which is a clear yellow. This somewhat paradoxical behaviour is accounted for by the regeneration of acid from the hydrolysis of the ferric salt. Were metallic iron present, this acid would be free to attack it.

The action of carbon dioxide in solution can also be demonstrated. Bright iron wire is carefully washed free from the lime in which it is stored, being finally dipped in dilute acetic acid and thoroughly washed with distilled water. It is then placed in a test tube with distilled water to which brom thymol blue (0·04 per cent.) has been added. The full yellow colour of the indicator denotes the presence of free carbonic acid, so that the water is at least as acid as *p*H 6. This indicator changes to a clear green at *p*H 7·0 and is blue by *p*H 7·3. To demonstrate the rapidity of the change, one must work near the neutral point and in an unbuffered solution; the water is therefore brought to a yellowish green colour, *p*H 6·6–6·8, by the addition of either a trace of pure sodium bicarbonate or a few drops of sea water. On standing, the very low acidity, *p*H 6·8, is reduced by the attack on the iron; within two minutes the reaction has become noticeably less acid; within five minutes the change is readily recognised. For lecture demonstration the experiment may be started an hour beforehand, when the green colour of the indicator will have been changed to an intense blue round the wire. On shaking up, the whole tube becomes blue, but on allowing to stand, a green colour reappears in the parts remote from the wire, especially near the surface, owing to the oxidation of the ferrous salt, with regeneration of acid. Inasmuch as increase in acidity appears to slow down the rate, there are reasons for thinking that the constituent most readily oxidised is the fraction of the ferrous salt which is hydrolysed to hydroxide. By its oxidation the equilibrium is upset and more ferrous bicarbonate hydrolysed to hydroxide, the equivalent of acid being set free. The changes occurring round the wire may be projected on a screen and so made visible to the audience.

With solutions which are alkaline at the start, namely, those containing fewer hydrogen ions than does *pure* water, the change proceeds, though more slowly. Using 0·02 per cent. phenol red, a pink colour may be obtained, increasing to a good red, indicating *p*H 8. Using xylenol blue, a light blue may be obtained, showing a reaction as alkaline as *p*H 8·4–8·6. Beyond this I have not succeeded in going, for the change being much slower, the liberation of acid through oxidation prevents further increase in alkalinity. Were care taken, however, to remove all oxygen, it seems likely that a greater alkalinity could be reached.

On standing in a tube with distilled water, iron wire in rusting continues to absorb carbon dioxide from the air to such an extent that when the acid is set free by 'hyperol' solution, as previously described, the solution, originally no more acid than *p*H 5·6–6·0, will give a good red colour with methyl red, showing that it is nearly saturated with carbon dioxide and is somewhere near *p*H 4·6.

Control tubes without the iron wire were used throughout and the tubes were of British resistance glass. The water was freshly distilled in a room free from chemical fumes.

The explanation given here of the mechanism of the rusting of iron is, I believe, that which is now generally accepted, and the hydrogen ion changes revealed by the indicators support it. It naturally follows that the experiments described are against the view that an oxidation of the iron is the first stage in rusting.

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The Disintegration of Radium E from the Point of View of Wave Mechanics.

ELLIS and Wooster (*Proc. Roy. Soc.*, A, **117**, p. 109) have shown recently that in the disintegration of radium E the single β-particle emitted has an *initial* energy which may vary from 40,000 to 1,050,000 volts. This means that the result of disintegration is in some way indeterminate, a conclusion difficult to reconcile with the usual ideas of radio-activity.

Some such result, however, is to be expected on the new wave mechanics, if the ejection of a β-particle is produced by anything like a sudden explosion. In such a case one would expect that the wave-group which accompanies, and on some views actually constitutes, the electron, would be of the nature of a single pulse, that is, the damping factor of the amplitude would be of the order of the wave-length. Such a wave-group, being very far from monochromatic, would spread rapidly lengthwise owing to the large dispersion of the phase waves, and so the distance within which the electron may occur becomes large, implying a marked 'straggling' in velocity. Similarly, if the waves pass through a magnetic field,

which is for them a refracting medium, the group will split into monochromatic waves going in different directions, just as white light is split up by a prism. Thus an observer who forms the magnetic spectrum of the β-rays will find electrons in places corresponding to paths of various curvatures, that is, he will find a spectrum continuous over a wide range.

This view can be checked numerically. Darwin has shown (*Proc. Roy. Soc.*, A, **117**, p. 258) that if we assume, for convenience of calculation, a distribution of 'intensity' (chance of the presence of an electron) in the initial wave of $\exp - (x - x_0)^2/\sigma$, that is, an 'uncertainty of position' σ, then there is an 'uncertainty of momentum' in the group of amount $h/2\pi\sigma$ and conversely. This is, of course, Heisenberg's 'uncertainty relation' in wave dress. I find that a fair fit to Ellis and Wooster's result is got by taking the number of β-particles with momentum g proportional to $\exp - \left[\frac{g - 1{\cdot}25 m_0 c}{0{\cdot}65 m_0 c}\right]^2$. Hence the uncertainty in momentum is $0{\cdot}65\ m_0 c$, and that in position is $\sigma = h/2\pi \times 0{\cdot}65 m_0 c$.

The mean wave-length by de Broglie's relation is $\lambda = h/1{\cdot}25 m_0 c = 2 \times 10^{-10}$. Thus, $\lambda = 3{\cdot}3\sigma$ and the wave is heavily damped, the amplitude at the first minimum being only 7 per cent. of that in the middle of the group. The group in fact looks like a typical pulse such as may be formed in a stretched rubber cord by a sharp blow. It should be noticed that the value of σ is much larger than the diameter of the nucleus, which might at first sight be expected to govern the uncertainty of position.

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April 2.

The Form of the Carbon Atom in Crystal Structure.

A. Gerstäcker, H. Möller, and A. Reis have published an account of the crystal structure of pentaerythritol tetra-acetate (*Zeitsch. f. Kryst.*, **66**, 355; Jan. 1928), in which they assign the crystals to the space-group C^3_{4h} with a simple tetragonal lattice (Γ_t). There are two molecules of pentaerythritol tetra-acetate to the unit cell and the space-group C^3_{4h} with a Γ_t lattice requires eight asymmetric molecules per unit cell. Therefore the molecules of pentaerythritol tetra-acetate must have some kind of fourfold symmetry. There are two types of fourfold symmetry possible in this space-group—either a simple fourfold rotation axis or a fourfold alternating axis. Messrs. Gerstäcker, Möller, and Reis have chosen the former, since it leads to a molecule which can be built into a chain-like structure, and the latter does not.

The authors base their expectation of a chain structure on the prismatic habit of growth and on the shortness of the c-axis compared with the a-axis ($c : a = 0{\cdot}458$), and claim that a chain structure, when present, has the length of the chain parallel to the axis of highest symmetry of the crystal. Now experience goes to show that prismatic growth and chain structure are not necessarily associated, either in the tetragonal system or in any other. There are many thin tabular crystals, which have a chain structure in which the chains are perpendicular to the plates, as, for example, the many long-chain carbon compounds, which have been investigated by X-rays. Moreover, in these long-chain compounds the direction of the chains was found to be perpendicular and not parallel to the axis of highest symmetry. Again, the interesting group of metallic tetraphenyl compounds (W. H. George, *Proc. Roy. Soc.*, A, **118**, 585; Jan. 1927), which crystallise in the tetragonal system, are prismatic in their habit of growth, but show no suggestion of a chain structure.

The form of the molecule of pentaerythritol tetra-acetate proposed by the above authors is shown in Fig. 1 (reproduced from Fig. 1 of their paper). It will be seen that the molecule is polar, and that the four bonds from the central carbon atom must be directed away from it towards a square base. It does not appear that the authors have put forward any evidence which could justify the adoption of a molecular form departing so completely from what would be expected from physical and chemical considerations.

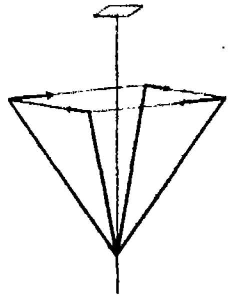

Fig. 1.

In May 1927, in a private communication to the Council of Girton College, I gave an account of an X-ray examination of pentaerythritol tetra-acetate carried out in this laboratory. My results led to the space-group C^4_{4h} and not to C^3_{4h}. The distinction between the two space-groups depends on the absence or otherwise of all odd order reflections from the (001) plane. I have been able to find only a second order reflection from this plane, after making a most careful search for other orders both on the ionisation spectrometer and by photographic methods. In a rotation photograph about the [100] axis, using copper radiation, a weak spot is found on the zero layer line, which, from its position, might be due either to the first order reflection from the (001) plane for copper $K\alpha$ rays or to the first order reflection from the (011) plane for copper $K\beta$ rays. However, in a rotation photograph about the [110] axis, the spot did not appear on the zero layer line. The conclusion is that it is not due to reflection from the (001) plane, for if it were, it should still be found in the same position as before.

In their paper, Messrs. Gerstäcker, Möller, and Reis state that they find a first order reflection from the (001) plane and are thus led to the space-group C^3_{4h}.

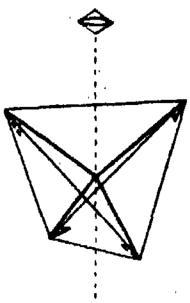

Fig. 2.

Their only mention of this reflection is in an oscillation photograph in which [100] is the rotation axis, but neither the range of the oscillation nor its angular relation to any plane appears to be stated. It is not possible to say with certainty, therefore, to what plane the observed reflection is due, or that it is not due to the $K\beta$-reflection from the (011) plane. It is not evident that the authors have taken any particular care to establish the presence of the first order (001) reflection, upon which their space-group and, moreover, the molecular symmetry which they propose, depend. For if, as I believe, the space-group is C^4_{4h}, there is no longer any possibility of a molecule with a simple fourfold axis of symmetry, the only possible molecular symmetry then being a fourfold alternating axis, the molecule having the form shown in Fig. 2. On this view, therefore, the carbon atom plays the part expected of it.

My measurements of the dimensions of the unit cell differ from those of the German workers. They find $a = 12{\cdot}34$ A., $c = 5{\cdot}56$ A., while the values I find are $a = 11{\cdot}98$ A., $c = 5{\cdot}47$ A. The density of the substance is 1·273. In a previous paper of mine (*Jour. Chem. Soc. Lond.*, **123**, 77; 1923) an overlooked printer's

error made it 1·213. With my figures and the correct value of the density, the number of molecules in the cell works out at 1·99.

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Science and Nature.

It is undeniable that the attitude towards Nature which inspired the author of Nature's motto, is implicitly repudiated by many of its readers. For that spiritual intimacy between Nature and man, which formed the substance of Wordsworth's poetry, is questioned and even rejected by a large body of investigators. To them Nature is the sphere of essentially impersonal energy and law, which are either absolutely indifferent or actively hostile to human ideals. Huxley, for example, regarded the 'cosmic process' as everywhere antithetic to 'social progress,' thus unconsciously destroying the continuity of evolution just where it becomes of supreme value to humanity; and in precisely the same spirit Mr. Bertrand Russell foresees the ultimate extinction, by natural agencies, of everything for which he himself bids us strive.

The validity of such a viewpoint is plainly a matter of the highest scientific importance. For since science is the investigation of Nature, any interpretation of Nature must reflect itself in the interpretation of science itself. Conversely, the implications of science must illuminate the character of Nature; so that quite apart from that fatal breach of evolutionary continuity postulated by Huxley, both the content and the expansion of modern science yield ample material for controverting his conclusion. From the strictly psychological viewpoint, all functions of the human mind are fully as natural as those of the brain. It follows, therefore, that reason, logic, and science are just as natural as the cerebral processes which sustain them; and even if any of these are 'emergent,' still this involves no essential loss of continuity. Thus Nature is not only the *object* of science, but also the sole and primal *source* of science; and this, still further, not in any merely passive nor indifferent way, but dynamically. For it matters not whether man's intellect is the result of heritable acquired characteristics or of natural selection, since in both respects alike it is the culmination of the age-long interplay of Nature's own agencies. Reason, then, is in no degree foreign to Nature; Nature therefore cannot be foreign, much less hostile, to reason and all that reason involves—to science, art, and morals. Only thus, in fact, can Nature's motto be accepted in anything beyond a purely metaphorical sense.

Turning next to the specific content of science, it is clear that the logic of science reflects an order of Nature. This remains true even if we regard scientific principles as mere formulæ which enable man to utilise and control Nature; the sole alternative being the abdication of thought in favour of Bergsonian 'intuition,' which is plainly suicidal so far as science itself is concerned. The truth surely is that science yields an insight, slowly growing in clarity and coherence, into the structure of Nature alike on its physical, vital, and psychical levels. To what degree these are continuous with one another is an important, but here subordinate, problem, since it cannot affect the conclusion that Nature, not partially but throughout its whole extent—from electron to galaxy, from space-time to Shakespeare—is coterminous both with human reason and, so far as man dominates Nature, with human purpose.

It may still be argued that this reciprocity is approaching its final limits, beyond which lies Nature not merely as unknowable, but as inimical. This suggestion, however, definitely contradicts the incessant *expansion* of modern science. For in all its details alike, scientific progress exemplifies the single fundamental principle that Nature possesses a structure and order so systematic and intricate, so delicate and precise, that all current theories are far too simple to be at all adequate for their understanding and explanation. The solution of every problem without exception reveals fresh problems of ever-increasing difficulty; but in spite of this, increased knowledge shows these to be, in principle, soluble problems. In other words, they are not, essentially, intractable to human reason as such, but only to the limited data with which reason, at any given stage, is condemned to operate; so that as these data slowly multiply, to that degree can more of Nature's riddles be read. Reason thus proves itself to find an ever-widening and favourable habitat within Nature's inmost realm, which thus reveals itself to be no hostile region, but rather thought's highest native sphere.

Nevertheless, the relation between science and Nature must always remain asymptotic; it can never become exhaustive. But this again is no occasion for pessimism and despair. Rightly understood, on the contrary, it plainly implies that Nature, far from mocking and defying human thought, beckons it ever onward to more intimate contact with herself. For her last secrets will be disclosed only to a reason and a science which transcend our own to the same degree that we transcend Eoanthropus.

J. E. Turner.

Light and Sight.

I have read Sir John Parsons' article in Nature of Jan. 21 and the letters of Mr. Smith and Sir John (Nature, Feb. 18) with great interest. Perhaps I may be allowed to make a few comments on them. Sir John's supposition was that since the retinal sensation curve reaches its maximum not far from that of the energy curve, and since the two curves are not unlike in shape, there may have been some evolutionary process at work. Mr. Smith's criticism is that only on a wave-length basis would this be the case. If, as is preferable, frequencies be taken, then the shapes of the two curves are quite different.

Now we cannot be sure that Mr. Smith's criticism is justified until we have considered the conditions present in the eye. Until we have done that, have we a pertinent reason for claiming one set of arbitary units (wave-lengths) to be better or worse than another set (frequencies)?

Now on a wave-length basis, equal wave-length differencies occupy equal areas and all wave-lengths have equal access, since the slit remains fixed in size to give equal wave-length purity. On a frequency basis, on the other hand, equal wave-length differencies do not occupy equal areas, since those of long wave-length are more condensed and those of shorter wave-length more spread out. Neither have all wave-lengths equal access, since the slit has to be narrower for short wave-lengths than for long, to give equal frequency purity.

In the eye, on the other hand, owing to the presence of chromatic difference of magnification, shorter wave-lengths are less spread out, and the pupil is slightly *wider for short wave-lengths than for long.* That is, the conditions present are far removed from the frequency basis and approximate fairly closely to the wave-length one. In view of this, I can see no reason to prefer the frequency basis or to criticise Sir John's suggestion as being impossible. With

regard to Mr. Smith's alternative suggestion that the use, on one hand, of the near ultra-violet rays has been avoided in vision because of want of contrast, and of the near infra-red rays, on the other, because of the blackness of the shadows: if there were such difficulties in the use of these rays, one would expect ordinary non-colour-sensitive photography to be adversely affected on one hand, and for these black shadows to become visible when the eye is made sensitive to rays between 6800 and 7100 A. on the other.

Yet in my experience such is not the case. Is it not conceivable that the blackness of the shadows was due in R. W. Wood's photographs to slight under-exposure, seeing that only recently have fast infra-red sensitive plates been available. To my mind, it is more likely that the exclusion of ultra-violet rays was due to the difficulty in producing living media transparent to these rays, and that the non-utilisation of the near infra-red rays (which do in point of fact reach the retina) is due to the absence of a suitable retinal pigment which will absorb and will undergo photochemical change as a result of the incidence of these rays. Now I will refer to the resolving power of the eye. Mr. Smith suggests that there are ocular powers of discrimination that are more refined than the coarser features of retinal structure—the rods and cones—would lead us to expect. This is a question to which I have given a great deal of thought, and the conclusion to which I have come is that if we are prepared to grant that the cones in some way are able to register increases or decreases of intensity of, roughly, 10 per cent. (which we should not find difficult, since we can prove by experiment that moderate sized areas of retina can register increases or decreases of intensity of less than 1 per cent.), then we can adequately account for all the finer ocular powers. We can explain on this basis how, for example, the eye that can just recognise the 'twoness' of two point sources when they subtend at the eye an angle of not much less than 50″, can see a black line when its width subtends at the eye an angle of only 3·1″; with cones, moreover, the diameters of which subtend at the nodal point of the eye an angle of about 44″.

Lastly, with regard to Mr. Smith's letter in Nature of Feb. 25 on "An Optical Paradox," would not any method of measurement depending on comparisons break down if put to a similar test? I would propose that the word 'optical' be omitted lest it suggest to the uninitiated the idea that the paradox only applies to visual measurements.

H. Hartridge.

The Density necessary to Produce the Nebular Spectrum.

In a recent letter to Nature (Jan. 7, p. 12) C. T. Elvey attempts to calculate the density, ρ, of the expanding gaseous shell of a nova at the moment when the nebular lines first appear. It is easily shown that $\rho = \rho_0 r_0^2/v^2t^2$ where ρ_0 is the original density of the shell when coincident with the stellar atmosphere, r_0 its original radius, v its velocity of expansion, and t the time elapsing between the outburst and the appearance of the nebular lines. The above equation involves the additional and somewhat questionable assumption that the thickness of the expanding shell does not change. Elvey takes v from velocity displacements on nova spectrograms. For Nova Aquilæ 3 this is about 1700 km./sec. and $t = 19$ days. Hence he finds,

$$\rho = 12{\cdot}7 \times 10^{-20} \rho_0 r_0^2 \text{ gm./c.c.}$$

(r_0 in km.). Since figures for eight additional novæ give coefficients for $\rho_0 r_0^2$ of the same order of magnitude, Elvey concludes that "the novæ originate from stars of similar physical conditions and that there is a limiting density above which the conditions are unfavourable for the production of the nebular spectrum."

It is my opinion that the experimental evidence is far too meagre to draw any further conclusions than those just quoted. Up to this point the assumption of constant thickness for the gaseous shell has been unnecessary. It would have been sufficient merely to suppose that it varies at the same rate for all novæ.

I think that Elvey's attempt to calculate an absolute value for ρ is not justified. Taking $\rho_0 = 10^{-9}$ gm./c.c. (corresponding to a pressure of some 10^{-4} atmosphere) and $r_0 = 6 \times 10^5$ km., he finds for the mean density, critical to the nebular lines, $1{\cdot}8 \times 10^{-17}$ gm./c.c. Elvey's use of $\rho_0 = 10^{-9}$ gm./c.c. is equivalent to the assumption that the phenomenon of the nova originates in that particular layer of the star's atmosphere. There is no *a priori* reason why a value of ρ_0 of 10^4 or more times the above should not have been employed in the calculation; the expanding shell would still be essentially atmospheric. It is true that the value, 10^{-4} atmosphere, is the pressure at which the stellar atmosphere is becoming opaque to visible radiation and hence marks a more or less definite layer, but this fact does not demand that all atmospheric phenomena originate there.

Bowen (*Publ. A. S. P.*, **39**, 295; 1927) has identified the nebular lines with metastable transitions in the atoms of singly, doubly, and triply ionised oxygen. These transitions, at one time spoken of as 'forbidden,' are presumably allowed in the very tenuous nebulæ, where the time between atomic collisions is extremely long. Ordinarily the time spent by an electron in an excited level is only about 10^{-8} sec. The time it would remain in a metastable state is much greater—so long, in fact, that before the natural atomic transition can occur, a collision with another atom (impact of the second kind) will knock the electron from its metastable orbit. Hence the 'forbidden' electron jumps should occur only when the time between collisions is longer than the excited time, that is, in gas of low density. A determination of the critical density, at which the metastable transitions begin to occur, would furnish valuable information regarding their life-time, but Elvey's value for it—a hundred seconds—is almost valueless for the reasons stated above.

The only fact that recommends Elvey's computed densities appears to be the close correspondence between them and the calculated values[1] for the planetary nebulæ (5×10^{-18} gm./c.c.). If the latter be assumed approximately true for the novæ, the more correct interpretation of Elvey's work is that the phenomenon of a nova originates in the star's atmosphere at a layer where the pressure is 10^{-4} atmosphere or less. When more data regarding the life histories of novæ have been obtained, and when the physicists have determined the metastable life of the atoms under consideration, these facts may be used to solve the nova problem. One should not neglect, however, to take into account photo-electric ionisation of the gas by the intense stellar radiation. Recent work by Bowen (*Astrophys. Jour.*, **67**, 1; 1928) shows that conclusions derived without considering this influence may be devoid of physical meaning.

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Mar. 14.

[1] Russell, Dugan, and Stewart, "Astrophysics and Stellar Astronomy," p. 835.

An Apparent Failure of the Hund Theory.

THE Hund theory of spectra includes, as an essential part of it, a prediction of the individual levels of an ion to which component term sequences will converge. The evidence supporting the predictions seem reasonably good in cases of spectra the character of which is determined by less than half-filled electron groups. On the other hand, the following two items of evidence seem to indicate that the theoretical predictions are not fulfilled in spectra determined by nearly completed electron groups.

1. The Paschen s terms in Ne I are, without doubt, the ${}^3P$ and ${}^1P$, which arise from an electron structure $2p^5ns$ ($n \geq 3$). The $1s$ terms can be arranged unambiguously from both position and Zeeman effect as follows:

$${}^3P_2 = 1s_5,\ {}^3P_1 = 1s_4,\ {}^3P_0 = 1s_3,\ {}^1P_1 = 1s_2.$$

Consequently, if one accepts Paschen's series, ${}^3P_2$ and ${}^3P_1$ converge to one limit; and ${}^3P_0$ and ${}^1P_1$ to a higher limit, the two limits together being the ${}^2P(p^5)$ of Ne II. This is in definite disagreement with the theory, which would reverse the limits of ${}^3P_1$ and ${}^1P_1$. Since the nature of the terms is determined empirically in this case by the first members only and the limits by the higher members, it is possible to reconcile observation and theory, as Hund has done, by associating $1s_4$ with the s_2 series as its first member; and $1s_2$ in the same way with the s_4 series. But there is now evidence against such a change. The series of s_2 and s_4 terms combine with the lowest term of the spectrum ${}^1S_0\ (2p^6)$ to give a far ultra-violet series of pairs ${}^1S_0 - ns_2$, ${}^1S_0 - ns_4$. In this series the line ${}^1S_0 - ns_2$ is the stronger of each of the pairs. This statement is based not only on the published material, but also on personal observation of plates taken in this laboratory. Such a regularity of intensities is incompatible with Hund's distortion of the series and leads definitely to the conclusion that the theoretical prediction is not satisfied for such sequences as the s-terms of neon. The whole argument applies equally to the corresponding terms of argon.

2. The second item of evidence is contained in the spectra of atoms and ions, of which the structure is based on 9 d-electrons. Ni I, Cu II, Pd I, Ag II all show sequences of ${}^3D$, ${}^1D$ terms of origin d^9s converging to the ${}^2D(d^9)$ of the higher ion. In Cu II, Ni I, and Ag II only two series members are known, but they are well verified in every case by intensities and in Cu II also by Zeeman effects. In all cases the calculated limits of ${}^3D_3$ and ${}^3D_2$ fall close together, as do those of ${}^3D_1$ and ${}^1D_2$, contrary to the theory, which predicts coincidence of the limits in pairs ${}^3D_3$, ${}^1D_2$; ${}^3D_2$, ${}^3D_1$. In Pd I the evidence is more striking, since three series members are present. To pick them correctly, it is necessary to identify consistently all the terms of the spectrum from intensities. This leads to an identification of the middle set of terms exactly as given by Bechert and Catalan and in disagreement with McLennan and Smith. The second member of the d^9s sequence is then McLennan's with ${}^3D_2$ and ${}^1D_2$ interchanged. In the third member, this interchange is again necessary, and also the addition of McLennan's ${}^3G_4$ as ${}^3D_3$. These identifications are unambiguous. The limits calculated from a Ritz series formula lead to the same disagreement with theory as the similar two term series. The separation of the two limits ${}^2D_3$ and ${}^2D_2$ of Pd II, is so great (more than 3500 wave-numbers) that there can scarcely be any doubt of the reality of the coincidences of the real limits even though the calculated limits differ by 80 units in one case (${}^3D_3$ and ${}^3D_2$) and 20 units in the other (${}^3D_1$ and ${}^1D_2$).

The disagreements with the Hund theory here pointed out are the only ones of which I am aware. More evidence is certainly advisable and it is being sought in this laboratory.

I cannot offer any explanation of these apparent failures of the theory. It seems that the operations with the electron vectors which lead to the predictions may be carried out in a great variety of ways and lead always to the same result so long as they are treated consistently in both series and limit terms.

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A Change of Wave-length in Light Scattering.

FURTHER observations by Mr. Krishnan and myself on the new kind of light-scattering discovered by us have been made and have led to some very surprising and interesting results.

In order to convince ourselves that the secondary radiation observed by us was a true scattering and not a fluorescence, we proceeded to examine the effect in greater detail. The principal difficulty in observing the effect with gases and vapours was its excessive feebleness. In the case of substances of sufficient light-scattering power, this difficulty was overcome by using an enclosed bulb and heating it up so as to secure an adequate density of vapour. Using a blue-violet filter in the track of the incident light, and a complementary green-yellow filter in front of the observer's eye, the modified scattered radiation was observed with a number of organic vapours, and it was even possible to determine its state of polarisation. It was found that in certain cases, for example, pentane, it was strongly polarised, while in others, as for example naphthalene, it was only feebly so, the behaviour being parallel to that observed in the liquid state. Liquid carbon dioxide in a steel observation vessel was studied, and exhibited the modified scattering to a notable extent. When a cloud was formed within the vessel by expansion, the modified scattering brightened up at the same time as the ordinary or classical scattering. The conclusion is thus reached that the radiations of altered wave-length from neighbouring molecules are coherent with each other.

A greater surprise was provided by the spectroscopic observations. Using sunlight with a blue filter as the illuminant, the modified scattered radiation was readily detected by the appearance in the spectrum of the scattered light of radiations absent from the incident light. With a suitably chosen filter in the incident light, the classical and modified scatterings appeared as separate regions in the spectrum separated by a dark region. This encouraged us to use a mercury arc as the source of light, all radiations of longer wave-length than 4358 A. being cut out by a filter. The scattered radiations when examined with a spectroscope showed some sharp bright lines additional to those present in the incident light, their wave-length being longer than 4358 A.; at least two such lines were prominent and appeared to be accompanied by some fainter lines, and in addition a continuous spectrum. The relation of frequencies between the new lines and those present in the incident light is being investigated by photographing and measuring the spectra. The preliminary visual observations appear to indicate that the position of the principal modified lines is the same for all substances, though their intensity and that of the continuous spectrum does vary with their chemical nature.

C. V. RAMAN.

210 Bowbazar Street,
Calcutta, Mar. 8.

Limits of Form and Magnitude in Desert Dunes.[1]

By Dr. VAUGHAN CORNISH.

REVIEWING in the light of later publications, particularly Sven Hedin's "Scientific Results" and Dr. W. F. Hume's "Geology of Egypt," vol. 1, the observations of sand dunes which I made more than a quarter of a century ago, I have been led to recognise the dynamical significance of the peaked structure which is so marked and picturesque a character in the sand seas of the Gobi, the Tarim basin, and western Egypt.

On the sea shore, loose, dry sand is arranged by the wind in little waves, which travel and keep station with one another as they move. They are a few inches from crest to crest, with short, steep front and long, gentle slope to windward. These little æolian waves, or ripples as they are called, are remarkably level-crested and long-crested, these characters being much more pronounced than in the waves which travel on water during the action of a breeze (Fig. 1).

FIG. 1.—The level crests of æolian sand ripples.

In the extensive deposits of dry sand which are called sand seas, these long- and level-crested ripples pattern the slopes of the larger waves, called dunes. The average steepness, or ratio of height to length, of the dunes is comparable to that of the ripples but generally rather less. The profile of the large waves, or dunes, is of the same general character as that of the ripples, a short, steep front and a long, gently-sloping back; but the section at right angles to the wind is very different. A manikin viewing a landscape of æolian sand ripples would see a succession of peaks when looking across the direction of the wind, but a level sky-line when looking up- or down-wind. The drawings of M. Binosi in the western desert of Egypt, of Dr. Sven Hedin in the Takla Makan, and that made from the notes of Sir Francis Younghusband in the Gobi ("The Heart of a Continent," p. 98) show that, in whatever direction we look, the sky-line is punctuated by sharp peaks, all of which attain about the same height. Thus, whereas the little sand-waves or ripples are normally level-crested and long-crested, the large sand waves or dunes which rise from a sea of sand subject to stormy winds are usually peaked and frequently short-crested.[2] The peaked form has been ascribed to a breaking of the level-topped ridges by wind from a direction inclined, or at right angles, to that by which the ridges were built. It is evident that such seasonal change of wind would furrow the ridges and make them otherwise irregular, but from observations which I made in Egypt in 1899 I infer that peak-and-saddle form can be produced by strong wind constant in direction, and that this is in fact the form of the maximum sand waves produced by such wind in a sand sea.

On a dried-out sandbank of the Nile near Helwan, where the sand is finer and more mobile than that of the desert, I watched a group of many little dunes, about twenty inches high and thirty feet in wave-length, during the process of transformation

[1] See paper on "Waves in Granular Material Formed and Propelled by Winds and Currents," *Monthly Notices of the R.A.S.*, Geophysical Supplement, July 1927.

[2] The term 'short-crested' has been introduced by Dr. H. Jeffreys for "wave systems in which the distance between consecutive maxima of elevation is of the same order of magnitude in whatever direction it is measured."

from the level-crested to the peak-and-saddle crested form, the direction of the wind remaining constant. It can easily be understood that if the wind increase after the ridges have attained their maximum steepness the crest will collapse here and there, but the natural expectation would be that the parts then left upstanding would soon give way, thereby levelling the crest, whereas in fact the undulation of the crest rapidly increased. It follows that if any lowering at the peaks occurred, it must have been less rapid than at the saddles, but in point of fact there was no indication that any lowering had occurred at the peaks. The action of the wind, as well as I could ascertain, was as follows. In passing through the notches or saddles it neither conformed to the profile of the surface nor circulated round a horizontal axis, but swirled spirally. It is significant that the ripples at the saddles were larger and the sand coarser than elsewhere. Under the lee of the peak the right- and left-handed spirals met. When the dunes were losing more sand than they received, and the wind was strong, the action of these converging currents under the lee of the peak was to scoop out the loose sand, lowering the trough, sometimes down to the bare floor. When, however, there was no depletion, a longitudinal bank of sand was piled against the lee of the peak where the converging currents met.

I measured the height and wave-length of a long series of these dunes which had level crests, and of another series the crests of which had marked peak-and-saddle form, and found that the average steepness was the same, a result which points to the conclusion that as much sand is piled on the peaks as is eroded at the saddles.

When I crossed the Suez Canal at Kantara and went east along the El Arish route to view the sand sea of northern Sinai, I found the western edge of the buried country, where the sand is not deep, was all in rounded, billowy undulations like those of gently rolling chalk downs; but farther on, where the deposit was thicker, the dunes had the characteristic desk-shaped profile. Their ridges, however, although of considerable crest-length, were neither level nor merely undulating, but punctuated by peaks the height of which above saddle was comparable to the height of saddle above trough. The moderate breeze which was blowing daily at the time of my visit was in the reverse direction to that of the wind by which the dunes appear to be formed, not oblique or at right angles thereto. As the height of peak above trough is sometimes as much as three hundred feet, it is evident that the force of the wind at the crests must be considerably greater than that to which the sand on the shallow margin of the sand sea is exposed. This would account for the more pronounced form of profile. It is evident, however, that the increased force of wind due to vertical deflexion must set a limit to the growth of peaks: there will be a certain height at which the top will collapse.

On the west side of the Suez Canal, near Ismailia and close to Lake Timsah, was a transverse ridge of dune from which rose a pyramidal peak so sharp that its appearance recalled the monumental pyramids of Egypt (Fig. 2). As I approached the peak from the lee side in order to obtain a nearer view, the vibration of my step caused a considerable landslide, the soft sand of the lee side breaking away from the crest-line where it abutted on the more compact sand of the weather slope. The accom-

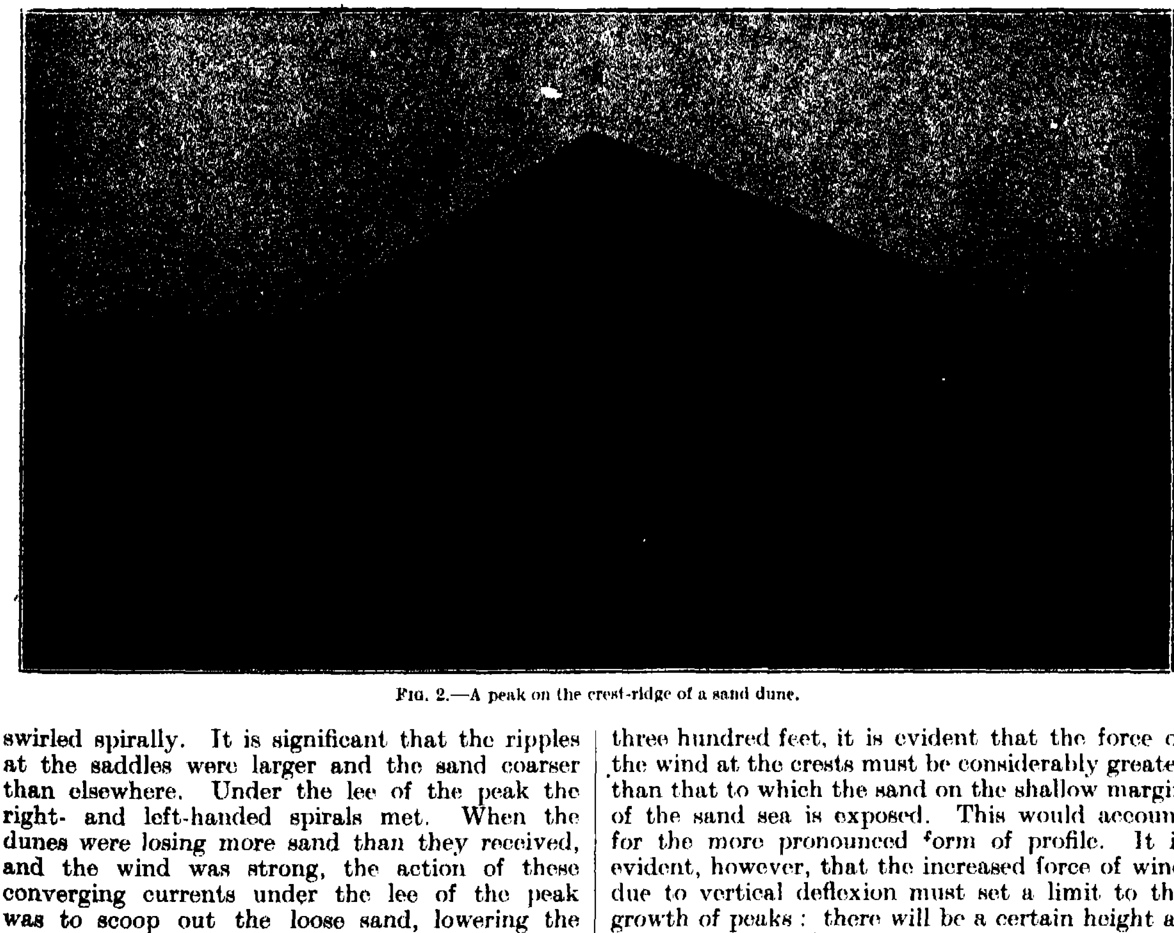

Fig. 2.—A peak on the crest-ridge of a sand dune.

panying photograph was snapped at the moment when slipping began. The occurrence emphasised the conclusion that such peaks are forms of accumulation, not erosion.

From the foregoing observations I infer that if a country be silted with loose, dry sand under the action of strong wind constant in direction until the dunes attain maximum height, the sky-line will be serrated by peaks not only when viewed at right angles to the wind but also when looking up- or down-wind; that these peaks are not remnants of erosion, but accumulations; and that the normal crest-line of maximum dunes in a sand sea subject to strong wind of constant direction is not level, but peaked.

Dr. Sven Hedin records in his "Scientific Results" that in the eastern part of the desert of Lop, the windward part of the Tarim basin, small dunes are formed during the dying-down of a storm, but when the wind gathers force in the next storm are dispersed. Mr. A. E. Douglass[3] and Prof. S. I. Bailey[4] record that in the windward part of the Peruvian desert of Islay the sand, which is derived from an extraneous source, collects in isolated dunes less than four feet high which are not permanent, being dispersed after a time, blown to pieces by the wind. As soon as a height of four feet is attained, permanence is assured, but does not occur nearer than twenty miles from the windward edge of the desert. From this position the moving mounds grow during a very short course of travel from four feet to fifteen feet in height, which is the characteristic maximum throughout the remaining twenty-five miles of desert plateau. The dimensions and movement of a dune near La Joya railway station have been recorded for several years. The rate of progress was remarkably uniform, 62, 57, 63, 63, 63 feet in successive years, and the height and breadth of the crescentic mound was almost constant. The length and direction of the tapering cusps or horns varied, but the quantity of sand added to or subtracted from the cusps was very small in proportion to the total mass of the dune, not, I think, greater than the quantity contained in one of the rudimentary dunes which form and disperse in the windward part of the desert according to the vicissitudes of weather.

It is well to bear in mind that most of the recorded observations of the movement of sand-grains in deserts have been made during moderate breezes, when the effect of a mound of sand is to provide shelter to leeward. During storms the atmosphere in a sand sea is usually so blinding and suffocating that no precise observations are made, but in this weather the increased force of wind at the summit of the dune is sufficient to cause dispersal, a reversal of the mode of action which we commonly observe.

[3] *Appalachia*, vol. 12, No. 1.

[4] *Annals of the Astronomical Observatory of Harvard College*, 29, Part II.

High Frequency Sound Waves of Small Intensity and their Biological Effects.

By Prof. E. Newton Harvey, Princeton University,
and Alfred L. Loomis, the Loomis Laboratory, Tuxedo Park, New York.

R. W. WOOD and one of us (Loomis) have described (*Phil. Mag.*, 4, 417; September 1927) certain physical and biological effects observed with high frequency sound waves of great intensity. To obtain this great intensity, high potentials (of the order of 50,000 volts) are required, and the oscillating piezo-electric quartz crystal must be operated in an oil bath. This method is not suitable for observing biological material under a microscope.

For this purpose we have constructed a special device which can be attached directly to a microscope and operated by an oscillator of relatively low power but must be accurately tuned to resonance with the quartz crystal. The entire oscillator (Fig. 1) is very compact and weighs only eighteen pounds. It takes current directly from the 110 volt A.C. lighting circuit and employs a 75 watt tube (Radiotron 852) with two small transformers (one giving 8 volts for the filament, the other 1100 volts for the plate). The microscope with quartz crystal is set up about three feet from the oscillator and connected through a shielded lead, so that movements of the operator will not materially vary the capacity and thus the frequency. Two controls which connect with the oscillator are operated from the microscope, one varying the plate and filament current and the other the frequency.

The crystal mounting consists of a bakelite ring which is placed directly on the microscope stage. Fastened to the top of this ring is a thin foil electrode connected to the high tension lead. The quartz crystal is placed on top of this electrode. The crystal is 54 mm. in diameter and 7·02 mm. thick. It is cut with its electric axis perpendicular to the plane of the disc. Its natural frequency is 406 kilocycles per second. The specimen to be examined is placed on the centre of the upper surface of this disc and protected with a cover glass. On top is placed the upper electrode, which is earthed. The frame of the microscope is also earthed. A small hole through the centre of the lower electrode permits adequate illumination of the specimen, and a similar hole through the upper electrode permits the light from the specimen to enter the microscope objective.

Observing under a high-power microscope, it has been possible to follow the progressive destruction of frog blood corpuscles. The oval cells at first become warped and twisted. Strained areas appear and the colour fades, leaving a pale distorted shadow. Human blood corpuscles are likewise twisted and sometimes broken up into many small globules like an emulsion of oil. Individual bacteria can be studied, but while they can be violently agitated, we have not yet been able to observe their destruction under the microscope.

If a fine emulsion of oil is examined, an individual

droplet of oil can be singled out and made to rotate rapidly in either direction at speeds that can be accurately controlled by varying slightly the frequency of the oscillating circuit.

An excellent material to illustrate the effects of these waves is a leaf of Elodea, two cell layers in thickness. The protoplasm with suspended chloroplasts forms a thin layer about the cellulose cell wall enclosing the vacuole of cell sap. High frequency sound waves of low intensity passed through these cells cause the protoplasm to rotate very much as in the normal rotation or cyclosis of Elodea. Increasing the supersonic intensity increases the movement until the whole cell is a rapidly whirling mass of protoplasm, fragments of which are torn loose and rotate as small balls in the vacuole. The effect is very striking and might almost lead one to conclude that the normal cyclosis of this plant was caused by high frequency vibrations. The normal protoplasmic rotation of Elodea is stopped by the waves unless they are of very low intensity. Rotation begins again provided the irradiation has not been too strong. Sugar-plasmolysed Elodea cells are affected in the same manner as are the unplasmolysed ones, the whole protoplasm rotating rapidly, until, with increasing intensity, the mass finally bursts and scatters the chloroplasts, still whirling, throughout the cell. Nitella cells when exposed to radiation have the chloroplasts torn from the walls of the cell and whirled rapidly, leaving a clear area which had originally been a uniform green colour.

This stirring of the cell contents is one of the most characteristic effects of supersonics. The smaller the cell, the more difficult it is to stir, but we have observed the rapid rotation of the chloroplasts in moss cells the diameter of which averages 12μ. The phenomenon is not connected with living cells only, but may be observed in Elodea killed by heating or by chloroform, although a greater intensity is necessary since the protoplasm is coagulated on death, and the coagulated mass is only churned with some difficulty.

This microscopic method offers a promising means of attack upon the problem of influencing the development of eggs of various species, as forces can thus be applied inside an egg at different stages of its development without the necessity of puncturing the cell wall or enveloping membrane. The results immediately suggest the interesting possibility of converting an egg with determinate cleavage into an indeterminate one by thoroughly mixing and redistributing the organ-forming substances of its interior. We are now engaged upon this and allied problems, the results of which we expect to publish in due course.

No effects of the waves have been noted that could be clearly traced to an influence on chemical processes in cells, although it is known that high intensity waves influence certain chemical systems, especially metastable ones (W. T. Richards and A. L. Loomis, *Jour. Am. Chem. Soc.*, **49**, 3086; 1927). The phenomena in living organisms, apart from temperature rise, are connected with mechanical effects, the most striking of which might be best described as 'intracellular stirring.'

In certain biological studies where great intensity is desired, and it is not necessary to observe under the microscope, a high-powered oscillator is required.

Using such an oscillator and placing the material to be treated in test tubes which were subjected to the vibrations, Wood and Loomis caused the rupture of filaments of Spirogyra, the tearing of Paramœcium and the laking of red blood corpuscles. This latter effect is very striking, defibrinated mammalian blood corpuscles in physiological salt solution laking completely in one minute before the average temperature of the fluid had risen to 37° C. They also noted the killing of small fish and frogs,

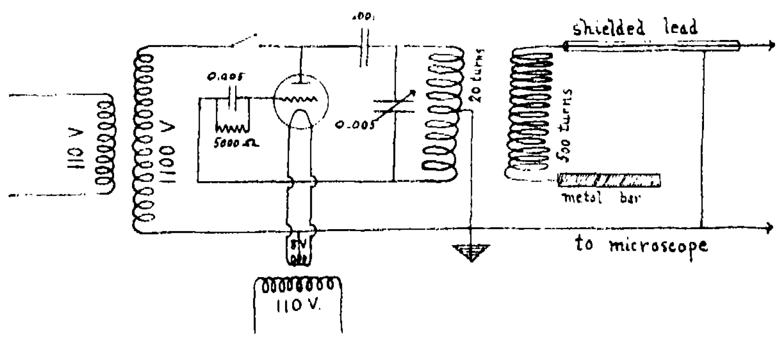

FIG. 1.

but the cause of death was not determined. Using the same high-powered oscillator, we have taken small organisms like Euglena or Paramœcium and enclosed them in capillary tubes sealed at the ends. When one end of such a tube is subjected to intense vibrations the organisms are thrown in piles regularly spaced (about 2 mm. apart, depending on the diameter of the capillary) along the tube, from which they are unable to swim. These piles represent nodes of *transverse* vibrations set up in the capillary. It is not that the organisms swim into these nodes but they are passively carried into the nodes, and fortunately so, for between the nodes they would be subjected to mechanical tearing that would disintegrate them. Thus, red blood corpuscles in a capillary tube are thrown into the nodes and quite unharmed by ten minutes' exposure to radiation, whereas the same corpuscles in a test tube, where convection currents carry them about, are laked in one minute. Even luminous bacteria and particles of gamboge form striæ in capillary tubes, but colloidal particles (as of benzo-purpurin, arsenic sesquisulphide, or ferric hydroxide) do not.

An emulsion of luminous bacteria in sea water in a test tube, exposed to radiation until the

temperature rose from 1·5° to 21·5°, luminesces considerably less brightly than a control tube heated from 1·5° to 21·5°. The turbidity is also less in the irradiated tube, indicating that some of the bacteria have undergone cytolysis. Control experiments showed that the dimming was not due to the electric field. The luminescence of a mixture of Cypridina luciferin and luciferase was unaffected by irradiation in any way that could not be accounted for by rise in temperature.

One might expect that high frequency mechanical vibrations, carrying as much energy as they do, would be capable of stimulating muscle or nerve tissue. All attempts to demonstrate a stimulating action have failed. The sciatic nerve of a frog connected with the gastrocnemius muscle may be touched (either nerve or muscle) to a test tube violently oscillating or be immersed in a salt solution in such a test tube without stimulation and without injury. Both nerve and muscle are later found to be quite irritable to electrical stimuli. The high tension field is unable to stimulate because of its high frequency. A bull frog's heart mounted in Ringer's solution in a test tube touching the oil and connected with a heart lever for recording movement, shows no peculiarities of the contraction, but an irregularity and usually a slowing of the rate, despite the rise in temperature that accompanies the irradiation. Further observations will be necessary to analyse these peculiarities.

Obituary.

Mr. W. B. Croft.

William Bleaden Croft died at Winchester on Mar. 23 at the age of seventy-six years. Born in 1851, the sixth son of a surgeon, Mr. C. I. Croft, he went to Christ's Hospital, and thence as a scholar to Pembroke College, Oxford, and obtained first classes in the schools of mathematics and natural science, besides rowing bow in the Pembroke boat at the head of the river.

Croft was a very remarkable man. He was appointed mathematical and then science master at Winchester College in 1874, but for the last twenty years of his service he taught only physics. He retired in 1915. During all this time he never missed an hour's teaching through ill-health. He was a fellow of the Physical Society, at the meetings of which he was a regular attendant, and was elected to the council in 1903. He served several times on the committee of Section A of the British Association, and examined for the final honours school in natural science at Oxford.

Croft took little interest in chemistry, but he was a born physicist. Had he been trained in one of the great university schools of to-day, he would have achieved a fame far beyond that which fell to his lot. He had the gift of a vivid scientific curiosity, an uncanny power of pitching upon the first hint of a new discovery before others were fully awake to its importance, and a talent for experiment that almost amounted to genius. He was a constant reader of Nature and other scientific periodicals, and he carefully cut out articles and pasted them into scrap-books, which he filled with comments and annotations. If anything struck him as likely to lead further, he at once got into touch with the writer of the article or letter, and repeated for himself any experiments that could be compassed in his laboratory, developing them in promising directions. Thus, for example, it came about that he was the first man in England to make a Branly coherer and to perform further experiments with Hertzian waves.

Croft was always at work on phenomena of common occurrence, and never rested until he, and some special pupils, understood its physical significance. Did a question arise about bells or fiddles? Croft set to work immediately upon the fundamentals and harmonics of college bells, and called in the assistance of the musical staff. His photographs of diffraction phenomena were extraordinarily good, and still enrich the pages of Edser's "Light for Students." Light and sound were perhaps his chief interests, but he did good work in electricity also.

A teacher for the few rather than the many, to those of his pupils who by diligence and aptitude proved themselves worthy of the meticulous care which he bestowed upon his lectures, Croft imparted all that they could receive of his knowledge of and reverence for science, and his gift of seeing the essential and planning an experimental approach; and he kept touch with them in after years. A permanent memorial of him is left in the collection of interesting apparatus which he gathered in the College laboratory; but above all, he will be remembered by his pupils, his colleagues, and his many friends for infinite courtesy and thoughtfulness. He leaves a widow, three sons, and a daughter.

We regret to announce the following deaths:

Prof. Wilhelm von Branca, emeritus professor of geology and palæontology in the University of Berlin, distinguished for his work on the evolutionary history of man and other animals and for work on the development of flight, on Mar. 12, aged eighty-three years.

Prof. Elmer E. F. Creighton, of the General Electric Co., Schenectady, a well-known consulting electrical engineer, on Jan. 13, at the age of forty-nine years.

Mr. Alexander E. Outerbridge, of the William Sellers Company, professor of metallurgy at the Franklin Institute, known for his work on the molecular physics of iron, on Jan. 13, aged seventy-seven years.

Mr. E. A. Reynolds-Ball, author of many travel and guide books, including "Mediterranean Winter Resorts," aged sixty-nine years.

M. Emile Senart, president of the Société Asiatique of Paris and an honorary fellow of the Royal Asiatic Society of Great Britain, and author of "Les Castes dans l'Inde," on Feb. 21, aged eighty years.

Mr. G. Chisholm Williams, a distinguished pioneer in the medical use of X-rays, on April 10, aged sixty-three years.

Supplement to NATURE

No. 3051 AI RIL 21, 1928

The Physical Basis of Light Therapy.[1]

By Prof. F. Ll. Horwood.

The Spectrum of Radiation.

THE visible spectrum is only a small portion of the complete spectrum of ethereal waves. Beyond the violet with progressively decreasing wave-lengths, come successively the radiations called 'ultra-violet,' soft X-rays, hard X-rays, the gamma rays of radium, and the very penetrating radiation, the so-called cosmic rays, which have only recently been proved to be of extra-terrestrial origin. Similarly, beyond the red, in progressively increasing wave-lengths, come in turn infra-red and the Hertzian waves used in radio communication.

Table I. gives the approximate wave-lengths of the various radiations, but it must be noted that the divisions are quite arbitrary and that the various regions may overlap; differences in properties arise solely from differences in wave-length.

Table I.

Type of Radiation.	Approximate Range of Wave-lengths.
Hertzian waves	40 kilometres to a few centimetres.
Infra-red	A few millimetres to 7000 A.
Visible spectrum	7000 to 4000 A.
Near ultra-violet	4000 to 3000 A.
Middle ultra-violet	3000 to 2000 A.
Far ultra-violet	2000 to 1000 A.
Soft X-rays	100 to 1 A.
Medium and hard X-rays (used in diagnosis and therapy)	0·2 to 0·05 A.
Gamma rays from radium C.	0·02 to 0·001 A.
Cosmic rays	0·0005 to 0·0003 A.

Note.

1 A. = 1 Angström unit = one hundred-millionth of 1 cm. $= 10^{-8}$ cm.

$$1\mu = \frac{1}{1000} \text{ millimetre}$$

$$1\mu\mu = \frac{\mu}{1000} = 10 \text{ A.}$$

Light used in Therapy.

Both natural and artificial sources of light are used for therapeutic purposes, and considerable differences of opinion exist as to their relative merits. These differences arise very largely from the fact that the relative distribution of energy amongst the infra-red, visible, and ultra-violet portions of the spectra of the different sources varies over wide limits.

Numerous observers have noted the close parallelism between pigmentation due to exposure to light and beneficial therapeutic results. Experiment has shown that the solar radiations which are most active in producing pigmentation of the skin and hæmobactericidal effects are those between 2900 and 3000 A., or, in other words, those which are situated in the middle ultra-violet part of the spectrum. Infra-red and visible radiations may certainly influence the rate at which these effects are produced, but in general cannot themselves produce them.

On account of the spectral region used and the effects produced, light therapy is often called 'ultra-violet light treatment,' 'phototherapy,' or 'actinotherapy.' More often these terms are used in connexion with artificial sources of light to distinguish such treatment from 'heliotherapy,' or sunlight treatment.

Sunlight.

The natural source of ultra-violet radiation is the sun. The spectrum of sunlight after filtration by the earth's atmosphere extends continuously from the infra-red to the middle ultra-violet regions (30,000 to 2900 A.), but its limits are influenced by the seasons, height of the sun above the horizon, altitude of the place of observation, water vapour content of atmosphere and atmospheric pollution. The lower the sun is in the heavens, the greater is the length of path through the earth's atmosphere that its radiations have to traverse, and the resulting absorption considerably shortens the range of the spectrum. The intensity of its ultra-violet radiation reaches its maximum about one hour after midday on a clear day. Dull, cloudy weather, coupled with atmospheric pollution due to smoke and chemical fumes, may practically reduce to zero the intensity of these active rays in the neighbourhood of a large city.

It is important to note that the total ultra-

[1] Reprinted, after revision and with additions, from *St. Bartholomew's Hospital Reports*, 1926.

violet radiation from the sky is more than that from the direct sun. Even with the sun at its zenith the ultra-violet radiation from it does not exceed 90 per cent. of that from the blue sky, whilst with a low sun the sky yields far more. This addition to the amount of ultra-violet radiation which a patient receives from the direct sun is due to the scattering of the sunlight by the smallest particles of the atmosphere. The effect is the more pronounced the shorter the wave-lengths involved. As Rayleigh has shown, the amount of energy scattered by a particle of given size varies inversely as the fourth power of the wave-length, and consequently the phenomenon exhibits itself more in the ultra-violet than in the visible spectrum. Thus—a fact of great practical importance—it is not essential to be exposed to the direct sun in order to receive the benefits of heliotherapy.

The above considerations show us that treatment by natural sunlight (heliotherapy) is intimately associated with geographical and climatic conditions. In the Alps, at altitudes of above 5000 ft., pure, fresh, dry air and an almost constant daily supply of sunlight are easily obtainable, whereas in England the sun appears only erratically, and its ultra-violet component varies rapidly within wide limits, rendering dosage difficult and regular treatments impossible. For these reasons, artificial sources of radiation have been developed by which constancy of output can be strictly controlled.

Artificial Sources of Ultra-violet Radiation.

All the artificial sources of light used for therapeutic purposes are heterochromatic (that is, emit a broad band of wave-lengths), since, up to the present, no one has designed a practicable source of monochromatic radiation of sufficient intensity to be of definite therapeutic value.

The chief sources of ultra-violet radiation are electric arcs. Incandescent electric lamps with their bulbs made of fused quartz or of glass manufactured for its special transparency in this region of the spectrum (such as vita-glass) are occasionally used for some purposes, but their low energy output makes their general use impracticable.

The arc-lamps usually employed are of two types, namely, (*a*) open arcs, and (*b*) enclosed arcs.

(*a*) Open arcs have electrodes of iron, tungsten, metallic alloys, or carbon. Carbon electrodes may be either solid, 'neutral cored,' or 'impregnated.' Neutral cored carbon electrodes have a soft core of carbon powder mixed with a small amount of some substance such as potassium silicate to ensure quiet, steady burning. Impregnated carbon electrodes have mixed with the carbon powder, either salts of various metals, powdered metals, or a central wire core. Thus 'white flame' carbon electrodes usually contain the fluorides of the rare earths obtained as residues from monazite sand; 'blue flame' carbons contain iron. The ultra-violet radiation emitted by these arcs varies greatly with the chemical composition of the electrodes and the current between them. A high current density is necessary for high efficiency.

(*b*) Enclosed arcs are mercury vapour lamps with fused quartz (not glass) envelopes.

All these lamps produce ultra-violet radiation of sufficient intensity and satisfactory quality for therapy. Each differs from the rest in spectral range and has its special advantages and defects.

One of the varieties of carbon arc is usually employed in institutions when group treatment is given, and a mercury vapour lamp for individual or localised treatment. The order of the maximum relative percentage of ultra-violet radiation of wave-lengths less than 3200 A. in the total radiation emitted by the above sources, is

Mercury arc.
Impregnated carbon arc.
The sun.
Neutral cored carbon arc.
Incandescent electric lamp.

The radiation from the neutral cored, or solid electrode carbon arc is similar to that of the sun, in that it is relatively weak in radiation of wavelengths less than 2900 A. It is, however, strong in infra-red radiation of wave-lengths longer than 30,000 A., which the earth's atmosphere has eliminated from the solar rays.

Special dispositions are required to maintain metallic arcs on an alternating current supply.

We know that radiations from the middle ultraviolet region can exert marked bactericidal properties *in vitro*, and also 'activate' certain substances such as ergosterol, etc., in such a manner that when ingested they tend to cure rickets. We also know that the bactericidal power of the blood is enhanced, and the mineral metabolism promoted, when the living animal is subjected to these rays. Some effects, such as the erythema following irradiation, only appear after an interval of time—called the 'latent period'—has elapsed since the exposure terminated. How these effects are produced is not known with certainty, and light therapy is still mainly empirical.

Photo-electricity.

For every substance there are radiations which will cause some of its atoms to eject electrons and consequently leave the stripped atoms positively charged. This phenomenon is called ionisation or photo-electric emission. For it to occur, it is only necessary that the wave-length of the incident radiation should be less than a critical or threshold value, which is characteristic of the atom ionised. For most substances the critical wave-length lies in the ultra-violet spectral region, but for some it occurs in the visible spectrum, and for cæsium is actually in the infra-red region (see Table II.). The wave-length which will cause maximum emission of electrons from any element is approximately two-thirds of the critical wave-length for that element, and for sodium, potassium, and cæsium lies in the visible spectrum. The velocity of emission of photo-electrons depends on the wave-length of the exciting light, whilst the number emitted depends upon the intensity of the light.

Table II.

Element.	Critical Wave-length in A. for Photo-electric Effect.
Graphite	2615
Copper	2665
Selenium	2670
Iron	2870
Cadmium	3130
Zinc	3425
Sodium	6000 (about)
Potassium	7000 ,,
Cæsium	8000 ,,

As the emission of photo-electrons from an illuminated surface is very susceptible to the presence of condensed surface films of gas or vapour, it is necessary for reproduction of photo-electric effects that the surfaces be prepared, and maintained, in high vacua.

Fluorescence and Phosphorescence.

Certain substances, when stimulated by radiation of one wave-length, emit radiation of a different wave-length. If the emission only appears whilst the stimulus is being applied the phenomenon is called fluorescence, but if it persists after the stimulus has ceased it is called phosphorescence.

Phosphorescence is only exhibited by solids: fluorescence by solids, liquids, and gases. Although Stokes stated that fluorescent light was always of longer wave-length than the exciting light, we now know that this rule, though generally valid, is not invariable.

Fluorescence is caused by the return to a more stable position in an atom, of electrons displaced by the exciting radiation.

Photo-chemical Action.

That chemical action can be brought about by light has been known for a very long time, and is familiar to everyone through photography. Photo-chemical actions are usually divided into three classes, namely:

(*a*) Photo-catalytic actions in which light only accelerates an irreversible process. Here the light cannot be regarded as stored up in the transformed substance as chemical energy. The action only occurs in the presence of a catalyst. Thus, in the presence of colloidal uranium, formaldehyde may be synthesised from carbon dioxide and water, by exposure to sunlight. Without the uranium no formaldehyde is formed.

(*b*) True photo-chemical equilibria in which the equilibrium of some reversible reactions is altered by light, and again brought back to the initial state on standing in the dark. (Compare the behaviour of a selenium cell which conducts electricity better when illuminated than in the dark.)

(*c*) False chemical equilibria, which are irreversible processes composed of two or more photo-catalytic reactions.

In certain cases the initial action of radiation is to decompose some substance (called a 'negative catalyst') which hinders the chemical action which takes place some time after the irradiation of the system has proceeded (cf. erythema and pigmentation).

Photo-chemical actions are subject to the following two laws:

Grotthus's Law.—Radiation must be absorbed in order to bring about the reactions which it produces.

Bunsen-Roscoe Law.—The amount of substance decomposed by radiant energy is proportional to the amount of radiant energy absorbed—that is, is proportional to the product of the intensity of the radiation, by the time for which it is applied.

In connexion with the above, it should be noted that radiations of different wave-lengths may produce different actions on one and the same substance. It appears to be a fairly general rule that of two radiations which produce opposite effects, it is the longer wave-length which produces the oxidising action and the shorter wave-length the reducing action. The decoloration, by infra-red rays, of glass which has been coloured by ultra-violet rays, illustrates this.

Several writers have claimed that they have detected a similar opposing action, or physiological interference, of infra-red and ultra-violet radiations in the production of erythema of the skin, or the

immobilising action on bacteria *in vitro*. These observations, which have not yet been confirmed beyond doubt, are of great interest from the point of view of choice of an artificial source of radiation and the measurement of dose.

Unlike most chemical reactions, in which rise of temperature produces a marked increase in the velocity of reaction, the effect of temperature on photo-chemical reactions is usually very small.

Absorption, Transmission, and Reflection.

Certain substances strongly absorb light corresponding to some parts of the spectrum, and transmit the remaining light unchanged. This phenomenon is called selective absorption. It produces dark bands, called absorption bands, in the spectrum of the transmitted light.

Absorption bands are characteristic of the absorbing substances and serve to identify them by examination with a spectroscope, for example, the bands of hæmoglobin and chlorophyll.

By making use of the selective absorption bands of different substances, it is possible to make light filters which will transmit narrow bands of wavelengths in chosen parts of the spectrum.

The reflecting, transmitting, and absorbing powers of a substance for light in the visible spectrum give no trustworthy indication of these properties for radiations in the infra-red or ultraviolet regions.

The percentage penetration of *dead* human skin by ultra-violet radiation is given in Table III., which records some measurements by Hasselbalch.

Table III.

Thickness of dead skin in mm.	Wave-length in A.						
	4360.	4050.	3660.	3130	3020.	2970.	2890.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
0·1	59	55	49	30	8	2	0·01
0·5	7·0	5·0	3·0	0·3	—	—	—
1·0	0·5	0·3	0·08	0·006	—	—	—

The practically negligible penetrative power of the biologically active ultra-violet rays indicated by this table is very marked. Definite clinical evidence is available, however, which shows that ultra-violet radiation of wave-lengths shorter than 2900 A. can produce marked physiological effects. The difficulty of explaining these effects by any direct or indirect action has recently been considerably lessened by the work of Macht and his co-workers. These investigators have shown that the penetration of ultra-violet radiation into *living* tissue is greater than for dead tissue. This is brought out by comparing the figures in Table III. with those published by Macht and summarised in Table IV.

Table IV.

(Transmission of monochromatic ultra-violet radiation through living animal tissue, 1·175 mm. thick.)

Wave-length in A.	4050	3660	3130	3025	2800	2650	2537
Transmission (per cent.)	16·3	11·4	19·5	27·2	56·3	23·8	42·8

Infra-red and luminous rays can penetrate more deeply than ultra-violet rays. Sonne has shown that the luminous rays can produce a greater elevation of temperature below the skin than the infra-red rays, and asserts that this heating effect due to absorbed luminous rays assists in the destruction of toxins and formation of antibodies.

Ordinary window glass transmits a portion of the ultra-violet nearest the visible region of the spectrum, but cuts out completely all wave-lengths less than 3100 A. It thus absorbs all the solar radiation which produces pigmentation, etc. Fused quartz and water transmit ultra-violet radiation quite freely down to wave-lengths of about 2000 A. Corning glass 980 A. transmits all solar radiation almost as freely as the more expensive fused quartz. Vita-glass resembles Corning glass 980 A. in its properties, but is not so transparent for equal thicknesses, and also exhibits some deterioration in transmission after exposure to sunlight.

'Wood's' glass, which cuts out most of the visible spectrum, transmits a band of wave-lengths in the near ultra-violet region about 3600 A. and is therefore useful for fluorescence experiments.

Snow is a good reflector of ultra-violet radiation, and snow-blindness is due to the reflection by it of the short waves of sunlight.

Polished surfaces of magnalium, nickel, and aluminium make the best reflectors of the middle ultra-violet region of the spectrum for ordinary purposes; silvered mirrors are much poorer.

The biological effect produced by uninterrupted exposure to ultra-violet radiation appears to be directly connected with, and in proportion to, the energy absorbed (Bunsen-Roscoe Law). The intensity of the incident radiation and the time of exposure are the external quantities, and the absorption coefficient of the skin the internal quantity, which determine the quantity of energy absorbed, and therefore the biological effect.

It has already been pointed out that all sources of radiation used in light therapy are heterochromatic, and that radiation from them is absorbed differentially by the skin. Reference has also been made to

Sonne's assertion concerning the effects of luminous rays, and also to the possibility of antagonistic action between infra-red and ultra-violet rays. Throughout this article it has been assumed that exposure to *ultra-violet* radiation is essential for the production of the recognised benefits of light treatment. This assumption seems to be perfectly in agreement with experience. What is not yet satisfactorily settled is whether (and if so, what) other wave-lengths are also useful or harmful.

It is this lack of knowledge which renders the physical measurement of the therapeutic efficiency of an arc-lamp uncertain.

Determination of Quality.

The quality of the radiation emitted by a given source may be determined by passing the radiation through a spectroscope and examining the emergent beam. As glass absorbs both infra-red and the middle and far ultra-violet rays, it cannot be used for this work, and therefore the prisms and lenses used are of quartz or rock-salt.

For the visible and ultra-violet regions down to wave-lengths less than 2000 A., this examination may be done by direct observation, the rays in the ultra-violet being detected by the visible fluorescence caused either in uranium glass or in a smear of vaseline. Alternatively, these regions may be recorded on a photographic plate. For the infra-red spectrum we must use one of the methods mentioned later. When examined by any of the above methods, it will be found that whereas the spectra of tungsten and mercury consist mainly of bright lines, that of pure carbon is practically a continuous one, being similar in character to the solar spectrum. From the known constants of the apparatus, or by making use of reference lines of known wave-lengths, it is possible to determine the range of wave-lengths in a spectrum and the wave-lengths of any bright lines in it.

Determination of Intensity.

In determining the intensity of radiation proceeding from a source and falling on a surface, we have to decide which of the following three quantities we wish to measure :

1. The total intensity.
2. The intensity of a group of radiations of differing wave-lengths.
3. The intensity of the radiation of a single wave-length.

In measuring the total intensity, no preliminary analysis of the radiation is required. To measure the intensity of a group of radiations, either colour filters must be used to isolate it, or some instrument employed which is only sensitive to radiations in the given region.

For the measurement of the intensity of the radiation of a single wave-length, the total radiation is first resolved by means of a spectroscope and the particular radiation caused to pass through a narrow slit to the measuring instrument.

Whichever of the three intensity measurements is to be made, the following methods are available : (*a*) Thermal, (*b*) fluorescent, (*c*) chemical, (*d*) electrical.

Thermal Methods.

Either a thermopile or bolometer may be used.

The thermopile consists of a number of thermocouples or pairs of electrical conductors of different metals, and is used joined in series with a galvanometer. Whenever one junction of a thermocouple has its temperature raised above that of the other, an electric current will flow through the galvanometer. By allowing the radiation to fall on the junctions of a thermopile which have been covered with lamp-black and by using a sensitive galvanometer, measurements may be made over the complete range of wave-lengths used in light therapy.

The bolometer consists essentially of a blackened fine metallic wire the rise in temperature of which, when radiation falls upon it, alters its electrical resistance. This change in resistance, when measured by suitable means, gives the intensity of the absorbed radiation. The sensitiveness of both thermocouples and bolometers is increased by mounting them in evacuated vessels to reduce the cooling effect of the surrounding gas.

Fluorescent Methods.

In practice these methods are only applicable to measurements made in the ultra-violet region. They depend upon the fact that the intensity of the fluorescent light emitted by such substances as barium-platino-cyanide and zinc sulphide is directly proportional to the intensity of the exciting radiation.

Chemical Methods.

A great variety of photo-chemical reactions have been proposed and used for measuring either total or ultra-violet radiation. The effect most frequently used is the reduction of silver chloride as in photography. Here, instead of weighing the silver liberated, the resulting blackening is used as a measure of intensity, either by finding the time necessary to produce a standard blackening, or the blackening produced in a definite time.

Leonard Hill has devised a system of measure-

ment of the ultra-violet radiation of wave-lengths shorter than about 3600 A. by making use of their bleaching effect on a solution of methylene blue in acetone.

The standard solution is exposed in a quartz tube and the 'exposure' measured by comparing its tint with some standard tints calibrated in terms of the lethal effect on infusoria. The scale adopted is quite an arbitrary one.

Janet Clark has suggested using the blackening effect of ultra-violet radiation on lithopone (a pigment containing zinc oxide, zinc sulphide, and barium sulphate) for intensity measurements. This substance, when moistened with water, darkens under the influence of rays of wave-lengths less than 3200 A. It thus appears to afford a simple colorimetric method of measuring those rays which can produce an erythema of the skin.

ELECTRICAL METHODS.

These generally make use either of the photoelectric property of some metal—generally zinc or cadmium—or the fall in electrical resistance of selenium when illuminated. A glance at Table II. will show what metal is best suited to the particular radiation to be measured. In principle, a photoelectric cell consists of an insulated plate of metal connected to an electrometer or gold-leaf electroscope, the system being negatively charged. Under the influence of a suitable radiation, the plate loses its charge at a rate dependent upon the intensity of the radiation.

The action of a 'selenium cell' is somewhat different. As ordinarily used, the change of resistance of the cell when illuminated is measured by the change in current through a microammeter connected in series with the cell and an energising battery. This effect can be produced by infra-red, visible, ultra-violet, Röntgen, and gamma radiations, and is not the normal photo-electric effect.

It is easily seen that any of the instruments described above can readily be used to give a trustworthy check on the emission of a given source at different times. Their value in comparing the different emissions of different sources is not quite so certain.

INVERSE SQUARE LAW.

The intensity of the radiation falling on a surface can only be assumed to diminish according to the law of inverse squares (1) when the active dimensions of the source are small compared with its distance from the surface, and in addition (2) when no reflector is used.

DANGERS AND PRECAUTIONS.

Three common sources of danger in connexion with the use of artificial sources of ultra-violet radiation, and the precautions necessary to avoid them, are:

(1) The production of a severe conjunctivitis, through looking directly at an arc. Operators and patients should always wear protective goggles or shades.

(2) Over-exposure through continuing a course of treatment after replacing an old mercury vapour arc-lamp by a new one, or substituting different electrodes in an open arc. An intensity measurement should always be made when using a new source.

(3) Electric shock through touching 'live' electrical conductors. Several fatalities have occurred through the use of electrical apparatus in bath-rooms, where the conditions for short circuiting the supply through the body are almost ideal.

No installation should be set up in such a position that a patient can touch a 'live' electrode and a water-pipe or 'earthed' conductor at the same time. It is advisable to use a floor covering of linoleum or carpet.

CONTRA-INDICATIONS TO LIGHT THERAPY.

In addition to the purely physical dangers mentioned in the last paragraph, there are many physiological and pathological conditions—such as menstruation in women, low blood pressure, fever, hyper-photo-sensitiveness, etc.—which are contra-indications to the therapeutic use of ultra-violet radiation. The discussion of these lies outside the scope of the present article.

Biological Action of Ultra-Violet Rays.

By Prof. LEONARD HILL, M.B., F.R.S.

RADIATIONS from sources of energy—sun, stars, etc.—are conducted by waves in a hypothetical ether with a velocity of 186,000 miles per second in the case of light. Ether radiations include the Hertzian waves used in radio with wave-lengths extending to a thousand metres or more, then the infra-red, with wave-lengths from 60,000 to 700 $\mu\mu$, then the visible with wave-lengths from 700 $\mu\mu$ (red) to 400 $\mu\mu$ (violet). Beyond the visible lie the invisible ultra-violet rays with wave-lengths from 400 $\mu\mu$ to 100 $\mu\mu$, and beyond these come the soft X-rays and

then the hard X-rays and the rays of radium with wave-lengths so short as 0·01 $\mu\mu$.

The body of a man is screened by the horny layer of the epidermis, varying in places from some 0·02 to 0·5 mm. thick, beneath which lie the living cells of the epidermis in layers of corresponding thickness to the thin horny layer. These cells are myriad in number, and are naturally exposed to the influence of light in wild naked men. Beneath these comes the derma or true skin, in which circulates the blood through close woven networks of capillaries, in streams some 0·01 mm. thick. Among the living cells of the epidermis and in the derma are nerve endings. The epidermis reflects and scatters a part of the rays which fall upon it, but some of the visible rays penetrate and are absorbed by the blood beneath, warming this. The infra-red rays, on the other hand, are absorbed by the least layer of water; caught therefore by the wet layer of the epidermis, they warm this and warm the blood in the derma indirectly by conduction. The biologically active or middle ultra-violet rays are also very largely absorbed by the epidermis, and exert their effect there. The shorter ultra-violet rays, powerful to kill microbes, fail to penetrate the horny layer and so have no action on the skin. The longer ultra-violet rays, like the visible rays, reach the blood in the capillaries of the derma and are converted into heat.

The skin screens itself from excessive light by its horny layer and by pigment. The horny layer is thickened by ultra-violet rays killing the living cells of the epidermis, and protection is thus quickly afforded from sun burning. Pigment lying in the deeper cells of the epidermis, by absorbing visible and ultra-violet rays, screens these deeper cells and the blood in the derma. It converts visible rays into heat, and this heat, stimulating the nerve endings in the skin, may reflexly lessen body heat production while increasing body heat loss by provoking sweating and dilatation of cutaneous blood-vessels. Increased transpiration of water is the chief method of warding off excessive radiant heat when shade is not available. The increase of heat and transpiration by the visible rays is important in the treatment of wounds, etc.

The sterilising power of the ultra-violet rays, first established by Downes and Blunt (1877), is not nearly so important as has been thought, for the rays can only kill the surface bacteria; they cannot penetrate into filth any more than through the epidermis. Tubercle bacilli rotated in serum in a quartz flask under a mercury vapour lamp are not killed, so great is the protection afforded by the proteins of the serum which absorbs the ultra-violet rays (Eidinow). In the case of tissues or infusoria screened by mesentery, there is a partial, by the skin complete, protection from the lethal action of ultra-violet rays. The penetration of the biologically active ultra-violet rays is not more than 0·25 mm. in an organ exposed to the mercury vapour lamp for an hour or two, as is demonstrated by the depth of the lesion thereby produced.

The intensity of illumination received from a point source of light is inversely proportional to the square of the distance from the source. The law is only accurate from a source sufficiently small or far enough off to be treated as a point. It does not hold for sources with reflectors behind or lenses in front of them. Only these rays which are absorbed exert an effect. When light passes through a layer of absorbing substance, the fraction transmitted depends on the nature and thickness of the substance and the wave-length; the transmission coefficient is the fraction transmitted by a layer 1 cm. thick.

If light passes two absorbing layers successively, the final fraction transmitted can be calculated by multiplying together the fraction transmitted by each layer alone. Thus, if each layer transmits 1/10th, two in succession transmit 1/100th. Epidermis 0·1 mm. thick transmits about 1/10th, and therefore epidermis 0·2 mm. thick transmits only 1/100th of the amount of active ultra-violet rays.

The biologically active region of the ultra-violet rays is round about 300 $\mu\mu$. Hausser and Vahle, using equal energy values, found the maximal erythema effect at 297 $\mu\mu$. Four per cent. of this effect was found at 313 $\mu\mu$ and 16 per cent. at 256 $\mu\mu$. The longer ultra-violet rays are little absorbed by the epidermis, and so have little action; the shorter ones are very active, but are absorbed by the horny layer of the epidermis and so do not reach the living cells. Owing to the absorption by the horny layer of the epidermis and its screening action, the living cells beneath are protected from the short ultra-violet rays of artificial sources which penetrate into and are most powerful in killing microbes, infusoria, and ciliated cells of the wind-pipe. The ultra-violet rays of the sun extend scarcely beyond 300 $\mu\mu$, and the sun exerts its sun-burning action by ultra-violet rays longer than those of artificial sources such as the long flame metal cored carbon arc or mercury vapour lamp, the active rays of which are mostly of wave-length shorter than 300 $\mu\mu$. Vita-glass lets 75 per cent. of the active ultra-violet rays of the sun

through, but largely reduces the active rays of the mercury vapour lamp, so that the lethal exposure for infusoria is made much longer when this screen is interposed. The rays which activate ergosterol and form vitamin D are in the region of about 280-300 $\mu\mu$; it is, then, clear skies and high sunlight, which afford rays about 300 $\mu\mu$, having this effect.

Mist, smoke-pollution, glass windows, walls and roofs, and clothes, cut out the sunlight and deprive us of the effect which the sun naturally exerts on naked wild men and animals, for example, on ergosterol, which, eaten in the food, is present in the skin, and there awaits activation into vitamin D by sunlight. It must be borne in mind that the bright sky shine is a source of ultra-violet rays, affording more (from the whole sky) than the high sun affords directly. Owing to this fact, cool ultra-violet treatment can be had from the sky without exposing febrile patients to the direct hot sun. Skyshine and earlier morning sun can be used by febrile cases of tuberculosis. To heat such patients is a disadvantage, hence the excellence of the alpine climate. Exposure to cold air stimulates the tone of the muscles and the appetite, and works, under proper control, as much good on the naked body as light does.

Rickety, weakly children kept in an open-air shed without artificial heat throughout the winter do wonderfully well, and become robust and full of life and energy. The clean cool air, absence of crowd-infection, and indoor dust, heat, and noise, work their good effects as well as light. It must always be borne in mind that the open cool air is at least as important as light in treatment of tuberculosis, wounds, etc.

We can take in vitamin D from cod-liver oil, or nowadays eat it in tabloids, the product of laboratory irradiation of ergosterol.

Not only rickets, but also osteomalacia, prevalent in the purdah women of Kashmir (Vaughan), is due to want of sunlight and vitamin D. With rickets go decay of teeth, liability to catarrhal and low infections. Open-air treatment and ultra-violet irradiation are powerful to prevent these troubles. In fowls kept under glass, ultra-violet irradiation improves the egg laying and hatching, and prevents leg weakness of chicks. Similarly, it improves the stamina and milk of cows kept in byres.

In the treatment of surgical tuberculosis and wounds, carbon arcs have advantages in yielding abundantly visible and infra-red rays as well as the ultra-violet rays. The mercury vapour lamp is relatively a cold source, but incandescent lamps can be added to it so as to make good the deficiency. The monkeys, iguana lizards, and tortoises at the Zoo do well under incandescent lamps. The monkeys are also given access to open air. The conversion of visible light into blood heat is most important to all these animals. The lizards, heated up by the visible rays of the lamps, become active, hot-blooded animals as they naturally do by day under the tropical sun. Babies exposed naked under incandescent lamps and given also exposure to cool open air, would thrive as well as the monkeys do, the diet chosen being of course one fully provided with the necessary vitamins, and those other qualities required for growth and health.

The ultra-violet rays reaching the living cells of the skin and absorbed therein, cause change in atomic structure (displacement of electrons from their orbits with consequent rearrangement of molecules), which result in chemical changes ending in coagulation and death. The increasing granulation of the protoplasm of infusoria can be observed under the microscope when these animals are exposed in a water-cooled quartz chamber to the mercury vapour lamp. The same sort of change is produced whether longer or shorter wave-lengths of the active region of ultra-violet rays are used to kill. There is no evidence of specific changes set up by one or other of the different wave-lengths absorbed by the skin, other than possibly in the case of activation of ergosterol. There is no evidence that one group of the active ultra-violet rays is more or less harmful to living cells than another; the result depends on penetration and absorption. Given a sufficient dose of rays absorbed, coagulation and death takes place. The damage of the living cells in the skin produced by sunburn provokes secondarily a local hyperæmia, œdema, and leucocytosis, followed by desquamation and pigmentation. The inflammatory reaction increases the power of the blood to kill staphylococci as tested *in vitro*. In some way, as yet unexplained, it provokes better feeling of health and vigour, but overdosage may have the opposite effect. The inflammatory reaction helps the skin to recover from infections such as lupus. This terrible disease is cured by local and general light baths. Surgical tuberculosis is benefited by light and open air.

The ultra-violet rays can be used successfully for certain affections of the eye as well as skin, but all this is the province of the medical practitioner skilled in such treatment. By the general public light baths should only be used in mild doses for taking the place of natural sunlight. The body

can conveniently be divided into four parts: 1, front of body; 2, back of body; 3, front of legs; 4, back of legs. One part is bathed at a time. Two baths a week suffice. Using a long flamed arc with iron-cored carbons or a mercury vapour lamp, a 5-minutes' exposure, 2 ft. away, suffices. Large doses result in a thickened horny layer and pigmentation which prevents the reaction of the skin. It may be as well to intermit the light bath for a month at the end of two months, and then start again. If a vita-glass screen is used, the artificial sources are made more to resemble sunlight and much safer to use. Overdosage can do more harm than good.

The Physiological Action of Ultra-Violet Radiation and its Use in the Home.

By W. Kerr Russell, M.D., B.S. (Dunelm).

The founder of the science of actinotherapy was Finsen, and he published his first paper on the subject of ultra-violet radiation in 1893. His efforts were directed to the cure of lupus (the wolf), that disfiguring disease of the skin caused by the tubercle bacillus, a disease which so often causes those attacked by it to hide themselves away in order to avoid the gaze of their fellows. This new local form of treatment devised by Finsen was a wonderful success, and it was only Finsen's early death, at the age of forty-three years, that prevented him from carrying out other most important applications of the treatment. He left at his death the complete designs for a clinic in which investigations were to be undertaken for the purpose of ascertaining more exactly what affections would lend themselves to treatment by general light baths, and among the diseases in which this treatment was to be used, he expressly mentioned tuberculosis.

Describing his proposed carbon arc bath, Finsen said it consisted of a circular room in the middle of which were two gigantic arc lights of 100 amperes, suspended about six feet from the floor; by numerous radiating partitions, bath chambers were arranged in which the patients could lie naked on couches. It was, however, only after a visit to Switzerland, where Reyn, Finsen's brother-in-law, saw the successful work of Bernhard and Rollier in the cure of extra-pulmonary tuberculosis by regulated exposure to the sun's rays, that he instituted the general light bath treatment at the Finsen Institute in 1913. Then came the War, and though it is true that hundreds of thousands of wounded men were treated by physiotherapy, and that the conflict was largely responsible for bringing physical methods of treatment into prominence, it has only been during the last few years that general ultra-violet treatment has received the recognition in Great Britain which it deserves.

Actinotherapy is still in its infancy, and a great deal of research work is necessary before the reproach of empiricism can be removed. This makes it imperative that it should only be employed with great care and discrimination. One must also remember the cruel fate which has overtaken so many of the pioneers of X-rays, and though, judging by the experience of the Finsen Institute, it is very improbable that a similar catastrophe will befall the actinotherapist, the need for the exhibition of great caution is obvious. Dosage is a very important factor in all forms of medical treatment; we make use of the beneficial action of heat when we apply a poultice to relieve the pain of inflammation, but in excess, those same heat rays can act destructively and cause a painful burn. This is the case with X-rays, where ulceration and even cancer can be caused. Ultra-violet rays, too, are harmful in excess; the same applies to drugs, most of which, given in too great doses, can act as dangerous poisons.

It is obvious that the prevention and cure of disease should principally be the concern of those who have been specially qualified by suitable training to perform this important work. Therefore, the only persons at the present moment who should undertake ultra-violet treatment are members of the medical profession. Unfortunately, anyone can at the present time administer ultra-violet or X-ray treatment to others. It is no longer fashionable for the quack to sell pills in the market-place; he much more probably nowadays administers physical treatment in some fashionable part of the town. It has been said that there is no part of medicine which is so nearly allied to quackery as is physical treatment, and this stricture will last so long as the present chaotic state of affairs is allowed to continue. The quack, with his power to issue blatant advertisements, will continue in his present affluent state, indiscriminately maltreating suffering humanity. It all reminds one strongly of a character in Shaw's sparkling play, "The Doctor's Dilemma," whose procedure was to give his advice free, the fee for the course of treatment to be paid in advance, and cure guaranteed. A correct diagnosis is the essential

factor in the satisfactory treatment of any form of disease.

Recently, owing to the ill-advised propaganda of certain manufacturing firms and individuals who have allowed their commercial zeal to outrun their discretion, the tendency has been rather for lay interest to exceed medical in regard to ultra-violet radiation.

There are two ways in which the ultra-violet rays can be utilised for curative purposes—exposure of the body to the sun's rays, or irradiation with an ultra-violet lamp. Ultra-violet treatment can be general, local, or internal, and in the writer's opinion the only form of ultra-violet treatment which should be used at home is general treatment, that is, exposure of the whole body to the rays.

In regard to the most suitable form of ultra-violet lamp for use in the home, the obvious choice is the carbon arc. The extreme power of the quartz mercury vapour lamp, which renders it a most valuable instrument in the doctor's hands, is a source of real danger when it is used in the home, and for the same reason, the home use of the tungsten arc with its short erythema-producing dose is also undesirable. Mercury vapour lamps can, however, be purchased where either the burner is made of translucent quartz, or a screen of the same material, or of vita-glass, is placed in front of the burner; in both these cases the time of exposure is greatly lengthened, and the risks of over-dosage considerably minimised, so that no objection can be taken to the home use of lamps of this kind.

The disadvantages of the carbon arc are the initial cost of a trustworthy model with automatic regulation, and the cost of the electric current necessary for the proper functioning of the lamp, which is considerable. Incidentally, several persons can be treated with one carbon arc lamp simultaneously, so that it seems that one solution of the difficulty is the formation of special clinics where ultra-violet treatment can be administered collectively at a reasonable charge under medical supervision. Special physical treatment clinics are increasing daily, especially in Germany, where there are many excellent establishments for the treatment of rheumatic disorders. However, the careful home use of ultra-violet radiation is justified by intelligent persons in good health who wish to make use of its tonic effects, but the treatment of disease is an entirely different matter, and the great temptation of a layman who has installed a lamp to treat various ailing friends and neighbours, should be firmly resisted. A doctor's advice and supervision are imperative in the treatment of disease.

The dangers of unskilled radiation treatment are very real, and many fatal cases of exfoliative dermatitis have occurred. A few years ago an accident took place in which a patient, who had been in the habit of giving himself ultra-violet treatment with a quartz mercury vapour lamp at home, while lying on his bed, fell asleep. Instead of his usual ten minutes' exposure, he was irradiated for one hour and ten minutes. Marked reddening of the skin occurred and peeling followed. Twelve days later, a general redness of the skin developed, and at the end of another five days, the heart became gravely affected and very irregular; the patient was seriously ill for four days and then gradually he began to improve. Meanwhile the peeling of the skin continued, and after the lapse of a further two weeks, a hæmorrhagic rash appeared all over the body, and afterwards the patient slowly recovered. A short while ago an acquaintance of the writer's bought a mercury vapour lamp, and his first irradiation was so ill-timed that a marked erythema developed, and as a consequence the expensive lamp was promptly laid aside.

Though the ultra-violet rays have very little power of penetrating the skin, they are nevertheless able to produce two striking peripheral effects, namely, erythema or reddening of the skin, and tanning, or pigmentation. Actinic erythema, unlike that produced by the infra-red rays, comes on after a latent period of four to twelve hours, and pigmentation follows the erythema. It must be remarked that the skin exercises an important protective function against excessive irradiation; it is also an insulating medium, an excretory and an endocrine organ, and it contains many arterioles, and is the most extensive sensory organ of the body.

There are many theories regarding the action of the ultra-violet rays. One is that some of the rays penetrate to the capillaries in the vascular layer of the skin, where they are absorbed by the blood and chemical changes occur, leading to a general body effect. Another theory is that the rays have a direct photo-electric effect on the nerve endings in the skin, and yet another that the rays act photo-chemically on the skin fat-producing vitamin D, the bone-forming vitamin. Probably all three theories are partly true. An important action of ultra-violet rays is their power of killing bacteria. Five seconds' exposure to the rays from a mercury vapour lamp is often sufficient to kill some virulent organism. Water, which is probably the most transparent liquid to the ultra-violet rays

that we know, can be sterilised readily by them. The sun is Nature's universal disinfectant, and it is only in darkness that the organisms which are harmful to man and other animals can flourish.

Irradiation of the body generally leads to a fall in blood pressure, and Finsen proved that there was a seasonal variation in the numbers of red blood corpuscles, the number being greatest at the end of summer and least at the beginning of spring. So that if the red blood corpuscles are reduced in number, they generally increase after exposure to the ultra-violet rays. The hæmoglobin colouring matter of the red cells also increases in amount, and this proves an analogy with plants which, when grown in darkness, are deficient in chlorophyll. Changes occur also in the white blood corpuscles; the polymorphonuclear cells decrease, and the lymphocytes and, most markedly of all, the eosinophilic cells, become more numerous. There are alterations in the blood serum, and if there is an excessive quantity of blood sugar present, it is reduced. The amount of tyrosin in the blood serum increases, but decreases when pigmentation occurs, and a basic hydrogen ion concentration generally takes place. The vasomotor reflexes of the body are stimulated by ultra-violet irradiation, and this leads to an improved regulation of the body temperature, so that a body habitually stifled by wearing an excessive amount of clothing becomes able to tolerate with comfort greater extremes of heat and cold. It is a common experience that less clothing is often worn after a course of irradiation.

Ultra-violet radiation provokes certain metabolic changes. It has already been mentioned that hyperglycæmia is reduced; fats are also oxidised, particularly by natural sun baths, but the most profound action is on the mineral metabolism, the body calcium, phosphorus, iron, and iodine being all increased in amount. The calcium salts play a very important part in the body economy. They have a tonic effect on the heart, they stimulate the peripheral circulation and decrease the permeability of the lymph and blood-vessels; in bleeding, their presence is essential before clotting can occur. Calcium salts also stimulate the phagocytes in the blood, and play an important part in repairing the local ravages of disease.

Ultra-violet rays probably influence the ductless glands through the medium of the sympathetic or vegetative nervous system. They stimulate the thyroid and sexual glands and cause depression of the suprarenal glands. It has been found experimentally that irradiation diminishes the acidity of the gastric juice. The ultra-violet rays act on the central nervous system, and cause mental stimulation. The cheering effect on our spirits of a bright sunny day has long been realised, and artificially produced ultra-violet rays generally have the same effect. Intelligence tests carried out at the Treloar Cripples' Hospital, Alton, proved that the children there were about a year in advance of crippled children of the same age living in London. Ultra-violet, like the infra-red rays, have an analgesic effect on the peripheral nervous system, thus relieving pain.

The ultra-violet lamp in the home can be installed in a bedroom, or preferably in a large spare room. It is certainly unwise to put it in the bathroom, because here the electrical dangers are very great, and many fatal cases of electrocution have been reported. Moreover, the steam rising from hot water in the bath would condense on the unlit lamp and cause certain metal parts to become rusty, and dampness damages insulation. For home use, a suspension type of lamp would probably prove most convenient; a beam should be found and a pulley securely fixed into it—the lamp should be counter-weighted so as to make it possible to raise or lower it at will. An arc with cored carbons often gives off unpleasant fumes, so that the ultra-violet room should be satisfactorily ventilated—cross ceiling ventilation is the ideal, but the creation of draughts must be avoided, as the open arc is very sensitive to air currents. It should be possible to heat the treatment room to a temperature of about 70°, as general treatment is always given to the nude body. Satisfactory wiring, able to carry the required load, must be installed, and if it is available, the direct current should be chosen. It is generally possible to obtain permission to use the ultra-violet lamp on the power circuit, and power rates are generally much cheaper than the rate for lighting. The polarity of the two terminals must be known, and a three pin, or non-reversible type of plug should always be fitted. There should also be a quick-break type of protected double pole switch to turn on and off the current. The fuses should be of the easy replacement type and some spare fuse wire should always be available. The lamp resistance can be mounted on the wall.

In my opinion the most trustworthy types of carbon arc lamp are (1) the 'short flame' arc taking 20 amperes, made at the Finsen Institute, Copenhagen, which can only be used with direct current (with 240 volts three lamps can be used in series), and (2) the 'long flame' arc (with 240 volts two can be used in series) designed to take 30 amperes.

The disadvantage of the short flame arcs is that the maximum exposure with them reaches 2½ hours, whereas with the long flame arc it never exceeds an hour, and when two long flame arcs are used simultaneously, one in front and the other behind, the time needed for treatment can be cut down to half an hour. The direction of the radiant emission from these two types of lamp varies considerably. The greatest ultra-violet emission from Finsen lamps is given off at an angle of about 45° to the lower carbon, whereas the maximum emission from the long flame arc is given off by the flame itself, and is therefore greatest in the horizontal direction.

With the Finsen arcs, irradiation is given while the subject is lying on a couch, first in the prone and then in the supine position. The subject should be seated on a chair during exposure to the long flame arc, and first the front of the body and then the back irradiated, the arc flame being on exactly the same horizontal plane as the lowermost ribs. If preferred, irradiation can also be made in the reclining position on a couch, the subject lying on his side and facing the lamp, and then lying on his other side with his back to the lamp. With carbon arc lamps, the distance of the subject from the lamp should be as short as the heat comfortably allows, but not too short, because burning with the infra-red rays can, of course, occur. The initial exposure to each side of the body with the short flame arc should not exceed ten minutes, and should be gradually increased to a total of seventy-five minutes, back and front. With the long flame arc fitted with white flame carbons, an exposure of each side of the body for five minutes, at a distance of approximately four feet from the arc, should be made. This time is gradually increased to a maximum of thirty minutes.

A trustworthy alarm system should be installed to give warning at the termination of the exposure, but it is generally safer for a second person to be present.

During exposure the eyes must be carefully protected with suitable glasses or some other material which is opaque to the ultra-violet rays.

Irradiation is generally carried out every other day, and can be continued regularly for months, though it is only fair to say that many actinotherapists consider that it is advantageous to make an intermission of about a month after every twelve exposures.

Ultra-Violet Radiation for Domestic Use.

By Prof. S. Russ.

It seems very natural for people to want to make use of 'artificial sunlight' in their homes, especially during the rather sunless seasons, but there are some points which should be considered before it becomes a general practice, especially among those who seem to get along very well as they are.

In the first place, how nearly are artificial sources of radiation a copy of sunlight as it reaches most of us, nearly at sea-level? Perhaps the nearest approach to this is given by a high temperature filament lamp, though this will err on the side of having too big a proportion of radiation in the red and yellow part of the spectrum. Such lamps are of course largely used therapeutically, but mainly for the radiant heat which they give in a very convenient form.

All the forms of arc lamps, carbon, carbon-cored, tungsten, titanium, or mercury vapour, give out a composite radiation which is very different from sunlight, as it contains a large proportion of ultra-violet radiation. So that none of these sources which are often described as providing artificial sunlight can be said to do so unless a large part of the ultra-violet is screened off, and the remaining part of the spectrum very carefully compensated so as to resemble sunlight as nearly as possible.

In the second place, even if a source were invented that gave a fairly exact replica of sunlight as it comes into our houses, would it be used to any extent, and if so, for what purpose? This raises the question rather at the root of the matter; Why this quest for body irradiation? Undoubtedly much more attention is now given to housing, particularly to ventilation and lighting; it seems in fact an inevitable part of the hygienic trend which aims at abolishing the smoke pall of big cities, and the basement life which many seem able to survive. But we shall probably not be far wrong in attributing the demand for some source of artificial sunlight rather to a wish for ultra-violet radiation, and this in turn is probably due very largely to the discovery that irradiation with ultra-violet rays can cure rickets in children. It is perhaps not so much this plain fact as the story of its unfolding that has appealed so strongly to the imagination. This discovery has shown how a deficiency disease can be cured by exposing the body to radiation which penetrates but a fraction of a millimetre into the skin. The inferences

drawn from this have of course been boldly acted upon, and in consequence the substance in the skin which when irradiated produces vitamin D, the anti-rachitic factor, has been tracked down. The whole sequence of discoveries following on that of Mellanby in 1915, that rickets was a deficiency disease, forms a most impressive example of what well-directed scientific effort can achieve.

The question now before us is whether, in view of the admitted value of ultra-violet radiation in the treatment of rickets and general deficiency diseases in children, it would be a good thing for the general public to make good the deficiencies in diet (which undoubtedly affect a big proportion of the population) by exposing their bodies to frequent, perhaps daily, doses of ultra-violet radiation. The position taken up by the writer is that it is inadvisable on many grounds, and probably nationally uneconomical.

One need perhaps not lay great stress upon the fact that such a daily ray bath would cost an appreciable sum. A source suitable for home installation has to be safe; therefore it would probably have to be some form of closed arc, such as a mercury vapour lamp requiring no handling of leads from the mains. The initial cost of such a lamp, if the demand were on a big scale, might be so low as £5 or £6. Consumption might reasonably be 4 amperes at 200 volts, say 800 watts; if used daily for 10 minutes for one-half of the year, the running costs, apart from breakage and depreciation, would be 12*s.* per annum, taking power at 6*d.* per B.O.T. unit; for many households a cost that need not be taken into account, but on a big scale—a big item.

Some count should be taken of the risks run by repeated exposure of the body to a form of radiation to which it is quite unaccustomed; almost as foreign to it, in fact, as X-rays or gamma rays. Without in any way wishing to become an alarmist on the subject, I think that definite risk would be run by anyone exposing his body to repeated doses of ultra-violet radiation unless he were under proper medical supervision. The various reactions of the skin to ultra-violet radiation, which happen soon after the exposure, are well recognised by medical men, but it is too soon yet to know much about later reactions which may occur as they sometimes do after exposure to X-rays.

One very well recognised feature of prolonged exposures is the pigmentation that occurs in most, though not all, skins. If the thing were carried to extremes and people in the winter months pigmented themselves very considerably, it is open to doubt whether this would be a very good thing. Pigmentation means opacity to radiation generally, ultra-violet or luminous; and it could well be argued that in winter months one is far better guarded against heat losses by having a skin rather devoid of pigment; the general feeling of well-being quite likely depends on the tissues being illuminated to some extent by daylight.

People who spend a good part of their time in the tropics generally appear to lack vitality. There are lots of factors contributing to this, quite apart from the diseases peculiar to these zones; high temperatures and excessive humidity no doubt account for a good deal, but the continual exposure to solar radiation, besides tanning the skin, may set up other changes in the body which react upon the general vitality.

Experimentally it is found that when ergosterol is exposed to the full radiation from a mercury lamp, the amount of vitamin D gradually increases with the exposure up to a certain point, but a stage is reached when this stops. Whether this is due to the gradual formation of a neutralising body perhaps cannot yet be stated, but a recent report on nutrition by the Medical Research Council mentions that there are constituents of diet which appear to nullify the action of vitamins.

The reason for mentioning this here is that it seems a doubtful thing to advise people to install sources of ultra-violet radiation in their homes until more is known about the effects of repeated doses of these rays upon the body.

It is indeed relevant to inquire on what grounds it can be advocated. It is known that these rays can help those on an inadequate diet to avoid some of the consequences of such deficiency, but this can be done equally well by supplying the accessory food factors at much lower cost, and in a far more certain manner than by the population taking such medical matters into their own hands.

It may, however, be argued with considerable weight, that ultra-violet radiation does far more than this for people. There are some who positively hunger for sunlight and feel much fitter for some ultra-violet radiation, and the question is whether there is any valid reason why they should not have it when it can be got so easily.

The enormous sale of patent medicines throughout the country shows how willingly people will do without medical help, especially if they think the ailment a trifling one, so that there is of course nothing to prevent people getting any of the various appliances for generating ultra-violet radiation and

using them in their own homes, but surely they should not be *advised* to do so. Suppose, for example, that it were a part of the regular equipment of a household, and normally healthy children were periodically given doses of this radiation, could it be looked upon as anything short of an experiment? If so, are such domestic experiments on a large scale to be encouraged? There are many who will feel that the balance of health is maintained by so many factors, many of which are clearly recognised, that on such slender grounds it is better not to bring into this delicate balance a kind of radiation that no living race has been accustomed to before.

Medical Aspects of 'Artificial Sunlight' in Private Houses.

By P. R. Peacock, M.B., B.S.

Though ultra-violet therapy has been practised in an empirical way from the earliest times, the association of sunshine with good health being in the nature of a primitive instinct, it is only during the past thirty years or so that any serious attempt has been made to establish it on a scientific basis.

Systematic clinical observation gradually led to an appreciation of the value of the alpine climate in the treatment of tuberculosis of the bones, joints, and lymph glands, and the establishment of centres for treatment of this crippling disease by heliotherapy in the Swiss Alps was largely a result of the patient work of Bernhard, followed by Rollier and others. The notable extension of ultra-violet therapy by Finsen brought the curative rays within the reach of those in comparatively sunless countries and marked the start of the modern practice of artificial actinotherapy.

The success of ultra-violet treatment for 'surgical' tuberculosis, saving as it has many children from mutilating operations, is undoubtedly one of the reasons for the popular desire for ultra-violet rays, but the more recent and far more spectacular series of discoveries linking the demonstration by Mellanby of the nature of rickets with the subsequent rapid strides of research, culminating in the synthesis of vitamin D from ergosterol by Rosenheim and Webster, probably constitutes an even stronger influence.

It is as well to have a clear idea of the real justification for ultra-violet therapy before considering the type of pseudo-medical publication or manufacturers' advertisement, from which it might be concluded that ultra-violet rays will not only prevent and cure all known diseases, but will also regulate even minor variations from the physiological standard of normality. Such one-sided propaganda has been much in evidence in recent years, and that it has borne fruit is easily judged from the number of hairdressers and beauty specialists who make a fine thing out of ultra-violet and 'violet-ray' treatments, not to mention the bottles of 'ultra-violet lubricant' and 'radio-active' bath salts, for both of which commodities the writer has been assured that there is a good demand.

In addition to the specific cure of rickets and the successful treatment of surgical tuberculosis, the value of ultra-violet rays in the treatment of septic wounds and burns was abundantly proved during the War. There is evidence that actinotherapy is of value in disturbances of the parathyroid gland and deficient calcium metabolism; possibly the rôle of ultra-violet rays is the same in these conditions as in the case of rickets, since there appears to be an intimate association between vitamin D and the absorption of calcium from the alimentary tract. Certain conditions are also directly benefited by the local reaction of the exposed part, increasing the blood supply and facilitating the removal of toxic products of the morbid state; the successful treatment of chilblains and of varicose ulcers is probably to be explained on these lines.

The powerful bactericidal action of ultra-violet rays is well known, but this property is rarely made direct use of in practice, owing to the very slight penetration of the rays, and to the fact that many of the bacteria that normally infest the skin are effectively screened from the rays in the sweat-glands or hair-follicles.

These few points have been selected from a great many known facts in order to emphasise the importance of recognising that actinotherapy is based on established facts, and it is only on such lines that it should be used. There are, however, many who would spoil a good case by overstatement, or hide their ignorance of the facts, and a dislike for critical investigation, behind a mass of plausible speculation as to some mysterious property of this or that type of arc lamp, and hinting darkly that science cannot detect properties of the rays with which nevertheless they themselves are familiar.

As there are specific cures, so there are specific diseases due to light and ultra-violet rays, and, although these are fortunately rare, they should be

considered by the advocates of wholesale light therapy. Xeroderma pigmentosum is the worst of all 'light' diseases and, in the unfortunate children affected, manifests itself as a malignant spread of pigmented spots under the influence of light, usually terminating fatally in early adolescence.

Equally rare are those cases of excessive sensitivity to light due to the presence of hæmatoporphyrin in the blood as a congenital abnormality, resulting in an eruption not unlike that of smallpox on the regions of the skin exposed to light.

Probably the greatest danger to the public from careless use of arc lamps is that of damage to the sight, a very real danger which, if not guarded against, may lead to many cases of permanent injury. Exposure of the unprotected eye to intense sources of light such as the tungsten or mercury vapour arc leads to acute conjunctivitis within a few hours, an experience that would probably induce greater caution on subsequent occasions, as few conditions are more painful. Deliberate staring at powerful sources of actinic light may lead to permanent blindness, or short of this to restriction of the visual field, the so-called 'ring scotoma.' There is a good deal of evidence that repeated exposure to unscreened arc lamps may lead to the development of cataract, and this is not surprising, since it is the lens of the eye that absorbs most of the ultra-violet rays.

If the dangers of this form of treatment have been rather stressed, it is only with the idea of emphasising that means of protection should never be neglected by anyone frequently exposed to the rays. As regards the skin, over-exposure is not as a rule followed by any permanent damage, though very painful burns and blisters are the penalty of careless handling of the lamps.

As there is no restriction of the supply of arc lamps or other apparatus for the production of ultra-violet rays to the public, the position is similar to that of patent medicines other than those scheduled under the Dangerous Drugs Acts. Inevitably, as in the case of proprietary drugs, a certain amount of amateur experimental medicine would follow the installation of arc lamps in private houses, and it cannot be too strongly pointed out that these rays are not to be regarded as practically foolproof, and should be treated with as much respect as a redhot poker or a loaded firearm.

Those who install lamps and wish to take regular doses of ultra-violet rays, would be well advised to begin by being medically examined and passed as fit for such treatment. Lamps should never be switched on until the eyes have been protected by goggles, which should be of glass tested and certified as cutting out the ultra-violet rays, and these should not be removed until the lamp has been turned off again. The technique of treatment does not come within the scope of this article, but it may be remarked that individual susceptibility varies greatly, and that this should be tested cautiously before starting general irradiation, otherwise extensive light-burns may result. The best thing would be for those who contemplate the installation of a source of ultra-violet rays to ascertain in the first instance whether they really benefit from such treatment, as by no means everyone is obviously improved by it.

One cannot help wondering whether the people who can afford to install arc lamps in their homes are those who would derive most benefit from the rays, since they are probably taking ample vitamins in their diet and live in relatively open and healthy neighbourhoods.

For the poor, whose diet is short of butter, eggs, milk, and fresh foods generally, there are already a number of clinics where they can be treated, with the best results, under proper medical supervision.

Extension of such clinics would appear to be the safest way of overcoming the defects of the rather sunless climate of Great Britain, though the intelligent use of artificial 'sunlight' in the home may be a means of improving the national health.

Lamps for Light-Baths.

By T. C. Angus.

ULTRA-VIOLET light between well-defined wave-lengths is one of the necessary accompaniments of primitive life in natural surroundings the tonic effects of which the human body is not only able to withstand, but without which it suffers a definite want. There can be no objection, therefore, to town-dwellers, during a European winter, who, while not being 'ill,' are still often in need of light and its good effects, making use of occasional light-baths from sources which emit ultra-violet light of moderate intensity. In fact, many such persons have followed this course for some time with considerable benefit, and there is little doubt that others will follow their lead.

A practical biological measure of the strength of ultra-violet light is the time for which it is necessary

to expose the skin to these rays for an erythema (reddening) and its after-effects to be produced. This erythema does not begin to appear until some hours after the application, and reaches its full intensity about 12 hours after the exposure, being followed by a brownish pigmentation or 'sunburn.' A band of cardboard or thick paper can be put across the abdomen, and small windows cut in this, so that the skin is exposed to the source 2 ft. away for 5 or 10 minutes and the erythema observed in each area. The dose required is that giving a slight erythema.

Lamps of various kinds capable of producing these effects after exposures of as little as two to five minutes are now obtainable through the medical stores, and can be fitted up in doctors' houses and in hospitals. Such powerful sources of light should only be used after the test of dosage by skilled people, or severe burns will result. This is obvious when it is remembered that it usually requires exposures of an hour or more to the summer mid-day sun in England to produce a sunburn on the skin of the neck or arms, so that an arc or mercury vapour lamp capable of producing this effect in five minutes must emit much more potent rays.

Lamps suitable for Domestic Use.

The Mercury Vapour Lamp.

In this well-known source of ultra-violet light the radiations are produced from an arc or stream of electrons carried by a column of mercury vapour, the whole enclosed in a quartz tube. The spectrum shows many characteristic lines of great intensity in both the near and far ultra-violet region, with much visible blue light and very little yellow and red.

A very small lamp of this kind would be suitable for the domestic use we are considering, and such a lamp would not take more than an ampere and a half after it had been alight for a few minutes.

The mercury vapour lamp is efficient and cheap in current consumption, whilst the cost of the quartz burner is lower than it was formerly, so that in price the mercury vapour lamp compares well with its rivals, and a very small lamp of this kind will be all that is desirable for domestic use. Elaborate stands and reflectors do not add to the efficiency of a lamp as they add to its cost. The quartz mercury vapour burner only requires a safe and simple support and a resistance and starting switch. The lamp is fairly cool, perfectly silent and easy to handle, though the burner is easily broken by shock or impact. The more powerful mercury vapour lamp commonly used for treatment might well be adapted for domestic use by interposing a thin filter or screen of vita-glass, which has the power of cutting off all the shorter ultra-violet rays and a proportion of those of medium length, whilst transmitting freely the near or longer rays: which last do not constitute a very powerful component of the mercury vapour lamp's output. The disadvantage of using such filters is that it is difficult to produce numbers of them with a consistent absorption, and that it would be more economical to use a much smaller and cheaper lamp to give much the same effect.

The running expenses of the mercury vapour lamp are due to current consumption, which is very small, and to deterioration of the burner, which usually has to be replaced or reconditioned after from 600 to 1000 hours' use. The atmospheric type of lamp lasts longer than the vacuum type.

Mercury vapour lamps can be made to work with direct or alternating current, lamps for the latter being rather more costly; or rectifiers can be obtained to make use of alternating current to work the direct current type of lamp.

The Arc Lamp.

This lamp has gained an unfair reputation for low output as a result of the perpetuation of obsolete designs by some manufacturers. As a result of recent improvements in lamp design and in the composition of the electrodes or carbons, therapeutic arc lamps are now obtainable that can give their effects as quickly, or more quickly, than the mercury vapour lamps commonly used.

Arc lamps using a current of three amperes, and therefore capable of being used on an ordinary lighting circuit, are now made, and these should be suitable for domestic use.

The quality and intensity of ultra-violet radiations from an arc can be varied over a wide range by the use of different electrodes—carbons cored with different metals and salts—so that the strength of the dose can be varied at will. The arc lamps used by Reyn of Copenhagen maintain a short arc between two plain carbons, the top one of which is the positive electrode. The distribution of light and ultra-violet light from such a lamp is greatest at an angle of 45° below the horizontal, and the relative strength of the biologically active rays is small compared with that of the visible light and the heat rays. Such lamps use very high currents, and the patients require exposures to them of an hour and more.

It was shown by Eidinow that the arc can be made a much more efficient source of ultra-violet light for treatment by lengthening the distance between the carbons, and by Angus by making the bottom carbon the positive instead of the top: the putting of the positive pole below ensures the diffusion up of the ionised gases and an effective flame from which most of the ultra-violet rays come. The distribution of light intensities from such an arc is nearly spherical, so that patients are best placed on the same level as the lamp. If a carbon cored with iron particles or a mixture of iron and cerium is used at the bottom, a much more powerful erythema-producing radiation is produced with which dosage time may be reduced to 2 to 5 minutes; it is then found that a plain and consequently cheaper carbon can be used in the top (negative) holder with practically no diminution of intensity of ultra-violet light from a direct current arc and a 20 per cent. diminution in an alternating current arc; this makes for a considerable saving in running

costs, because the top carbon is always the more quickly consumed.

The advantages of the arc as a source of ultra-violet light may be given as:

1. Quality and intensity of output can be varied at will by changing the electrodes.
2. No deterioration or loss of power with age.
3. A large output of warm visible light as well as ultra-violet, making the treatment pleasant.
4. Not easily broken or put out of order.

The disadvantages:

1. Uses more current than an equivalent mercury vapour lamp.
2. Carbons have to be renewed when they burn away.
3. Lamp gets hotter than mercury vapour lamp.

Precautions.

Overdosing should not be possible with lamps used for domestic self-treatment: lamps strong enough to produce overdoses should only be used under the control of a doctor.

Fire.—Lamps should be thoroughly stable and not so easily overturned that fires might be caused. All wiring and connexions should be of the best possible quality.

Electric Shocks.—Unlike the ordinary glass lamp in common use, ultra-violet lamps have one or two points where bare wires or points are exposed and may be touched when, by oversight, the current is switched on and the lamp is therefore 'alive,' although it may not be burning, and an unpleasant and even dangerous shock may thus be obtained. This may happen with the mercury vapour lamp when cleaning the burner with alcohol, as the makers recommend, and with the carbon arc when changing or renewing the electrodes; although, of course, both these operations should be carried out before the lamps are switched on at all. This being always a potential risk, it may be well to install lamps for home treatment in the *bedroom* rather than in the *bathroom*; this because the latter place is one in which possible shocks are far more likely to be serious on account of the large number of earthed metals and the state of moisture of floors, objects, and particularly of the body. Also, it may be well if buying an arc lamp to specify one where proper provision is made for changing electrodes without risk of shock should the switch be inadvertently left 'on.'

Care of the Eyes.—The cornea and conjunctiva are very sensitive to ultra-violet light and should always be protected by dark goggles during light treatment; these should have close-fitting side pieces.

The relative 'cost of lamps' is as follows:

	amperes. volts.
Short flame Finsen arc .	. 70 × 110 = 7700 watts.
Long flame arc . .	. 25 × 110 = 2750 ,,
Tungsten arc . .	. 5 × 110 = 550 ,,
Mercury vapour lamp .	. 4 × 110 = 440 ,,

The carbon arcs require purchase of carbons. The tungsten arcs require expensive tungsten electrodes. The mercury vapour lamp usually wants renewing after about 600-1000 hours' run, but is the cheapest.

A self-regulating long flame arc costs about £20-£25. A mercury vapour lamp without stand or reflectors costs about £10. A hand-fed tungsten arc can be made for £1 or £2. Then there are the expenses of resistance coils, wiring keys, etc.

The price of lamps is put up by provision of plated reflectors and stands. A mercury vapour lamp with an iron retort stand and a tin or cardboard screen suffices. Domestic mercury vapour lamps are now sold complete for about £10 direct, or £18 alternating current. Hand-fed arc lamps with iron and cerium cored carbons can be had for about £5. These can be run off the house circuit.

Selection of Ultra-Violet Lamps for Home Use.

By B. D. H. Watters.

THE idea of employing ultra-violet radiation at home is a new one, and there is as yet no wide selection of lamps made for this purpose. Those at present on the market must be regarded as largely experimental attempts to meet the new demand. The majority of them are of the type used for general irradiation in hospital practice, but reduced in size, and it is not generally realised that an exposed and live electrode which is safe enough in the laboratory or clinic in the hands of trained workers, may be quite definitely dangerous in the home.

The first of these lamps which were put on the market were all carbon or carbon-cored arcs, but recently the quartz mercury lamp has been produced commercially in a small size. The carbon lamps burn either plain carbon electrodes, or carbon cored, with some metallic mixture which volatilises and adds the characteristic spectrum of that metal to that of the carbon arc. The metals or mixtures of metals selected are such as to enrich the arc with radiation of the shorter wave-lengths. From a therapeutic point of view, there seems little to choose between the different corings.

Carbon Arcs.

Ajax, Ltd.—The lamp is known as the 'Uviray,' and is a magnetically controlled tungsten-cored arc. It is remarkably steady in running owing to the automatic control. The arc is housed in a deep hood supported on a stand which contains the series resistance. A small knife switch is fitted to break the circuit, which serves the purpose admirably, but the fact that the contacts are so much exposed is a weak point in an otherwise good design. The current consumed is 4·5 amp. Price £5 10*s*.

Apex Sun Ray, Ltd.—The No. 1 model made by this firm is a small arc made between two thin pencils of carbon which are mounted almost

parallel in a deep metal hood. Very little adjustment is required. The series resistance is mounted on the large base of the instrument. The beam is somewhat concentrated by the narrow hood. Price £6 6*s.*

Arnold and Son (John Bell and Croydon).—The 'Arnold' artificial alpine sun lamp is a large and expensive instrument on a heavy stand which carries two carbon arcs in series. It is made in two sizes for 5 and 10 amp. respectively. Such a lamp is more suitable for use in a hospital than in an ordinary house. Not only is the heavy current of the larger model more than the fuses and wiring of an ordinary installation can handle, but the output of radiation is more intense than is necessary for the simple tonic treatment required. Price £20-£25.

Bower Electric, Ltd.—The 'Uvral' lamp is an interesting form of double arc. The whole instrument is housed in a teak outer case, a window being raised to expose the beam. On the side of the case is a special timing switch termed an 'expometer.' This is set for some predetermined period and the lamp switched on. At the end of the period the lamp is automatically switched off, thus reducing greatly the danger of too long exposure. The general design shows that much care has been taken to avoid accidental shock. The degree of safety has to be paid for as the price is relatively high. Current 4-5 amp. Price 24 guineas.

The 'Junior' U-V ray apparatus, by the same firm, is a much smaller apparatus. Two parallel carbon pencils are mounted in the usual hood. The series resistance takes the form of spiral coils mounted round the inside of the hood. These reach a dull-red temperature when the arc is running and radiate a certain amount of heat. The lamp requires more care and attention to use than the more expensive models. Current 4·5-5 amp. Price £5 15*s.* 6*d.*

Brodie, Oakley and Co.—'Artsun' lamp—a hand-controlled carbon arc mounted in a reflector hood. The electrodes are narrow pencils and stick out at top and bottom of the instrument quite unprotected. Price £4 17*s.* 6*d.*

Quain Ray Lamp Co.—This is also a hand-controlled carbon or cored carbon arc, but of an unusual type. The carbons are mounted horizontally in the centre of a shallow dish-shaped reflector which is covered with a grid of stout wire. The mesh is open and does not cut down the total radiation appreciably. The series resistances are radiator heating units which are also mounted in front of the reflector, so that a certain amount of heat is radiated as well as ultra-violet radiation. A switch on the back of stand serves to short-circuit the arc, when the lamp functions as a heating radiator of the usual type.

The carbons used are of medium size and burn fairly slowly, but the method of replacing them is clumsy and is likely to result in burnt fingers. There is also no main switch on the lamp itself for breaking the circuit. As the carbons burn away they have to be readjusted after a run of about ten minutes. This is claimed by the makers as an advantage, as it reduces the chance of an overdose owing to the patient going to sleep. At the same time, the output of radiation varies considerably during the ten minutes.

Rouse and Sons.—Rouse No. 1 Junior U.V. lamp. This is a simple carbon arc, the carbon pencils being mounted almost parallel in a metal hood supported on a light tripod. The series resistance is a separate unit. Tungsten electrodes can be obtained as well as plain carbon.

Mercury Lamps.

Medical Supply Association, Cox Cavendish Ltd., and other firms.—The 'Homesun' lamp is made with two types of burner for D.C. and A.C. In either form, the lamp is more constant than any of the carbon arcs, and the current consumption is only 2·0–2·5 amp. The radiation is also richer in the shorter wave-lengths of the ultra-violet, but whether that is an advantage or not is a question. The D.C. burner operates better when the current is flowing in a certain direction, but, unlike the big mercury arcs, it is not injured by being used with the polarity reversed. The mounting of the lamp is in a hood on a stand containing the series resistance. The heavy starting current which is characteristic of mercury lamps necessitates the use of fuses which will stand 6 amp. Price, D.C. £10; A.C. £18.

Medical Supply Association.—The 'Medisun' lamp is a similar instrument to the above, but requiring even less current (on D.C. 1·0–1·2 amp.). An indicating 'on and off' switch is fitted. So far as running costs only are concerned, this must be the most economical source of ultra-violet radiation available at the moment. Price, D.C. £10; A.C. £18.

Stanley Cox, Ltd.—The simple type 'Actinosun' No. 2 is a mercury lamp similar to the others described, and though not made specially for use at home, would be quite suitable for that purpose. Half-power burners can be supplied. The lamp is obtainable in two models for D.C. and A.C. respectively. Price, D.C. £9 15*s.*; A.C. £12 10*s.*

Filament Lamps with Vita-Glass.

The use of ordinary incandescent filament lamps with a vita-glass bulb for home irradiation has been somewhat superseded by these newer and more powerful lamps. The Emesay warming screen sold by the Medical Supply Association is a light radiator using ordinary bulbs, but, if the bulbs mentioned above are substituted, the screen acts as a source of weak ultra-violet of the longer wave-lengths. Such an apparatus would be free from any of the risks attendant on the ignorant or incautious use of any of the lamps described above.

Selecting a Home-Radiation Outfit.

For the purchaser and the designer of ultra-violet lamps for the home, the following points should be noted:

1. The live leads, etc., should be protected by a

deep hood or wire grid and should be as few as possible.

2. The lamp should be fitted with a good switch, in which the moving parts separate far enough to preclude all chance of arcing. A double pole type would be of advantage to ensure *both* electrodes being dead before they can be touched in the replacement of carbons, etc.

3. A well-fitting pair of goggles should always be worn. The use of goggles is so essential, especially with the small mercury arcs, that it would be an excellent thing if manufacturers agreed to mark all lamps intended for home use with the inscription, "Goggles must be worn when using this lamp." At present it is to be regretted that in a number of catalogues, etc., the artist has tried to express the pleasures of basking in artificial sunlight, but has omitted in his pictures the disfiguring goggles. The necessity of using goggles is mentioned in the catalogues, but a good illustration is often remembered when the written instructions have been mislaid. There are many satisfactory makes to be obtained, but, if there is any question, the only certain test is by spectrometer. A good pair of goggles should not transmit any ultra-violet radiation at all, not even of the longer wave-lengths.

The danger of falling asleep during the exposure is a perfectly definite one, as ultra-violet radiation often has that effect. In such a case it is possible for the patient to experience a severe blistering of the skin due to over-exposure, as this skin-burning does not appear until some time has elapsed. The simplest manner of guarding against this danger is to make it a rule always to stand up for an ultra-violet bath, and never to sit or lie down.

The most suitable place for the installation of these lamps is a matter for careful consideration. The bathroom, as has been pointed out elsewhere, is not the safest place, because of the danger of a bad shock due to the moisture present. On the other hand, it should be remembered that this radiation is a very powerful bleaching agent, and that the colours of fabrics, etc., will fade, and often the materials themselves perish, if exposed constantly to the rays.

The lamps reviewed here have been considered from the point of view of the man who wishes to have ultra-violet radiation available in his house as a tonic during the dark winter months. To use it for the treatment of any definite disease without the direction of a qualified physician is highly dangerous, for it must be realised that the irradiation used in medicine is often only a part of curative treatment. Further, there are conditions and diseases which can be made worse by ultra-violet radiation, and in spite of the enthusiastic pamphlets and catalogues which record its application in every human ill, it cannot be too strongly insisted that ultra-violet radiation is not a universal panacea.

The Ultra-Violet Transmission of Transparent Materials.

By Dr. L. C. Martin.

We may be forgiven for a little scepticism regarding the highly coloured reports which have been current during the last few years concerning the possibilities and effects of ultra-violet radiation. It must be admitted, however, that there appears to be a considerable measure of truth in such accounts; the physicist must assist in disentangling the errors and in weighing the evidence.

The shortest wave-length for which light is visible to the eye is roughly $0{\cdot}39\mu$, but the spectrum of sunlight extends, although faintly in the end, to a wave-length of about $0{\cdot}295\mu$ at sea-level; the cornea, the outer transparent coat of the eye, transmits down to about the sunlight limit. The 'lens' of the eye is more opaque; it will not transmit beyond $0{\cdot}376\mu$, and can be made to fluoresce by radiation of about this wave-length reaching it through the cornea. Severe inflammation of the conjunctiva can be caused by exposure to intense radiation of wave-lengths shorter than about $0{\cdot}305\mu$. Physiological and germicidal actions occur with radiation of still shorter wave-lengths down to about $0{\cdot}21\mu$, but beyond this point we soon reach the region $0{\cdot}193\mu$ to $0{\cdot}185\mu$, where air becomes practically opaque. The region of interest in ultra-violet transmission measurements for present purposes extends, then, roughly from $0{\cdot}4\mu$ to $0{\cdot}2\mu$.

In connexion with the various sources for the production of ultra-violet radiation for clinical purposes, the transmission of the globes, screens, or containing vessels has to be studied; the transmission of window glass is also a special case. It may be added that the photometric study of the *emission* of the source is of no less importance. Naturally, the ultra-violet emission of many sources such as tungsten filament lamps, for which the familiar 'black-body' radiation laws are a sufficient guide, is extremely low in proportion to the total radiation. Much more energy, relatively speaking, is derived from arcs and sparks which give bright line spectra. The region $0{\cdot}4\mu$ to $0{\cdot}2\mu$ can be studied with the aid of fluorescence or photography. In some cases the absorption of media grows very rapidly with changing wave-length in a certain region; thus the simplest kind of information useful in some cases is the short wave-length limit of the transmission.

Quartz in the crystalline state is fairly transparent down to $0{\cdot}18\mu$ in pieces 2 cm. in thickness; the quartz spectrograph as made by the firms of Hilger and Bellingham and Stanley, in which the whole optical system is made in quartz, projects the entire visible and ultra-violet spectrum down to about $0{\cdot}185\mu$ on a photographic plate; the substitution of a screen of uranium glass for the plate converts the instrument into an ultra-violet spectroscope in which the lines of the spectrum are seen by fluorescence. Wave-lengths can be given by a scale marked in the glass. An iron arc or

tungsten arc gives a wealth of lines in the ultra-violet spectrum, so that if a piece of the substance under test has sufficiently good surfaces it may be held in the path of the light reaching the slit, when its 'limit of transmission' may become manifest by the darkening of the spectrum beyond a certain point. Such tests are useful for protective glasses or goggles. A compact ultra-violet spectroscope for hand use is made by Messrs. R. and J. Beck, Ltd.

Fluorite is one of the most transparent media for the ultra-violet (when pure it transmits down to $0{\cdot}125\mu$), but it is difficult to obtain good specimens of any size, so that even its optical use is rather restricted; but this crystal, together with rocksalt and certain other crystals and gems, has important possibilities for scientific purposes.

Fused quartz is not doubly refracting, and is little less transparent than crystalline quartz; it has great resistance to heat, and its extremely high melting point makes it specially suitable for containing the mercury arc, one of the most useful sources of ultra-violet radiation. In spite of a great deal of research carried out for long periods, it has not yet been found possible to produce the material in a truly homogeneous state; there is always a residual structure showing small local variations of refractive index. Even though microscope lenses are made from it, they could be improved if the homogeneity were perfected.

The cost of using fused quartz for windows would be prohibitive, but since the range of transmission of glass can be made to include the whole sunlight range, it is unnecessary. Common soda glass is practically opaque beyond $0{\cdot}33\mu$, but in Hovestadt's "Jena Glass" the increased ultra-violet transparency due to the use of barium is pointed out. Generally speaking, the transparency diminishes with increasing proportions of lead in the flint glasses. Researches in the effect of the composition of glass on the ultra-violet transparency have been made by Zschimmer, who found that boric oxide was very transparent. The use of sodium oxide in a glass decreased the transparency more than potassium oxide. Useful figures and curves are given by Schulz ("Das Glas," Munich; 1923. Kösel and Pustet) from the results of H. A. Kruss. Particulars are also given of the 'Uviol' Jena glass which has been most useful for spectroscopes and other purposes, since it transmits down to $0{\cdot}280\mu$. Fritsch has published particulars of a glass made from calcium fluoride and boric oxide which is said to be transparent down to $0{\cdot}185\mu$.

Comparatively recently, Messrs. Chance Bros. of Birmingham have brought out their 'Vita-glass' made to the specification of Lamplough. In a plate 2 mm. thick this will still transmit 10 per cent. at $0{\cdot}272\mu$. Also, the Corning Glass Works have announced a special ultra-violet transmitting glass (not yet available in large pieces) for which an even greater transparency is claimed.

The measurement of the transmission is usually made with the aid of the spectrograph. Half the slit is illuminated by light transmitted by the specimen, the other half by an exactly similar beam, the intensity of which can be diminished (in effect at least) in definite ratios by a special device. The spectrum is thus split into two; we find the wave-lengths at which the intensity has been diminished by the specimen to those ratios used for the above device, by comparing the densities of the two parts of each spectrum photograph. The action in the variable beam can be controlled by a polarisation device or by a rotating sector; in the latter case it seems to be sufficiently accurate to assume that the reciprocity relation is valid for the plate. The optical arrangements for carrying out these tests have been so far standardised that they can be used without difficulty to obtain trustworthy results.

Special apparatus for ultra-violet spectrophotometry, for which greater speed and ease of working is claimed, has also been developed by S. Judd Lewis. Mention must also be made of the photographic methods in which special non-selective 'wedges' are employed; such methods have been worked out (chiefly for the visible region) by Mees, Dobson, and others; in some cases they can be applied to the ultra-violet.

The durability of the new glasses referred to above can only be tested properly by experience. One important matter is their stability under the continuous action of ultra-violet radiation. Some glasses containing small amounts of manganese are well known to develop a pink tinge when used in globes round arc lamps; such action under exposure to intense radiation is likely seriously to prejudice the ultra-violet transmission, and effects of a similar kind should be looked for even in the absence of manganese. Naturally, the relation between the conditions of normal use and the conditions of the test would have to be carefully considered.

Important questions are likely to arise in connexion with the screening off of undesirable components of the radiation; it is possible that liquid 'filters' may become useful in such cases. Much information on recent work on the transmission of liquids is given in Luckiesh's useful book on "Ultra-violet Radiation," and recent work on the transmission of solutions has also been carried out by Dahm.

In conclusion, it may be said that photometric methods are so far developed that it should not be difficult to measure and to control the characteristics and intensity of any ultra-violet radiation used for medical purposes. In the somewhat arbitrary and experimental condition of present practice, it is not possible to be too precise and definite in the specification of physical conditions.

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News and Views.

IN an address on "Science and the Civil Service," given in November last to the Professional Institute of the Civil Service in Canada, Prof. J. C. McLennan reminded his audience, which included members of the Canadian Cabinet, of the benefits which scientific workers employed by the State have conferred on the populations in the Dominion. So far from scientific men being mere 'high-brows,' unpractical dreamers, and visionaries whose services are worth a mere pittance, they are more practical than the arm-chair politicians who despise science. It was a member of the Geological Survey of Canada, Dr. Dawson, who discovered the famous gold-bearing belt in the Yukon territory. It was largely owing to Prof. Miller and his colleague, Mr. Thomas Gibson, that a mining policy for the development of the silver, nickel, copper, gold, and other metallic mineral fields in Ontario was inaugurated. Canada's remarkable success in agriculture was based on the work of two public servants, Dr. William Saunders, who created the Experimental Farm System, and his son Dr. Charles Saunders, who discovered the Marquis variety of wheat. To another, Dr. Gordon Hewitt, who developed the Dominion Entomological Service and devised means for the control of grasshopper pests, must be given the credit of saving Canadian farmers millions of dollars yearly. The list of services rendered to the material prosperity of Canada by scientific workers in the public services could be extended indefinitely. For the most part they have worked for wretched salaries and, in some cases, with but the most meagre recognition of their great works. It is time the statesmen of the Dominion realised the immense potentialities of properly endowed scientific services.

PROF. MCLENNAN did well to point out to the statesmen and other public men present that if the scientific services are starved in Canada, the best brains of the community will continue to migrate to its great neighbour, where they can expect greater encouragement and more freedom to apply their discoveries. The tendency on the part of the wealthy and financial houses to send money to the neighbouring State for investment is a direct consequence of the apathetic attitude of the Dominion Government towards scientific research. Money now goes for investment and people of ability for employment to places where science is appreciated, where invention and discovery find application in industry. Scientific workers, by the discoveries and advances they are making continually, not only stabilise industries, but also point the way for still greater developments. The best protection for Canada is the adoption of a policy "Science in the Civil Service and Science in Industry." Canada badly needs a National Research Institute in which those scientifically inclined, or those in control of industries, can have their problems investigated. With this view the Hon. Charles Stewart, Minister of the Interior, entirely agreed, and made the useful suggestion that the scientific workers of Canada, led by Prof. McLennan, should go out into the highways and byways and convert the laymen of Canada, who wield the 'big stick' to urge on or frighten members of Parliament, to the need for and value of scientific research.

AT the risk of appearing tedious, anthropologists continue, and wisely, to urge the importance of their studies for purposes of administration among backward races. The latest pronouncement is by Mr. J. H. Hutton, of Assam, who is well qualified to speak both as an anthropologist and an official. In his presidential address to the Anthropological Section at the Calcutta meeting of the Indian Science Congress last January, he argues ably for the utility, and indeed the essential need, of a knowledge of the principles of the science in dealing with such a people as that with which he is most familiar, namely, the Nagas. He points his argument with many an apt illustration in which knowledge of sentiment and custom, especially in the judicial field, has been an essential condition to secure the right handling of incidents such as crop up daily in the path of the administrator. He deals with the difficult question of missionary activity temperately, even though he is compelled to conclude that their influence is in practice harmful, as it breaks bonds which form part of the tribal complex, but for which Christianity affords no substitute to help the native. Supporters of the missionary, it may be noted in passing, who think that Christianity should be able to afford the necessary influence to replace tribal custom, in arguing from the analogy of a Christian society, overlook the fact that ethics are fundamentally cultural even when they have a theological sanction, and to a great extent cannot be transposed from one sytem to another. Mr. Hutton's careful analysis of the results which arise from culture contact between east and west to the detriment of the health and numbers of the native population constitutes a warning against the too hasty introduction of civilising influences, which deserves careful pondering by those who are interested in the advance of backward peoples.

A PAPER was read on Mar. 30 by Mr. D. Brownlie, before the Diesel Engine Users' Association, on the subject of liquid fuel from coal. He pointed out how necessary a supply of liquid fuel produced in Great Britain will be if the Diesel engine is to attain an importance commensurate with its thermal efficiency. This supply may be derived from coal by carbonisation at high or low temperatures, by hydrogenation, or by synthetic processes based on carbon monoxide. The author dealt with these methods *seriatim*—in particular with the carbonisation of coal at low temperatures, on which he listed seventy-five different processes, describing thirty of major importance which have been in more or less continuous operation in large-scale plant. Hydrogenation and synthetic fuel production were described in outline. The author deplored the slow advance of the production of liquid fuel from British coal, and indulged in a jeremiad on the absence of scientific development of

our home resources. It is easy to exaggerate here, for there has been no lack of ingenuity applied to the carbonisation of coal by British workers. About a third of the processes scheduled by the author are of British origin or development; undeniably capitalists have not withheld ample financial support, as many of them would ruefully agree. The author himself throws light on the slow progress when he enlarges on the development of mineral oil production. Oil *can* be produced from coal, but *must* be sold in competition with natural petroleum, and present-day economic conditions do not lighten the task of those who seek to manufacture liquid fuel from coal.

"THE Agricultural Depression, its Causes and Possible Cures," was the subject of an address by Mr. W. C. D. Dampier-Whetham at the ordinary general meeting of the Surveyors' Institution, held on April 2. A comparison of the present situation with previous depressions shows that all have occurred during times of falling prices in both agriculture and industry and are ultimately due to monetary instability. After discussing the theory of prices, Mr. Dampier-Whetham showed that the general changes in price level from 1843 to 1914 are explained by the varying relations between the world's supply of and demand for gold. Whereas plentiful gold invariably results in an increase of prices and prosperity for the farmer, depressions arise from a falling average level of prices, whether this be due to shortage of gold as in 1873, or to deliberate deflation as in 1920, when efforts were made to restore the gold standard. Protection or free trade has less effect on prices than changes in the value of money. As regards possible remedies for the existing depression, much may depend on the policy of the Federal Reserve Board and possibly on some future international agreement as to the control of the world's gold supply. A system, other than the gold standard, may ultimately be devised for the management of currency and credit, which will tend to keep the index number of wholesale prices constant, and counteract the effects of a probable world shortage of gold. Although such fundamental changes may be premature, some measure of relief will be obtained if efforts are made by the farmers themselves to reduce costs and charges in every possible way, particularly in the sheltered industries, and the questions of marketing, import control, and agricultural credit are still further explored by the Government. The only radical cure, however, is stabilisation of the general price-level, that is, of the value of money.

THE contrast between the Building Exhibition of to-day and those that were held in former years at the Agricultural Hall is very marked. Those at Islington were well attended, it is true; for architects, builders, and others of such groups went there in order to gain up-to-date knowledge of marketed goods and processes; but it was purely as a duty that the journey was undertaken. Since Mr. Greville Montgomery has organised the show at Olympia, the duty of attendance has become a real pleasure. Environment and district have not a little influence in the change of sentiment; Kensington against Islington, for north is north, and west is west, "and never the twain shall meet." But the character of the display is a more powerful influence still. One outstanding feature is, that all the exhibitors may be regarded as having some association with building; and, again, there are no extraneous attractions, with the exception of good music. The Government shows its sense of the value of the exhibition by having representative departments there; there is the Empire Marketing Board, the name being self-explanatory; and at this stall are to be seen several interesting tests results upon timber beams carried out by the Forest Products Research Laboratory. The Department of Scientific and Industrial Research supplies information as to the work carried on at the Building Research Station near Watford, to which reference was made lately in our columns. As the majority of people are interested in building in one form or another, the attendances at Olympia are naturally large; the goods are attractively displayed, and inquiries are dealt with intelligently. The work of various arts and crafts training institutes forms a feature, and there is also an admirable loan collection of antique and modern furniture, the latter from the designs of well-known architects and others. Altogether, there are close upon four hundred exhibitors.

THE trans-Atlantic flight from east to west by a heavier-than-air machine has at last been accomplished. Capt. Hermann Köhl, Commandant James Fitzmaurice, and Baron von Hünefeld started from Baldonnel aerodrome, near Dublin, in the *Bremen*, early in the morning of April 12, and landed at Greenly Island in the Strait of Belle Isle on the following day. Capt. Köhl, manager of the night-flying department of the Deutsche Lufthansa, and Baron von Hünefeld, with a mechanic, flew from Berlin to Dublin on Mar. 26, where they had to await favourable weather conditions for their Atlantic flight. The mechanic was replaced by Commandant Fitzmaurice, acting officer in command of the Irish Free State Air Service, who acted as second pilot when the flight began on April 12. The *Bremen* is a Junker metal monoplane fitted with a 200 k.w. Junker engine. A rough analysis gives aeroplane weight as 1·2 tonnes; crew, etc., 0·2 tonne; fuel and oil 1·6 tonnes, giving 40 hours' flight at cruising speed 150 km./hr., that is, a range of 6000 km. in calm air. The actual geographical distance covered was about 3500 k.m., so that changes in course and head winds reduced the effective speed to about 90 k.m./hr. Herein lies the patent secret of previous failures. A small circle of about 3500 km. with Dublin as centre grazes the North American coast at Greenly Island, the landing point, from which we may infer that another disaster was averted by a sound decision, good navigation, and the last litre of fuel. Capt. Köhl and Baron von Hünefeld attempted a trans-Atlantic flight from east to west last August, but, after making their way from Dessau across England and Ireland, they were forced to turn back by bad weather and lack of fuel.

A PRELIMINARY notice of the International Meeting of Geologists to be held in Copenhagen on June 25–28, on the occasion of the fortieth anniversary of the Geological Survey of Denmark, has already appeared (NATURE, Dec. 17, 1927, p. 890). The provisional programme of excursions has now been revised. Excursions before the meeting are as follows: June 17–20, to Bornholm; June 21–24, to South Sjælland and the Island of Möen. After the meeting a longer excursion, June 29–July 9, is being organised to north-west Sjælland, Fyn and the Island of Langeland, and Jutland. Geologists who are returning to England or France from Esbjerg will have an opportunity of seeing the Yoldia clay of the Mindel-Riss interglacial episode. The number of participants in each excursion is to be limited, and notice of intention to attend should be sent as soon as possible, and in any case before May 1. Full details of cost, itineraries, and accommodation will be found in the second invitation circular, which can be obtained from the Secretary, International Geological Meeting, Danmarks Geologiske Undersögelse, Gammelmönt 14, Copenhagen K, to whom all other relevant inquiries should be addressed.

MARSTON TAYLOR BOGERT, senior professor of organic chemistry at the Columbia University, New York, who celebrated his sixtieth birthday on April 18, spent the past winter in Prague as the first visiting professor for international relations to Czechoslovakia sent by the Carnegie Endowment for International Peace. As the guest of the Charles' University he delivered five highly interesting lectures on his original researches on thiazoles and selenazoles; odour and chemical constitution; science and industry; science, the individual, and the State; science in the interest of peace. He also gave similar lectures at the Universities in Brno, Moravia, and Bratislava, Slovakia. The Charles' University Medal has been awarded to Prof. Bogert for his work for the advancement of science, and the honorary degree of Doctor Rerum Naturalium of the Charles' University has been conferred upon him for his discoveries and researches in organic and applied chemistry.

PROF. YUKICHI OSAKA has recently retired from the chair of physical chemistry which he has held for twenty-three years at the Kyoto Imperial University. An account of his career by S. Horiba, with a photograph, is given in the *Bulletin of the Chemical Society of Japan* for January. Prof. Osaka came to Europe in 1899, having already had some experience of teaching chemistry, and studied under Ostwald and Nernst. Four years later he was appointed to the chair of applied electrochemistry at Kyoto, but very soon became professor of physical chemistry. He is best known for his work upon heterogeneous equilibria, although he has also conducted researches upon the catalytic effect of the hydroxyl ion and upon overvoltage. Prof. Osaka is sixty years of age, and his latest paper also appears in the above journal.

DR. ROY CHAPMAN ANDREWS, after maintaining the headquarters of the Expedition of the American Museum of Natural History to Central Mongolia immobile at Peking for a period of two years owing to political troubles in China, has now left Kalgan to resume work in the desert. According to the Peking correspondent of the *Times* in a dispatch in the issue of April 17, he hopes to ensure the safety of the expedition by a capital payment to the Chief Officer of the brigands of the area, a monthly subsidy, and a sum equal to the first capital payment if the expedition returns safely. The expedition consists of ten Americans, experts in palæontology, geology, archæology, and topography, and a surgeon, a photographer, and two motor experts, with twenty-six Mongols and Chinese. The expedition will continue its search for traces of earliest man, and in addition of the five-toed horse, believed to be the progenitor of the four-toed fossil horse of Europe and America.

As promised, the results of Prof. Trombetti's researches in the Etruscan language, following his investigation of the "Liber Linteus," the linen book, in which the mummy of an Etruscan lady, discovered in Egypt and now at Agram, had been wrapped, were duly laid before the first International Congress of Linguists which opened at The Hague on April 10. Prof. Trombetti gave it as his opinion that Etruscan could not be regarded as an isolated language, but showed close relation to the Indo-European and belonged to the group in which the pre-Hellenic languages of Asia Minor were to be found. Of the twelve chapters of the "Liber Linteus," one was said to bear every indication of being an account of the *lectisternium*, *i.e.* the meal provided for the images of various gods, while others contained a litany, an enumeration of the *Cepen* or magistrates, and a calendar giving the dates of various festivals.

WE learn from a *Daily Science News Bulletin*, issued by Science Service of Washington, that F. W. Peek has been able to store in a suitable condenser and discharge electricity at a pressure of three million six hundred thousand volts. The experiments were carried out at the Pittsfield laboratory of the General Electric Company. The object of the research was to imitate as closely as possible the phenomena that happen during a lightning discharge from a cloud, so as to help in designing effective lightning conductors and safety devices. Although the spark lasted less than a millionth of a second, yet its growth and decay were accurately measured by a cathode ray oscillograph, which uses a beam of electrons for a pointer. In some cases the flash lasted only the ten-millionth of a second. Remembering that light travels with a velocity of 3×10^{10} cm. per second, the flash will be over by the time the light has travelled a hundred feet from the spark.

THE following appointments have been made by the Secretary of State for the Colonies: Mr. S. Gillett to be assistant agricultural officer, Kenya; Mr. W. H. W. Baird, to be entomologist, Veterinary Department, Tanganyika Territory; Dr. R. R. Le Geyt Worsley, formerly sub-director of the Chemical Section, Egypt, to be chemist, East African Agricultural Research Institute, Tanganyika Territory;

Mr. J. G. Brash and Mr. J. C. Bytheway, to be produce inspectors, Nigeria. Recent transfers and promotions made by the Secretary of State include: Mr. R. A. Altson, formerly assistant botanist and mycologist, British Guiana, to be assistant mycologist, Department of Agriculture, Federated Malay States and Straits Settlements; Mr. J. T. Templer, formerly administrative cadet, Tanganyika Territory, to be assistant conservator of Forests, Uganda. Mr. Baird's appointment is of interest in that it appears to be the first appointment, on a permanent basis, of an entomologist to a veterinary department in the Colonial Services.

Farmers' and farm workers' associations and clubs, chambers of agriculture and horticulture, students' societies, and other bodies interested in agriculture or market gardening are again being invited to inspect the Rothamsted and Woburn Experimental Plots during the coming summer. Mr. H. V. Garner and Capt. E. H. Gregory will be available to demonstrate the plots at any time. At Rothamsted the soil is heavy. The experiments deal with the manuring of arable crops, especially sugar beet, potatoes, mangolds, barley, oats, wheat; manuring of meadow hay; effect of modern slags and mineral phosphates on grazing land and hay land; inoculation of lucerne; crop diseases and pests; new experiments are in progress on the laying down of land to grass; demonstrations of modern implements, tractors, and good types of tillages. At Woburn the soil is light. The experiments there are concerned more particularly with the manuring of potatoes, sugar beet, wheat, malting barley, and the use of green manures. All communications and requests to visit the Stations should be addressed to the Secretary, Rothamsted Experimental Station, Harpenden.

The Faraday Medal of the Institution of Electrical Engineers will be presented to Prof. J. A. Fleming at the ordinary meeting of the Institution to be held on Thursday, April 19, at 6 p.m. The presentation will precede the nineteenth Kelvin Lecture, by Sir Oliver Lodge, on "The Revolution in Physics."

A violent earthquake was recorded at Kew Observatory on April 16 at 9 h. 4 min. 32 sec. G.M.T. The epicentre is estimated to be 1430 miles away, probably near the western coast of the Black Sea. The disturbance at Kew was of about the same intensity as that produced by the destructive earthquake which occurred near Smyrna on Mar. 31.

The Council of the Institution of Automobile Engineers has awarded the Institution Medal to Major G. S. Wilkinson for the prominent part taken by him in the design of the Napier Lion 875 h.p. engine fitted to the Supermarine-Napier S5 with which Flight-Lieutenant S. N. Webster won the Schneider Trophy Race in September last.

It will be remembered that at an extraordinary meeting of the general committee of the British Association held on Dec. 2, it was resolved to apply for a Royal Charter for the Association. Mr. A. A. Campbell Swinton very generously offered to bear the cost of obtaining the Charter. It is now announced that His Majesty the King in Council has been pleased to grant the petition of the British Association.

The recently issued catalogue of Judex Analytical Reagents and Laboratory Chemicals, issued by the General Chemical and Pharmaceutical Co., Ltd., Willesden, includes a wide range of inorganic and organic chemicals. Among them are analytical reagents of guaranteed purity, standard solutions for volumetric analysis, special reagents for use in the analysis of water, gas, milk, sugar, urine, iron and steel, volumetric solutions of the "British Pharmacopœia," indicators, chemicals for electroplating, accumulator acid, etc. Besides supplying rare chemicals for research and analysis, the firm undertakes the manufacture of large or small amounts of unusual substances required for special purposes.

The "Statistical Report of the Health of the Navy for the Year 1925" and the "Report on the Health of the Army for the Year 1926" have recently been issued by the Admiralty and the War Office respectively (London: H.M. Stationery Office). As regards the Navy, the returns for the total force for the year show a decrease in the incidence of disease as compared with the previous four years' average and with 1924. In the Army, the incidence of sickness was a trifle higher than in 1925. The incidence of tonsillitis again increased, and as a cause of admission to hospital took second place; all attempts to elucidate the cause of this high incidence have so far failed. Middle ear disease, as in the previous year, heads the list of causes of invaliding.

Historical details given in a catalogue issued by Messrs. W. Ottway and Co., Ltd., manufacturers of optical and scientific instruments, Orion Works, Ealing, W.5, show that the foundations of the business were laid about three hundred years ago. In 1640, the shop at the Royal Exchange occupied by Thomas Francis Ottway, a maker of instruments of a scientific nature, was destroyed by the fire which devastated central London. The business was afterwards carried on at various addresses until 1900, when the present works at Ealing were opened. The firm is still owned and managed by descendants of the original founder, and their works are now so well equipped as to enable the company to manufacture all the various parts required for the instruments produced by them. These include equatorial mountings for reflecting and for refracting telescopes; astronomical transits; astronomical clocks and chronographs; cœlostats with driving clocks and with mirrors up to 18 inches in diameter; control instruments for controlling electrically the driving clocks of astronomical instruments; and a wide range of astronomical telescopes with object glasses up to 5 inches aperture. The instruments mentioned are fully described and illustrated in the catalogue, which contains also a list of various types of naval, military, and sporting telescopes. Achromatic objec-

glasses up to 6 inches clear aperture and 90 inches focal length, heliographs, prismatic compasses, and prismatic binoculars are also included.

THE 1928 edition of "British Spas and Climatic Health Resorts" has recently been published (London: J. and A. Churchill. 1s.). It gives much information concerning the choice of waters and climates and on British and Irish marine and inland health resorts. Lists of the residential accommodation available in the principal resorts are furnished.

IN connexion with the tercentenary of the publication of Harvey's "De Motu Cordis," the Cambridge University Press will issue a limited edition of "A Bibliography of the Works of William Harvey," compiled by Mr. Geoffrey Keynes. The work will be illustrated by a number of collotypes and facsimiles in line. The same house also announces "The Theory of Probability," which Prof. W. Burnside had almost completed at the time of his death. The volume has been seen through the press by Dr. A. R. Forsyth, and includes the memoir of the author which Dr. Forsyth wrote for the Royal Society.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant part-time lecturer in the biology department of the Plymouth and Devonport Technical College—The Secretary for Education, Education Office, Cobourg Street, Plymouth (April 28). A district agricultural organiser under the Essex Agricultural Committee (on the Staff of the East Anglian Institute of Agriculture)—The Clerk of the Essex County Council, Shire Hall, Chelmsford (April 30). Professorships of geography, medieval history, Egyptian and Oriental history prior to Græco-Roman times, classics and Græco-Roman history, in the Egyptian University, Cairo—The Director, Egyptian Educational Office, 39 Victoria Street, S.W.1 (April 30). A professor of botany in the Egyptian University, Cairo—The Dean of the Faculty of Science, Egyptian University, Cairo (April 30). A junior assistant (engineer) at the Building Research Station, Watford—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (April 30). A government analyst and bacteriologist for Cyprus—The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, Whitehall, S.W.1 (May 7). A lecturer in physics in the University of Western Australia—The Agent-General for Western Australia, Savoy House, 115 Strand, W.C.2 (May 9). Head of the architectural, building and surveying department of the Northern Polytechnic—The Clerk to the Governors, Northern Polytechnic, Holloway, N.7 (May 11). A temporary agricultural entomologist in Fiji and, possibly, afterwards in the British Solomon Islands Protectorate—The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, Whitehall, S.W.1 (May 21). An assistant professor in the department of mathematics of the Imperial College of Science and Technology—The Secretary, Imperial College of Science and Technology, South Kensington, S.W.7 (May 25). A curator of the Gloucester Museum—Mr. St. Clair Baddeley, Castle Hale, Painswick, Gloucestershire.

Our Astronomical Column.

NOVA PICTORIS.—Another telegram from Mr. Wood at Johannesburg was distributed from the I.A.U. Bureau, Copenhagen, on April 14. It states that the Nova is now surrounded by a ring 3 minutes of arc in diameter, with two smaller rings inside it. These rings are clearly much too large to be produced by the outward motion of matter from the Nova since the outburst in 1925. We may assume that they are similar to the nebulosity photographed round Nova Persei in the autumn of 1901, which was explained by the hypothesis that the nebulosity was previously there in a dark state, and became visible by reflecting the light of the outburst.

Pop. Astron. for April states that the magnitude of the Nova in mid-December last was 6·77. As it is falling at the rate of a magnitude per annum, it is probably a little fainter than mag. 7 at present. Several of the daily papers erroneously gave its present magnitude as about 11.

COMETS.—M. Mineur obtained an observation at Paris on Mar. 28 of the comet detected on Mar. 17 by M. Giacobini; the following are the two positions:

	R.A.	N. Decl.	Mag.
Mar. 17. 9264 .	$5^h\ 50^m\ 0^s$	14° 35′ ″	11
28. 9585 .	6 12 26·5	14 57 39	10½

The daily motion on Mar. 28 was given as $+3\frac{1}{4}$ min in R.A., 0′ in decl. The position on April 21 may be about 8^h in R.A., 14° in decl.

Dr. C. P. Olivier states in *Pop. Ast.* for April that the comet Pons Winnecke yielded a rich shower of meteors on June 23 last. Meteors were fairly numerous on June 26-29.

APRIL SHOWER OF METEORS.—These meteors may be expected on April 21, and should attain a maximum either in the morning or evening of that date. Moonlight will not interfere with the display should it actively return this year. The shower is no doubt a periodical one, but the exact period, or that of the supposed associated comet 1861 I, is not known. Apparently the earliest exhibition of the meteors occurred in 687 B.C., and later returns possibly occurred in 15 B.C. and A.D. 582, but identity may not be absolutely certain though the dates conform within small limits.

April is one of the spring months when meteors are generally rare, so that, should the Lyrids fail to present themselves, meteoric apparitions are somewhat scarce, and long vigils are not suitably rewarded. But the special Lyrid shower may develop unusual strength at any time and amply repay observation. The sky should be attentively watched every year at the end of the third week in April, for evidence as to the character of the shower's return cannot fail to add to our knowledge.

On April 21, before daylight, the radiant will be very high and favourably placed for the visibility of its meteors, but the evening hours between 10 and 12 are indicated as the most probable time for the earth's passage through the denser part of the stream. At the latter time the radiant is in the north-east and not very high. Observations of the paths of any bright meteors that may appear will be valuable, whether they belong to the system of Lyrids or to one of the minor displays of this epoch.

Research Items.

Lubaantun.—In vol. 57 (1927), Pt. 2, of the *Journal of the Royal Anthropological Institute*, Mr. T. A. Joyce, with the assistance of notes contributed by Mr. Cooper Clark and Mr. J. E. Thompson, reports on the excavations which he conducted on behalf of the British Museum on the Lubaantun site in British Honduras in 1927. The excavation of the megalithic hill-terraces, discovered in the previous year, was continued. It is now confirmed that these terraces were constructed before the two large pyramids, and probably constitute the earliest phase of architecture on the site. Excavations to the north of Mound *S*, as it is now known, in search of a continuation of the megalithic hill-terraces, while unsuccessful in finding them, produced clear indication of five architectural periods. The earliest phase of building laid bare at this point consisted of a stairway which ran under the mound. It was approached by an inclined stucco flooring. Behind the stairway was a wall built against the hill-side, which may be earlier than the steps, or may have been built as a containing wall to enable them to be constructed. Examination of the exposed surface of the whole pyramid suggested to Mr. Thompson that the remarkable in-and-out style of architecture may have been the result of disintegration rather than an artificial and conscious product; but Mr. Joyce is not inclined to agree, especially as this style occurs only in the Lubaantun area and not elsewhere as might be expected if it were the result of disintegration. Mounds *D*, *F*, and *G* were also excavated and produced a considerable number of relics. A platform in mound *G* would appear to have carried a wooden structure which was destroyed by fire. The floor was covered with three feet of burnt clay mixed with wood ash. Old Empire pottery of excellent style precluded any possibility that the structure dated from a re-occupation of the site.

Vitamin Concentrates for Margarine.—It is generally conceded that the average consumption of fat in Great Britain is below the optimum, and also that a proportion, sometimes the major part, of that consumed is in the form of vegetable fat (or margarine). Now, although an animal fat can be replaced in the diet by isodynamic amounts of carbohydrate, protein or vegetable fat, so far as the supply of energy to the body is concerned, yet none of these other foodstuffs can supply the fat soluble vitamins A and D, which are present in varying degree in the different animal fats. The importance of these vitamins for the maintenance of general health and wellbeing and the prevention of certain diseases need scarcely be emphasised at the present time. The drawback to an increased consumption of animal fat is the cost of such products, hence a more practicable alternative would seem to be the enrichment of vegetable margarines with a source of the fat soluble vitamins. Messrs. Planters Foods Ltd., Brombro Port, Cheshire, have recently put on the market several brands of vitamin margarine: each contains a sufficiency of their vitamin concentrate 'Essogen' to bring the potency of the margarine up to that of the best summer butter. The potency of the products is controlled by experimental feeding tests. The addition of the concentrate has no deleterious effect upon the taste or palatability of the margarines.

Body Defence against Pathogenic Organisms.—Di Cristina's views on the processes by means of which the animal organism defends itself against infection is the subject of a communication by Caronia in the *Atti della Pontificia Accademia delle Scienze* for 1927. The results of more than ten years' work in the vaccine therapy of infectious diseases have led di Cristina to the conclusion that Ehrlich's original conception of immunity, according to which the defensive mechanism of the organism is based on the struggle between antigens and anti-body, neither corresponds with the facts nor explains the processes of cure. The infected organism is highly sensitive to the protein homologous to the pathogenic germ and remains so until the infection becomes extinguished naturally. Thus a direct relationship exists between the condition of hypersensitisation and the disease, and this stands out the more clearly as the special property acquired by the organism to withstand the action of the bacterial protein is the more marked. Cure occurs gradually as the organism becomes desensitised. The desensitisation, which takes place naturally in the case of spontaneous cure, is best effected artificially by the intravenous or subcutaneous administration of small doses of protein derived from the corresponding pathogenic agent. The antigen thus introduced leads, by true anaphylactic reactions, to complete desensitisation in a period varying with the method employed. The actual mechanism of this process is still obscure, but probably depends on phenomena originating at the expense of the equilibrium of the colloids of the tissues, new conditions, which prevent further development of the pathogenic action of the germs, being thus determined.

Microbiological Observations at Novaya Zemlya.—A. F. Kazansky, who is microbiologist of the Russian Academy of Science, according to the *Information Bulletin* of the Academy, has recently returned from an expedition to Novaya Zemlya, where he studied the microflora during the winter and summer of 1927. Microflora of the air proved to be remarkably poor, especially in winter, when Petri dishes with media remained sterile after long exposures; only in a few cases were micro-organisms found when the dishes were exposed near to habitations. In summer some micro-organisms were observed more regularly, up to 13 in one dish, but on the average only 1-3, while many dishes remained sterile even after exposures for an hour. Sterilised meat exposed for eight months, from February to September, remained fresh, though microscopic analysis revealed the presence of some micro-organisms. Analysis of snow gave in most cases negative results, but during summer the number of bacteria in snow was greater than in the air. Study of the soil microflora revealed the presence of atmospheric nitrogen fixing bacteria, nitrifying and denitrifying bacteria, and bacteria causing aerobic decomposition of cellulose. More detailed studies of the organisms found will be continued in the Academy laboratories in Leningrad.

Mouth-Parts of a Blood-sucking Midge.—In the *Bulletin of Entomological Research*, vol. 18, Feb. 1928, Mr. B. Jobling provides an illustrated account of the structure of the head and mouth-parts of the common blood-sucking midge *Culicoides pulicaris* L. Among various features described in this detailed study it is noteworthy that, unlike many blood-sucking flies, mandibles are present in both sexes, although weakly developed in the males. The labrum-epipharynx, hypopharynx, and mandibles form together a piercing organ which is driven into the skin of the person or animal attacked. The

galeæ of the maxillæ are blade-like, with numerous fine teeth distally, but being only partially chitinised they evidently perform merely an accessory function in piercing. The labium plays no part in the process, but serves to maintain the other organs in position. The author follows Frey, Crampton, and others in regarding the labella as the modified labial palps. The intense irritation caused by the punctures of these minute flies is alleviated if the lesion be moistened and rubbed with a crystal of sodium carbonate. The author states that with this application it ceases in a few seconds and does not recur.

Lake Michigan Plankton.—Mr. Samuel Eddy ("The Plankton of Lake Michigan," State of Illinois Department of Registration and Education. Division of the Natural History Survey. Bulletin, vol. 17, art. 4, 1927) bases his account of the plankton from the inshore waters of Lake Michigan on two collections taken respectively in 1887–88 from November to October, and in 1926–27 in October, May, and July. These were worked out qualitatively, and in the later collection also quantitatively, the chief purposes being to present a general picture of the plankton of Lake Michigan, to determine the relative abundance of the constituent organisms and to incorporate and summarise the facts now known relating to the plankton of the Great Lakes. The physical conditions in Lake Michigan vary little from year to year, and variation among the plankton organisms is slight. A comparison of the two collections shows little change in the plankton over the period of forty years, the only notable exception being the copepod *Epischura lacustris* Forbes, which was abundant in the early collection but absent altogether later. This may be due to larger nets being used, as more of the larger and less of the smaller plankton animals were present in the earlier collection generally. The seasonal changes are slight, but in 1887–88 the animal plankton decreased in the cold weather and was almost entirely absent from December to March. The plankton is characteristic of a large and deep lake. The chief constituents are diatoms; especially Asterionella, Striatella, and Fragilaria. There are a few Cyanophyceæ and Chlorophyceæ, only two peridinians, and the metazoa are represented by Hydra, nematodes, rotifers, Cladocera, and copepods.

Survey in the Gold Coast Colony and Protectorate.—The *Report* of the Survey Department for 1926–27 records that nearly two-thirds of the total area, including the mandated territories on the east, have now been surveyed. The parts that remain to be surveyed are mainly in the north-east of Ashanti, the west of the Northern Territories, and the mandated territories which were formerly part of Togoland. The total number of one-inch sheets printed is eighty-two, and of half-inch sheets twenty. In recent years the department has had not only its own school of instruction for native surveyors but also its own printing establishment. It is of interest to note that during the season when the harmattan blows, which is chiefly in January, all colour printing has to cease. This dry wind following rapidly on humid conditions causes a change in the area of the paper of as much as a quarter of an inch in a sheet two feet square, making it impossible to secure registration. The department has also produced a wall map of the Colony for the use of schools. The *Report* contains indices of the published sheets.

The Lancashire Coalfield.—Another addition has been made to the valuable series which is being gradually issued by the Fuel Research Division of the Department of Scientific and Industrial Research (*Physical and Chemical Survey of the National Coal Resources*, No. 10, The Lancashire Coalfield, The Wigan Four-Feet Seam. London: H.M. Stationery Office). It contains a complete description of the character and composition of the important seam known as the Wigan Four-Feet Seam, as well as by a number of other names which appear to be variations of the words 'Ell Hole.' It occurs throughout the South Lancashire Coalfield, its thickness increasing with considerable regularity from about 2 ft. in the eastern portion of the Coalfield to a maximum of 6 ft. 3 in. at Garswood, and getting slightly thinner from this point towards the St. Helen's district. Analyses and laboratory tests show that the coal is of good quality with an ash which is generally low, averaging between 3 and 4 per cent., though occasionally going up to nearly 10 per cent.; volatile matter averages about 40 per cent., and the coal is accordingly used chiefly as a house coal or a gas coal, though its high coking qualities fit it for the manufacture of coke. The report records a complete series of laboratory tests including full analyses, carbonisation assays, investigation of the melting point of the ash, of the caking index, and washing tests, the latter showing that the coal is quite suitable for further cleaning. The report gives evidence of much careful and painstaking work, and there are numerous illustrations; it may be doubted whether the plates showing the cokes produced in the assays are worth the cost involved in their reproduction, and it is also to be regretted that more distinctive colours have not been employed in the map of the Coalfield affixed to the report.

Artificial Disintegration of Elements.—In the issue of *Die Naturwissenschaften* of Mar. 23, W. Bothe and H. Fränz have given a short report of some experiments made by them at Berlin, by which they have attempted to decide whether or not the claims of the Viennese school to have effected an extensive disintegration of atomic nuclei by bombardment with α-particles can be substantiated. The source of α-particles employed was a strong preparation of polonium, and since this emits scarcely any β-rays or γ-rays a Geiger electrical counter could be used as a recording instrument in place of a zinc sulphide screen. On the whole, the results obtained confirm the work of Sir Ernest Rutherford and Dr. J. Chadwick. Less than ten per cent. of the retrograde particles from beryllium, carbon, aluminium, and iron recorded at Vienna could be detected, whilst in the forward direction about one H-particle of range greater than 10 cm. in air was found with aluminium and iron, and about ten from paracyanogen ahd boron, in each case per million α-particles. Boron seems to give two sets of protons, which it is suggested may come from its two isotopic components. It is pointed out that it has not yet been shown that flashes due to β-particles are not detectable with the powerful microscopes now used for viewing scintillations, and that if these are present they will be confused with flashes due to protons, which will thus appear to be present in unduly large numbers.

X-ray Kinematography.—The *Chemiker-Zeitung* for Mar. 24 contains a brief description of a new process evolved by Dr. Gottheiner, the Röntgen-ray expert of Berlin, by means of which kinematograph films can be made of objects illuminated by Röntgen-rays. The extreme shortness of the wave-lengths of these rays has hitherto been an insuperable barrier, since they do not converge when passed through lenses of glass or quartz. Thus it has been impossible to obtain reduced images except by re-photographing

life-sized negatives. But by means of suitable screens it is possible to convert these non-converging rays into simple light rays, which can be photographed in the ordinary way on kinematograph films. Dr. Gottheiner has devised screens which give sufficient intensity for the purpose. The process should be extremely valuable in the diagnosis of diseases.

Long-Distance Telephony in Europe.—At the 'Volta' conference of telegraphists and telephonists, held at Como last September, P. E. Erikson read an interesting paper on long-distance telephony in Europe. In a few years the principal countries in Europe have developed rapidly and methodically methods of communication through underground cables. These now form the main highways of speech. The various countries have all made provision for international circuits. In many cases special mains have been included in the international circuits for the relaying of broadcasting programmes. These additional mains can advantageously be used during the hours when the ordinary traffic is light. They also enable small broadcasting centres to obtain excellent programmes of high artistic merit at a small cost. The cable between Plymouth and Glasgow, a distance of 554 miles, in the longest in Great Britain. There is now a regular service between England, Berlin, and Stockholm. The Paris to Strasbourg cable is destined to play a very important rôle in the future, as it will connect France with central and southern Europe. Paris and Berlin are linked by a cable about 770 miles long, which employs no less than fourteen repeaters. The Berlin-London cable, which was opened in 1926, is the longest through cable (858 miles) in Europe. It is interesting to learn that the London to Glasgow circuit contains some specially loaded cables which are part of the London to New York trans-Atlantic telephone circuit. The thermionic valve repeater has enabled small gauge conductors to be used for long-distance use. Thus many of these circuits are carried within the cable sheath. In addition, the number of communication circuits is appreciably increased by utilising certain of the circuits so as to form 'phantom' circuits. These circuits were first used in the London to Liverpool cable in 1913. To illustrate how rapidly long-distance telephony has advanced, it has been calculated that the total length of 'cable-pairs' in Europe alone would circle the globe sixty-eight times.

Variations of Radio Broadcast Signals.—Broadcast listeners who are situated between 100 and 150 miles from an emitting station notice that nocturnal variations of signal intensity frequently occur. If a galvanometer instead of a telephone be used, small variations in signal intensity at much shorter distances can be detected. In a paper on signal fading, read to the Institution of Electrical Engineers on April 4 by E. V. Appleton, it is shown by analysing the results obtained at the Peterborough radio research station that the phenomenon of fading is in accordance with the Kennelly-Heaviside layer theory. There are two sets of waves falling on the receiver. One of these is the ground wave and the other is reflected from the ionised layer. During a normal night the height of this layer may vary from 56 to 81 miles. On some nights in winter, however, heights varying from 155 to 217 miles were observed during the three hours before dawn. The author also gives an account of observations taken during the solar eclipse in June 1927. The results prove that the eclipse had a very definite effect on the properties of the ionised layer, which deflected the waves back to the ground. A very striking effect was the large increase in the intensity of the downcoming ray. This effect is ascribed to the increase in height of the deflecting layer and partly also to the rapid removal of the ionisation in the lower layers of the atmosphere consequent on the removal of the solar ionising agents. Another striking feature of the observations was the short time the eclipse effect lasted. The period varied between 20 and 50 minutes at the different stations, while the total time taken for the moon's shadow to pass across the earth was nearly two hours. This means that quite an appreciable fraction of the sun's radiation may be cut off before the effect can be detected by radio methods. The morning after the eclipse happened to be quite exceptional, as night-time conditions persisted for a long time after sunrise. The formulæ given in the paper will be a help to radio engineers.

A New Antiseptic Solution.—A new antiseptic solution has been introduced by Messrs. The British Drug Houses Ltd., London, in the form of "Caprokol, antiseptic solution, S.T.37." It is stated that 'Caprokol' lowers the surface tension of liquids in which it is dissolved: this results in increased penetration into the fissures of a surface, especially when the latter is greasy, increased adsorption on to the surface of suspended insoluble material, for example micro-organisms, and an increased rate of diffusion. Hence the antiseptic becomes concentrated round the cell wall of the organism and then penetrates with ease into the cell. 'Caprokol' solution is a solution of 'caprokol' in glycerin and water: its surface tension is 37 dynes per square centimetre, as compared with 77 dynes for water. The carbolic acid coefficient of 'caprokol' is 72: in spite of its strong disinfectant power it is nontoxic. The solution is also non-irritating, odourless, colourless, stainless, and non-corrosive: it is recommended for the disinfection of wounds or tissue surfaces, and for use in the mouth, nose, or throat, or for urethral and pelvic lavage. It is supplied in 3-oz. and 12-oz. bottles.

The Photochemical Decomposition of Nitrous and Nitric Oxides.—The *Journal of the Chemical Society* for January contains a paper by J. Y. Macdonald describing the results of an investigation of the decomposition of nitrous and nitric oxides by light of wave-length 1860-1990 A. The source of radiation was a condensed spark between aluminium electrodes, and a parallel beam was obtained by using a fluorite lens. Nitrous oxide was found to decompose according to the equation $4N_2O = 2NO + O_2 + 3N_2$, nitrogen peroxide being formed afterwards by the interaction of the nitric oxide and oxygen. The quantum efficiency, that is, the number of molecules decomposed per quantum of radiation absorbed, is 3·9, and appears to be independent of temperature, although the amount of light absorbed, and hence the rate of reaction, varies with temperature. The following mechanism for the reaction is suggested and discussed (N_2O' is an activated molecule):

$$N_2O + h\nu = N_2O'$$
$$N_2O' + N_2O = O_2 + N_2 + 2N$$
$$2(N + N_2O = NO + N_2).$$

In the case of nitric oxide, the quantum efficiency is much lower, about 0·75, and the absorption coefficient is less than that of nitrous oxide. The decomposition appears to take place in two ways according to the equations:

$$2NO = N_2 + O_2$$
$$3NO = N_2O + NO_2,$$

about 90 per cent. of the nitric oxide being decomposed in the first way. Beer's law for the absorption of light holds for both the oxides.

Commercial Shark Fishing.

AN interesting article on a commercial net-fishery for sharks at Port Stephens appears in the *Australian Museum Magazine* (vol. 3, No. 5, Jan.-March 1928). The nets used, each twenty feet in depth, are constructed of forty-two or sixty thread cotton, and are of twelve, sixteen, and twenty inch mesh (six, eight, and ten inch squares). The 'head-line' of the net is buoyed with glass floats, five inches in diameter, every eight feet. The 'ground-rope' is weighted with four-ounce leads every three feet. The nets are set loosely between pairs of buoys and lie vertically on the bottom. They are hauled daily at dawn. Entangled sharks are despatched by heavy blows on the back of the head, or by a revolver bullet through the brain after being initially secured by a large hook thrust through the jaws.

The commercially valuable sharks in their order of prevalence are the whaler (*Carcharhinus macrurus*), grey nurse (*Carcharias arenarius*), tiger shark (*Galeocerdo arcticus*), and white shark (*Carcharodon carcharias*). The largest specimens of these species so far captured vary from 8 ft. to 13 ft. in length and from 370 lb. to 1000 lb. in weight. Species of smaller sharks are actually the more prevalent but are at present discarded.

The daily catches are conveyed to the depot at Pindimar, where cutting up at once begins. First, the fins are removed; these are cut off close to the body and then dried in the sun or in patent hydrators. They are exported to the East for conversion into soup or gelatine. Next the skin in stripped from the carcase. The detached hide is placed on a beaming board, a curved upright iron stand, and the adhering flesh trimmed off with a sharp knife. After trimming is complete, the hide is thoroughly washed with salt water and placed in brine for from twenty-four hours to a week, after which it is stored ready for shipment to the tanners. If the leather is required for other than ornamental purposes, the shagreen must be removed before or during tanning. This is usually accomplished by treatment with hydrochloric acid and salt. Shark leather is very durable and makes an excellent shoe leather. Shark skins with the shagreen left *in situ* are being preserved for ornamental purposes, such as coverings for caskets, trinket boxes, and toilet sets. They may be dyed very beautiful colours. The flesh of the shark is cut into strips a foot long; these are soaked in brine and then hung in dehydrators. When dried it is ready for shipment to the Malay States or Africa, where there is a considerable demand for dried shark flesh for food.

When the hide is being stripped, the abdominal contents are exposed, the most conspicuous feature being the liver. Shark livers are rich in oil, which is extracted in a steam-jacketed kettle of fifty gallons capacity. The best oil producer so far treated is the tiger shark. A thirteen-foot tiger shark yielded eighteen gallons of oil, or at the rate of forty gallons to the ton of shark. Shark liver oil is used for the currying of leather, the tempering of steel, and in soap-making. If extracted from perfectly fresh livers it will probably be used for medical purposes, for it is rich in vitamins A and D.

The brief experience of the Port Stephens Company appears to indicate that catches of sharks are likely to be irregular, at least during some periods of the year. Careful consideration must therefore be given, before embarking on such an industry, to the question whether the profits which accrue from an intensive fishery will compensate for intervening slack periods. Solution of some of the difficulties may be found in the establishment of a depot vessel capable of treating the sharks on board, the catches being supplied by small shark boats fishing in the vicinity. Then, should the shark give out temporarily in one district, the vessel could proceed to other grounds and, if the catches proved to be good, remain there until the depletion of the supply necessitated a further change of ground.

Malay Resins and the Trade.

AN interesting paper, and one of some value on Malayan varnish resins, was recently read before the Royal Society of Arts by Mr. Hedley Barry (*Jour. Roy. Soc. Arts*, Dec. 16), who has carried out considerable investigations into Empire resins. During the past three years the author has been more intimately concerned with the group of Malayan resins. The paper deals with the Malayan varnish resins, with special reference to the work of the Forestry Department of the Federated Malay States and Straits Settlements in the development of the damar industry in the Malay Peninsula.

The Forestry Department, said Mr. Barry, has indeed undertaken a task which all those who have to deal with resins will agree is of the utmost importance. It is endeavouring to supply definite standard grades of the resins found in the forests, the botanical origin of which shall be known, and their freedom from adulteration guaranteed by the Department. This is indeed an ambitious scheme and one of which chemists in particular will cordially approve. The author alludes to some of the difficulties which the Forestry Department—and the remarks are applicable to other Forestry Departments of the British Empire—has to face in carrying out the aims and objects its work entails. In Malaya the rapid development of the tin and rubber industries has been achieved at the expense of an enormous destruction of timber, which is estimated to be of the order of 75,000,000 tons in the last twenty years. At the present time Malaya uses about 5,500,000 tons of timber, of which it produces only about 5,250,000 tons. To produce this amount it is necessary, according to the author, to maintain about 25 per cent. of the country under forest. At present the Forestry Department controls about 19 per cent. of the area, but much of this is not productive land. Its policy is to balance the conflicting demands of the users of forest products and those who require land for rubber planting, tin mining, and similar activities which are making such headway in the Colony. In addition, the maintenance of forests on high land for the protection of cultivated tracts below from the dangers following excessive erosion and the protection of catchment areas requires the careful attention of the forest officer.

In view of these demands on its activities, it is not surprising that it is only within the last few years that the forestry officials have been able to turn their attention to improving the market position of the several valuable resins which the forests produce. The main difficulty which faces the forest officer on such occasions is to get into touch with the trade itself. The forests are situated in far-off tracts of the Empire —almost unknown to the actual users of the raw product—and without some intelligent connecting link little advance can be made, or so the past has

shown on innumerable occasions, in placing a new and perhaps valuable product on the market. As this paper indicates, it is not the forest officer who is often to blame, but the merchant himself at the other end.

It is not possible here to follow the author through his interesting description of the resins and the methods of tapping the trees and so forth dealt with in his paper. The inadequate labour supply forms one of the main difficulties to an increase in output of the resins. At present about 26,000 trees are tapped, but of this number 16,000 are as yet only giving a partial yield, being only tapped up to eight feet instead of the whole height of the stem.

That Mr. Barry's treatment of the subject was that of the expert who is at the same time capable of making his meaning and the interpretation of his work clear to his audience is apparent from the very interesting discussion which followed the paper. An important representative of the trade said that they had learnt a great deal from the lecture. From the trade point of view the Malayan damars are the newest. Of the two Malayan damars the 'cat's eye' (derived from various species of Hopea), from the trade point of view, has the greater value and is pushing the Singapore almost out of use. It is far above the Batavian in value, and is certainly very favourably received by the trade. With regard to black damars, the first sample of black damar received in London came with the useful information that the natives use it to caulk their boats. That is the purpose for which it is usually used in Great Britain, and a huge business has been done in it. The genuine black damar has certainly made its mark. The chairman, Mr. Suter, a leading gum merchant, in winding up the discussion, pointed out the value of the paper with the remark that in the trade they often say, "What can the Government do for us? They simply hinder us: they ask questions and want to know things." Lecturers like Mr. Barry bring it home to the trade that they are mistaken. If they were allied more closely to those in authority, and if they looked to the authorities for more help, they would probably get on quicker than they do.

University and Educational Intelligence.

Aberdeen.—The King has appointed Prof. J. J. R. MacLeod to be regius professor of physiology in the University in succession to Prof. J. A. MacWilliam, resigned. Prof. MacLeod is at present professor of physiology and director of the Physiological Laboratory of the University of Toronto, and is well known for his work on insulin, for the discovery of which he was awarded, with Dr. F. G. Banting, the Nobel prize for physiology and medicine in 1923.

London.—The following courses of free public lectures are announced: "The Electrical Theory of Molecular Constitution," by Prof. P. Debye, at Birkbeck College, at 5.30, on April 26, 27, and 30; "The Pharmacological Evidence for Current Methods of Treatment," by Dr. J. H. Burn, at University College, at 5, on May 1, 2, and 3; "Anatomy and the Problem of Behaviour," by Dr. G. E. Coghill, at University College, at 5, on May 7, 8, and 10; and "Animal Psychology for Biologists," by Dr. J. A. Bierens de Haan, at King's College, at 5.30, on May 4, 9, and 11.

Oxford.—Three public lectures of general interest will be delivered during the ensuing term. These are: (1) At 5 p.m. on May 4, "Palæontology and the Origin of Man," by Prof. D. M. S. Watson (Romanes Lecture). (2) At 5.30 p.m. on May 18, "Professions: their Organisation and Place in Society," by Prof. A. M. Carr-Saunders (Herbert Spencer Lecture). (3) At 5 p.m. on June 18, "The Extent and Structure of the Milky Way," by Dr. Harlow Shapley, Director of the Harvard College Observatory (Halley Lecture).

On May 8, alternative schemes for the extension of the Bodleian Library will be considered by congregation.

Notice is given that applications for grants from the Dixon Fund for assisting scientific investigations, accompanied by the names and addresses of two references, must be made to the Academic Registrar, University of London, South Kensington, S.W.7, before May 15 next.

Applications are invited by the London County Council for two Robert Blair fellowships in applied science and technology, each of the value of £450 and tenable for one year. The fellowships are for advanced study or research in applied science and technology, and will be tenable in the Dominions, the United States, or other foreign countries. Application forms (T.2.a./300) may be obtained from the Education Officer (T.2.a.), The County Hall, S.E.1, to whom the form must be returned by June 18.

Applications are invited by the Ministry of Agriculture and Fisheries for research scholarships in agricultural and veterinary science, not exceeding seven in number, each tenable for three years and of the yearly value of £200. Applications must be received (upon form 900/T.G.) by June 15 by the Secretary of the Ministry. The Ministry also invites applications from students who propose to take up posts as agricultural organisers, teachers, or lecturers in agriculture, for not more than five agricultural scholarships tenable for two years and each not exceeding £200 in value per year. The latest date for the return of applications (on form A.189/T.E.) is June 15.

The Educational Settlements Association's report for 1926–27, published in a recent issue of *The Common Room*, shows that from the income of the year, consisting chiefly of grants from the Joseph Rowntree Charitable Trust (£5350) and the Thomas Wall Trust (£850), grants amounting to £3741 were paid to settlements and colleges. In addition, grants amounting to £735 from the Board of Education were distributed to settlements through the Association. Among the affiliated institutions, now numbering seventeen, are three settlements in London, a college at Surbiton for working women, a college near Evesham for rural workers, two colleges at Birmingham, Coleg Harlech in North Wales, and settlements at Plymouth, Bristol, Letchworth Garden City, Rugby, Leeds, York, Birkenhead, Gateshead, and Lemington-on-the-Tyne. The warden of Coleg Harlech, opened last September as a residential college for adults, contributes an article in which he calls it "a symptom of a universal tendency which owes its origin primarily to Denmark." Its teaching is to be characterised by attention to the needs of students individually; formal lectures are dispensed with, and, as in the Danish Folk High Schools, no encouragement is given to students to leave their former occupations. Intercourse with foreign countries is a noticeable feature of the work of several of the settlements. Thus, Avoncroft reports that Scotland, Holland, Denmark, and Germany are represented among its students; the Gateshead settlement entertained visitors from Germany and Czechoslovakia; Bristol Folk-house organised a Rhine tour, and Letchworth an Italian tour.

Calendar of Customs and Festivals.

April 23.

St. George, Patron Saint of England. Martyr under Diocletian, A.D. 285. Notwithstanding his widespread fame, nothing authentic is known of his life. According to the generally accepted version he was born in Cappadocia, son of a martyred father, served with distinction in the army, and, inheriting a great fortune on the death of his mother, declared himself a Christian before the Emperor, and was martyred with many miraculous incidents. According to Ammianus Marcellinus, however, he was born in Cilicia, and it is said that he acquired a fortune at Constantinople as a purveyor of bacon to the army by anything but honest means. On being found out, he fled to Cappadocia, where he professed Arianism and was promoted to the throne of St. Athanasius. As primate of Egypt he behaved with pride and insolence, while plundering the rich temples of the pagans. This led to his martyrdom at the hands of the heathen, but the date, A.D. 361, points to a confusion of two different personalities.

A mass of legend was incorporated in the lives of St. George, and he became one of the Seven Champions of Christendom. The story most familiar is that of the slaying of the dragon and the rescue of the princess, an incident which is said to have taken place at Silene in Libya. This story was accepted without question in orthodox belief of the Middle Ages; but was excised by Clement VII. It belongs to a group of legends of which the story of Perseus, the Minotaur, Fafnir, and the various 'worms' of English ballad are typical examples. This attained a great vogue in the medieval church from the identification of the dragon or snake with the devil.

St. George is a prominent figure among the saints of most, if not all, European countries. He became the patron saint of England under the early Norman kings, and was made the Saint of the Order of the Garter when it was founded by Edward III. It is, however, in the Mediterranean and in Russia and eastern Europe under the Greek Church that St. George is especially prominent. Among the peasantry of Greece and the Balkans, April is known as the month of St. George. He is the object of a cult of the gypsies of the East as their patron saint. They also, it may be noted, are specially connected with the snake, of which they are reputed to be skilled charmers.

Throughout the Mediterranean the feast of St. George has taken the place of a pastoral festival known to us principally through the *Parilia* of Rome, which took place on April 21, the traditional date of the birth of Numa. On that day the flocks and herds were purified, preparatory to driving them out to their summer pasturage. Fires were lit, the flocks were fumigated, or driven through the fires, over which the shepherds jumped, and offerings of milk and millet were made to Pales. This pastoral ceremony corresponded to the *Fordicidia* of April 15, an agricultural ceremony in which a pregnant cow was sacrificed to the earth goddess Tellus, and the ashes of her unborn calf, mixed with the blood of a horse and bean stalks, were preserved to be used by the senior Vestal Virgin to purify the people six days later at the shepherds' festival of *Parilia*.

April 24.

Hoke or Hock Day. Hock Tide.—An English popular festival of which the name appears in writers so early as the thirteenth century. At one time it was generally observed, but after the Reformation it gradually died out. The principal day of Hock Tide was the Tuesday after the second Sunday following Easter, when the women hocked the men, the men hocking the women on the preceding day, though in some localities the procedure was reversed. An alternative name, Binding Tuesday, indicates the nature of the custom. Women stopped the way with ropes and, pulling passers-by to them, released them only on payment of a fine. The proceeds, which were usually more considerable on the women's day, were devoted to the renovation of the parish church. The performance was accompanied by a good deal of merrymaking, and, according to one account, beating of brass instruments and singing old rhymes. Traditionally the festival was connected with a defeat of the Danes—according to one version, on St. Brice's day (Nov. 13) 1002. A Hock Tuesday play, acted before Queen Elizabeth at Kenilworth in 1575, represented this action, in which the Danes were shown to be finally defeated by the help of the Saxon women—clearly a popular explanation of the peculiar position accorded to the women by the custom.

Rents were sometimes payable on Hoke day, and at Hungerford, Hock Tide customs were observed in connexion with the tenure of rights over lands bequeathed to the town by John of Gaunt. These facts, like hirings and leasings at other times, point to it being a traditional termination of an annual period. This view is further supported by the resemblance of hocking to the Easter inter-sexual customs such as 'lifting,' buckle stealing, and the observance by which the men beat their wives on the Tuesday in Easter week, but the women beat the men on the following day.

April 25.

St. Mark's Day.—On the eve of St. Mark's day, ashes were riddled on the hearth. If any in the house were predestined to die within the year, a shoe would appear impressed in the ashes. A similar forecast was obtained in Yorkshire by watching in the church porch from eleven until one o'clock. When this has been done three years in succession, the ghosts of all who would die within the next year passed into the church, infants and young children rolling along the pavement. In Northumberland a practice similar to those of St. Agnes' eve was observed. Parties of girls, never more than three, baked a 'dumb cake,' made in silence and eaten at twelve o'clock, when the members of the party each retired to bed backwards. Those who are to be married see their sweethearts hurrying after them; or they may hear a knocking at the door or a rustling. Another ceremony with the same object is to eat the yolk of an egg in silence, filling its place with salt.

April 27.

From April 27 until May 3 (O.S.) is known in Morocco as *n-nisän*—a propitious period when everyone is happy. The rain is considered highly beneficial, alike to men, animals, and crops. Owing to its powers it is collected and used for a variety of magical purposes. It will prevent snakes and scorpions from biting if kept in the house, will cure headache, and will increase the butter-yielding qualities of milk. But it must not touch the earth, be exposed to the sun, or be breathed upon. It is used as a fertility charm by women, and it protects grain from the evil eye. Similar beliefs relating to this period are recorded from Palestine. In the Highlands of Scotland the period of fourteen days before May Day is known as the 'balk or ridge of Beltane.'

Societies and Academies.

London.

Mineralogical Society, Mar. 20.—**A. F. Hallimond**: On the atomic volume relations in certain isomorphous series (2). The volume relations of compounds of calcium, strontium, barium, with oxygen, sulphur, selenium, and tellurium correspond in every way with those previously indicated for potassium, rubidium, cæsium, sodium, lithium, and the halogens. The difference in the volume produced by the interchange of eutropic elements exhibits a constant ratio in each series. The partial volumes calculated for the radicles from the volumes of the free metals agree with those already obtained for the alkali compounds, and the values for oxygen and fluorine agree with those calculated by Wasastjerna from the refractive indices. The volume effect of substitution in the sodium chloride lattice varies somewhat with the size of the cell, but the variation never attains the extent required for a law of constant radii. Other isomorphous series agree with the Law of Retgers, and the present results are therefore expressed in terms of a law of additive volumes rather than additive radii.—**A. Holmes** and **H. F. Harwood**: On the age and composition of the Whin Sill and the related dikes of the north of England. The rocks of the Whin Sill and its associated dikes are quartz-dolerites of substantially identical composition. Dikes of this series run north of east. They are quite distinct from the system of tholeiite dikes to which the Bingfield dike, the 'Brunton type' of Teall, belongs. A pebble of quartz-dolerite in the Upper Brockram of George Gill, Brackenber Moor, near Appleby, has been proved by chemical analysis to be definitely of the Whin Sill type. This, with other evidence, indicates that the age of Whin Sill and its associated dikes is post-Westphalian and pre-Upper Brockram.—**A. W. Groves**: The identification of dumortierite in grains: dumortierite in Cornish granite. Dumortierite may be confused with a number of more common minerals. It is recorded in several sediments in southern England and in the Land's End granite.—**T. V. M. Rao**: On 'bauxite' from Kashmir, India. The so-called bauxite of Kashmir consists mainly of diaspore and an opaque mineral corresponding in composition to a monohydrate of alumina. The deposit was derived from beds of clay, having been first altered into the dihydrate (bauxite) and afterwards to its present condition through dehydration and thermodynamic metamorphism.

Linnean Society, Mar. 29.—**Malcolm Wilson** and **Miss M. J. F. Wilson**: The Dutch elm disease and its occurrence in England. The Dutch elm disease was discovered in Holland in 1919, and during the same year in the north of France. The following year it was reported from all parts of Holland, and in 1921 was stated to be present throughout Belgium. In the same year it was recorded from western Germany, and since that date has spread over the greater part of that country. An outbreak of the disease was discovered near London last July. Three explanations have been offered as the cause of the epidemic: (1) The fungus *Graphium Ulmi* Schwarz; (2) *Micrococcus Ulmi* Brussoff; (3) unfavourable climatic conditions, *i.e.* drought and frost. The first explanation is generally accepted by the Dutch investigators. The disease may be readily recognised by the yellow discoloration of the leaves in the crown of the tree or at the tips of the side branches. This condition usually spreads rapidly over the tree, and is followed by leaf-fall and by the death of the tree. Defoliation may be complete within a week, but sometimes extends over a much longer period. Infected branches, when cut across, show one or more rings of small brown spots in the most recently formed wood. These internal symptoms sometimes, but not invariably, can be found in the roots. The disease is present in epidemic form throughout most of western Europe, and shows no sign of becoming less virulent. No species of Ulmus grown in Holland appears to be immune, and no adequate method of control has yet been discovered.—**R. W. Butcher** and **F. T. K. Pentelow**: The effect of pollution on the ecology of a small stream. An ecological study has been made during the past two years of the River Lark in West Suffolk. From September to February a beet-sugar factory empties into the river about four million gallons of waste waters a day. This water contains much organic matter and so deoxygenates the river-water; *e.g.* at one station the oxygen fell from 110 per cent. to 19 per cent. saturation. There is also an increase in the ammoniacal nitrogen. The effect on the flora is to increase the number of bacteria and cause very large growths of 'sewage fungus,' of which *Sphærotilus natans* is the commonest. The fauna of the river may be divided into three definite ecological associations dependent on the oxygen present—the Gammarus type occurring everywhere among the weeds and among stones and gravel on the bottom, the Sialis-Sphærium type occurring on the bottom in muddy stretches, and the Chironomid-Tubificid type which occurs in very foul mud. The effect of pollution is due to the reduction of oxygen, and results in the encouragement of Sialis-Sphærium and Chironomid-Tubificid associations at the expense of the Gammarus type.

Society of Public Analysts, April 4.—**John Evans** and **T. E. Wallis**: Coffee parchment as an adulterant of bran and sharps. The 'parchment' consists of the thin and tough endocarp of the coffee fruit, and may be recognised by its distinctive cellular structure. When added to sharps it is usually finely comminuted, and in testing a sample a few of the suspicious pieces should be boiled with chloral hydrate solution until transparent, and a fragment mounted in chloral hydrate for microscopical examination.—**W. B. Adam**: Determination of the colour-producing constituents of the cacao bean. The two principal colour-producing constituents are cacao catechin and cacao tannin. The former has been extracted with ether and determined colorimetrically by means of Mitchell's ferrous tartrate reagent, whilst the latter is extracted with hot water and determined by precipitation as cinchonine tannate. The catechin is destroyed during fermentation, and the tannin is reduced to about 2 per cent.—**A. T. Etheridge**: Determination of vanadium in steel. The method consists in removing iron (as chloride by extraction with ether) and other interfering metals, by electrolysis over a mercury cathode, leaving a solution in which the vanadium can be determined by titration with permanganate. The process is accurate for all kinds of steels. In the case of molybdenum steels the molybdenum is removed together with the ferric chloride on extraction with ether. Manganese, like aluminium, has no influence on the final permanganate titration.—**S. G. Clarke**: Colorimetric determination of small quantities of antimony and their separation from tin. The antimony is deposited on metallic copper as in the Reinsch method, the deposited film stripped off by means of sodium peroxide, and the antimony determined colorimetrically. The method is applicable to antimony in either state of oxidation, and in the presence of tin or arsenic, but bismuth and severa

of the other heavy metals give precipitates, usually coloured, with the reagents.—**A. Riad**: Determination of carbon dioxide in soils. Hepburn's modification of the Van Slyke method of determining carbon dioxide in carbonates (in which the evolved gas is absorbed in standard baryta solution, the excess of which is titrated with oxalic acid) has been adapted to the determination of carbon dioxide in soils. The method is suitable for general soil analysis.

PARIS.

Academy of Sciences, Mar. 12.—The president announced the death of M. Guignard.—**E. Gourat**: Some singular lines of surfaces admitting a given linear element.—**E. Mathias**: Magnetic measurements in the Haute-Marne, Côte-d'Or, and Aube. An account of work done in 1924 at forty-two stations, twenty-three of which are new.—**Georges de Rham**: Duality in *analysis situs*.—**Paul Montel**: Continued functions of a real variable, which admit a theorem of algebraic addition.—**Paul Lévy**: An asymptotic point of view in the study of ensembles of points on a right line.—**N. Saltykow**: The integration of partial differential equations by separation of the variable.—**Alfred Rosenblatt**: Certain stationary movements of incompressible viscous liquids.—**S. de Glasenapp**: Personal equations in the micrometric measurement of double stars. The method suggested is the comparison of the results of observation with the values, assumed to be known exactly, of the angles of position θ_0 and distances ρ_0 for a certain number of comparison stars, such that the relative displacement of the components is negligible. To facilitate the application of the method a list of comparison stars is given, uniformly distributed over the sky, with varied angles of position and distances ρ less than 3″.—**Mme. E. Chandon**: The tides of the Red Sea. Correction of an error in the calculations of A. Blondel. The differences between the observed and calculated values do not exceed 2 cm., and it is concluded that friction does not have any appreciable effect on tides in the Red Sea.—**A. Lambert**: The velocity of propagation of radiotelegraphic waves. The velocity as determined by recent experiments would appear to be appreciably lower than 300,000 km. per second, the mean result being 247,000 km./sec. ± 9000.—**Canaud**: The electrolysis of water by an alternating current. If the water is allowed to reach its boiling-point some hydrogen is evolved at a regular rate, in amount corresponding to about $\frac{1}{30}$ of that which would have been produced by the corresponding continuous current. Iron electrodes were employed.—**Svend Aage Schou**: The absorption spectrum of formaldehyde in solution. Previous work has proved that aqueous solutions of formaldehyde contain only the polymerised form. The monomolecular aldehyde in hexane at − 70° C. gives a spectrum with at least 17 bands between 3542 and 2750 A., the positions of which are given.—**A. Boutaric** and **Mlle. G. Perreau**: The determination of dilute saline solutions by the opacity of fine suspensions obtained starting with these solutions. An account of attempts to stabilise precipitates, such as silver chloride, by the addition of various colloids.—**J. Huggett** and **G. Chaudron**: The thermomagnetic study of some iron minerals.—**P. Nicolau**: Annealing anomaly of copper and brasses after hammer hardening.—**L. Bert**: A new general synthetic method for preparing arylaliphatic aldehydes. In a previous communication the author has given a method for preparing the chlorides $RC_6H_4(CH_2)_n Cl$. The magnesium compounds prepared from these condensed with methyl orthoformate give good yields of the acetals of the aldehydes $RC_6H_5(CH_2)_n CHO$, from which the corresponding aldehydes are readily obtained by hydrolysis with hydrochloric acid. Details of new aldehydes prepared by this method are given.—**Albert Kirrmann**: The action of amines on bromo-œnanthol.—**Vavon** and **V. M. Mitchovitch**: The *o*-cyclohexylcyclohexanols.—**R. Locquin** and **R. Heilmann**: The separation of the stereoisomeric unsaturated ketones.—**L. Neltner**: The geology of the Goundafi country (Morocco Haut Atlas).—**J. Repelin**: The Aquitaine basin at the Helvetian epoch: the marine gulf.—**G. Mangenot**: The cytological localisation of the peroxydases and the oxydases.—**Tsen-Cheng**: The phenomena of necrosis in potato disease. The necrosis of the diseased potato is in most cases only an exaggeration of the normal destruction of the sieve tubes accompanied by defensive reactions on the part of the neighbouring cells.—**Auguste Lumière** and **Mme. R. H. Grange**: The comparative toxicities of sera arising from venous blood and blood from the umbilical cord.—**Henri Pottevin** and **Robert Faillie**: The variation of the visual psychomotor reaction as a function of the lighting.—**Jean Verge** and **Edmond Grasset**: Researches on the microbial flora of frozen eggs. Amongst the organisms found in Chinese eggs were some belonging to the paratyphic and coli groups, which might possibly give rise to toxic infections. The eggs should be sterilised by heat during preparation as food.

GENEVA.

Society of Physics and Natural History, Feb. 16.—**F. Chodat**: The specificity of Stichococcus, more particularly from the soil of the [Swiss] National Park. The author communicates the results of his tests for Algæ in the soils of the National Park and presents a first series of pure cultures belonging to the genus Stichococcus.—**Amé Pictet** and **H. Vogel**: The synthesis of cane sugar. When fructose is treated with acetic anhydride, it forms a normal tetracetate and an isomer. An equimolecular mixture of these two substances, suitably treated, leads to the synthesis of cane sugar.—**O. Jaag**: New researches on the gonidia of lichens. These researches lead to the proof, for the two varieties of the lichen studied (*Parmelia caperata*), of the formation of gametes, a new fact for algæ of lichen symbiosis, and also to the existence of zoospores different from those already described.—**F. Wyss-Chodat**: The transmissibility to the animal of the parasite of fungoid mycosis. The author has studied a fungus isolated from the skin and from the ganglion of a subject attacked with fungoid mycosis. From the observations it must be admitted that this is a parasitic disease. The inoculation of mice has given results confirming this hypothesis.—**R. Wavre**: Figures of equilibrium of a heterogenous fluid mass. The author brings forward some results new to the solution of this problem of rational mechanics. These results, which are unsuitable for abstraction, lead to important modifications of the laws of rotation of planets in the fluid state.—**M. Gysin**: The application of the methods of Fedorow to the identification of microcline without macles. The author's researches allow of the identification of the mineral in gneiss and prevent the confusion frequently made between microcline and orthose.

Mar. 1.—**G. Déjardin**: (1) Recent spectroscopic applications of the electrodeless discharge. Experiments made on different substances, phosphorus in particular, show that the spectra characteristic of different degrees of ionisation may be separated by utilising the electrodeless discharge to produce them. (2) The filtration of the solar radiation by ozone.

(Observations carried out at the Mont Blanc Observatory, from 1923 to 1926, in collaboration with Lambert and Chalonge.) These experiments show that for each zenithal distance of the sun the curve representing the variations in absorption as a function of the wave-length reproduces perfectly, in certain regions of the spectrum, all the known details of the absorption curve of ozone. From this it is deduced that the ozone should be found localised, for the greater part, in a zone situated about 45 kilometres above the earth.

ROME.

Royal National Academy of the Lincei, Jan. 8.—**F. Severi**: Simple and double algebraic integrals (1 and 2).—**G. Fubini**: A new generation of Darboux's quadratics.—**U. Cisotti**: An exception to Kutta-Joukowski's theorem.—**N. Parravano** and **G. Malquori**: Molybdenum sulphides. (1) Tensions of the sulphur of molybdenum trisulphide. The logarithm of the tension of the sulphur of molybdenum trisulphide is a linear function of the temperature, the emission of the sulphur vapour being irreversible.—**P. Vinassa de Regny**: The geochemical inertia of the triad elements. As a general rule, both simple and compound substances, whether natural or artificial, organic or inorganic, have even molecular numbers. Almost the whole of the earth's mass is composed of substances with atomic numbers below 28, that is, those of the first triad. The geochemical inertia of the elements of the triads may be related to the number and disposition of the electrons corresponding with a condition of equilibrium.—**S. Franchi**: The series of rocks from the Priabonian to the Noric in the neighbourhood of Albenga.—**L. A. Herrera**: Artificial albuminoid cells. Imitations of the natural cells of organisms may be made with the help of egg albumin.—**S. Minetti**: The necessary and sufficient conditions that an entire function may be of a certain genus and of a certain order.—**Rosalind Cecily Young**: The values of the integral $\int_a^b f(x)dg(x)$ of a function $f(x)$ with a non-integrable point, in relation to $g(x)$.—**V. Hlavatý**: Linear differential systems with an indefinite quadratic integral.—**E. Pistolesi**: A supposed exception to Kutta-Joukowski's theorem. Investigation of the problem of a plane strip in an indefinite current, with circuitation different from zero, regarded by Cisotti as an exception to Kutta-Joukowski's theorem, shows that this is not the case, and places beyond doubt the quite general character of the theorem.—**M. Maggini**: The effective wave-length of [radiation from the] stars and a method of determining it by means of the interferometer.—**G. Andrissi**: The absorption of stellar light in the atmosphere of Rome.—**M. Bossolasco**: Plasticity in the phenomena of orogenesis.—**U. Panichi**: Diabases and melanocratic veinous rocks of Sardinia.—**G. Quagliariello**: Action of cold on the fats of milk. The lowering of the surface tension of milk cooled below 10° C. is dependent on the passage of triglycerides of the lower fatty acids from the globules into the interglobular liquid, in which they dissolve.—**G. Martino**: Different contents in 'phosphogen' of striated muscle under rapid and under torpid contraction.—**G. Brunelli**: Anatomico-physiological investigations on the significance of the intrahepatic pancreas in the Teleostei.—**G. Brunelli** and **G. Fasella**: A very rare cetacean on the coast at Nettuno. A cetacean, stranded near Foco Verde in Nettuno in November last, belongs to the genus Mesoplodon and is probably *M. bidens*.—**R. Savelli**: Giant seeds and a case of poly-endospermia due to extraneous pollination on *Nicotiana rustica*.—**E. Francini**: Phenomena of somatic asporia, gonial asporia, and adventitious embryony in *Ochna multiflora*.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 14, No. 1, January).—**Raymond Pearl, Agnes Allen Winsor**, and **John Rice Miner**: The growth of seedlings of the cantaloup, *Cucumis melo*, in the absence of exogenous food and light. The growth in length of cantaloup seedlings grown in the dark on a sterilised medium and supplied only with sterilised water, with or without fresh supplies of sterilised air, follows a logistic curve essentially the same as that for normal growth.—**David White**: Some factors in rock metamorphism. The progressive transformation of carbonaceous sediments can be used as a scale for the determination of the stages of incipient metamorphism. Carbonisation is the result mainly of horizontal thrust, temperature, and time, of which the former is of pre-eminent importance. Vertical pressure is relatively insignificant in effect; it assists the strata to resist buckling and helps to raise the temperature. The time factor only becomes important in the presence of advanced pressures and their consequent temperatures.—**D. F. Hewett**: Late Tertiary thrust faults in the Mojave Desert, California. The Spring Mountains and adjacent ranges contain at least six extensive overthrust faults and numerous minor thrusts as well as normal faults. They dip westward at angles of 5°-45°, and rocks ranging from pre-Cambrian granite gneiss to Pennsylvanian limestones are thrust generally eastward upon younger rocks ranging from lower Palæozoic to Jurassic. The thrust faults seem to have been formed in early Eocene times.—**Raymond T. Birge**: The quantum levels and resulting constants of the hydrogen molecule (*v.* NATURE, Jan. 28, p. 134).—**Charles S. Barrett**: The scattering of X-rays from gases. Filters of strontium oxide and zirconium oxide, each adjusted to absorb 50 per cent. of molybdenum $K\beta$ radiation, are well matched at all wave-lengths except between their K absorption limits; the two thus give practically monochromatic radiation (Prof. P. A. Ross). Such a beam is passed through a gas chamber and into an ionisation chamber. It is concluded that interference occurs in X-rays scattered from a single molecule of carbon dioxide or oxygen, and is absent in rays scattered from a hydrogen molecule (between 30° and 90°).—**Louis S. Kassel**: The distribution of energy in molecules. In a group of oscillators in statistical equilibrium, some classical and some quantum, the latter all having the same frequency, the chance that a given classical oscillator shall have energy equal to or greater than m quanta is exactly the same as the chance that a given quantum oscillator shall have m or more quanta.—**I. S. Bowen**: The life of atomic states and the intensity of spectral lines. The origin of the strong nebular spectral lines in electron jumps from metastable states in oxygen and nitrogen is evidence that metastable states are states of long mean life and not absolutely metastable. If the ratio of the mean time between collisions of the second kind to the mean life of the state before spontaneous emission is small, the majority of the atoms are taken out of the excited state by collisions of the second kind and the line is weak; if the ratio is large (as it is under nebular conditions) the atoms can radiate spontaneously and the line appears strongly. This explanation is applicable to other anomalous line intensities and suggests a gradation of mean lives from 10^{-8} sec. (normal lines) to 1 sec. or more (nebular lines).—**R. J. Lang**: The spectra of singly and doubly ionised

germanium (Ge II and III).—Jared Kirtland Morse: (1) The structure and dimensions of the ethane molecule. A scale model is built up, using the cubic lattice already employed in discussing the crystal lattices of diamond and graphite. (2) The lattice structure of ethane. The model constructed would cause diffraction effects agreeing well with Mark and Pohland's results for solid ethane, except in regard to the 004 plane.—R. A. Millikan and C. C. Lauritsen: Relations of field-currents to thermionic-currents. It has been shown by Millikan and Eyring that in the extraction of electrons from metals, the electrons constituting the field current are not identical with the thermions and, over a range of 700° C., are independent of temperature. The data used, and also new data, give curves for the relationship between log i (i = field current) and $1/F$ (F = applied field) which are straight lines. At sufficiently high temperatures the thermionic- and field-currents are not independent. A combined formula is obtained showing that the application of an external field is equivalent to increasing the temperature of the electrons within the metal.—Gregory Paul Baxter and Howard Warner Starkweather: (1) The density, compressibility, and atomic weight of neon. In purification, the gas was absorbed on chabazite cooled with liquid oxygen or nitrogen. The density and atomic weight found are 0·89990 and 20·182 respectively. (2) The density, compressibility, and atomic weight of argon. The normal density is 1·78364, the limiting density is 1·78204, and the atomic weight 39·943. These values assume that the conventional method of calculating the deviations from Boyle's law is correct; a more rigorous investigation, however, only makes a difference of so much as 0·00001 in a few of the results. —A. M. Showalter: The chromosomes of *Pellia Neesiana*. The male and female plants contain nine chromosomes. One of those of the female seems to be an X-chromosome; in the growing regions, it remains condensed throughout the interphases, recalling the behaviour of sex chromosomes from spermatogonia of animals.—T. H. Goodspeed and A. R. Olson: The production of variation in Nicotiana species by X-ray treatment of sex cells. Mature plants bearing flower buds were subjected to X-ray bombardment for 10 min. or 20 min. Their seed gave more than 20 per cent of morphologically abnormal plants, but only rarely were the variants completely sterile. Similar effects are obtained if only the male sex cells are irradiated. Cytological examination of the variants shows that, in some of them, one of the meiotic chromosomes has an appendage similar to that born by many somatic chromosomes.—L. J. Stadler: Genetic effects of X-rays in maize. Heavy treatment reduces considerably the yield and viability of pollen, but seems to have no effect on crossing-over in a particular region of the chromosome; it does increase, however, the percentage of seed with mosaic endosperm when crosses of an endosperm dominant with an endosperm recessive are used.—Edward Kasner: General theory of polygenic or non-monogenic functions. The derivative congruence of circles.—G. A. Miller: Number of systems of imprimivity of transitive substitution groups.—R. L. Moore: Concerning triods in the plane and the junction points of plane continua.—Cecilia H. Payne and Frank S. Hogg: On methods and applications in spectrophotometry. The work being carried out at Harvard in this field is described and discussed. It should result in placing several qualitative astrophysical arguments on a quantitative basis.—Willard Owen Thompson, Phebe K. Thompson, and Mary Elizabeth Dailey: The effect of posture upon the composition and volume of the blood in man. In standing still, the blood suffers a net loss of about 11 per cent. of the total plasma volume of approximately protein-free fluid, due to increase in capillary pressure. The loss, which occurs in 20-30 min. and is recovered in a similar time on lying down, is greatest at the extremities.—Alfred J. Lotka: Sterility in American marriages. Using the data for 1920 of the United States Census Bureau, it is calculated that the effective sterility of American (white) wives is 17·1 per cent. Of this total, 1·2 per cent. is due to premature death of wives, 2·0 per cent. to premature death of husbands, and 0·8 to divorces. The net sterility of American (white) wives is thus 13·1 per cent.—Louis Harris: The photochemical union of hydrogen and chlorine. The apparatus was entirely of quartz and the reaction vessel was illuminated with light of wave-length greater than 4050 A. A thermopile behind the reaction tube measured the energy available. The final hydrogen pressure was measured after freezing out the hydrogen chloride formed and the unchanged chlorine. The minimum yield with excess of hydrogen was 6×10^5 molecules of hydrogen chloride per quantum of light.

Official Publications Received.

BRITISH.

Government of Bengal: Irrigation Department. Report on Rainfall and Floods in North Bengal, 1870-1922. By Prof. P. C. Mahalanobis. Pp. v+90+32 maps. (Calcutta: Bengal Secretariat Book Depot.) 20 rupees; 30s.

The National Benzole Association. Fifth Report of the Joint Benzole Research Committee of the National Benzole Association and the University of Leeds. (Presented March 21st, 1928.) Pp. iv+237 (London: National Benzole Association.)

Colony of the Gambia. The Annual Report of the Department of Agriculture for the Period January 1st, 1926, to March 31st, 1927. Pp. 53. (London: The Crown Agents for the Colonies.) 5s.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Dominica, 1926-27. Pp. iv+41. (Trinidad, B.W.I.) 6d.

The Journal of the East Africa and Uganda Natural History Society. No 30, July 1927. Pp. 55-110+25 plates. (Nairobi.) 5s.; to non-Members, 10s.

Report of the Felsted School Scientific Society for the Years 1926 and 1927. (No. 30.) Pp. 40. (Felsted.)

Papers and Proceedings of the Royal Society of Tasmania for the Year 1927. Pp vi+237+28 plates. (Hobart: The Tasmanian Museum.) 10s.

Ceylon Journal of Science. Section B: Zoology and Geology. Spolia Zeylanica. Edited by Dr Joseph Pearson. Vol. 14, Part 2, March 12th. Pp. 135-340. (Colombo: Colombo Museum; London: Dulau and Co., Ltd.) 3 rupees.

Rhodesia Museum, Bulawayo. Twenty-sixth Annual Report, 1927. Pp 12. (Bulawayo.)

Proceedings of the Society for Psychical Research. Part 105, Vol. 38, April. Pp 16. (London: Francis Edwards, Ltd.) 1s. 6d.

Agricultural Research Institute, Pusa. Bulletin No. 171: The Improvement of Indian Wheat; a Brief Summary of the Investigations carried out at Pusa from 1905 to 1924, including an Account of the new Pusa Hybrids. By Albert Howard and Gabrielle L. C. Howard. Pp. v+26. (Calcutta: Government of India Central Publication Branch.) 8 annas; 10d.

Supplement to *The Journal of Ecology*. 1, February. British Empire Vegetation Abstracts: Titles and Abstracts of Publications on the Vegetation and Ecology of the Overseas Empire and on related Topics. Pp. 20. (Kew, Surrey: British Empire Vegetation Committee; Hon. Secretary: Dr. T. F. Chipp, 199 Kew Road.) Subscription price, 5s. a year.

Transactions of the Optical Society. Vol. 29, No. 2, 1927–28. Pp. 49-100. (London.) 10s.

Board of Education. Educational Pamphlet, No. 57: Memorandum on the Teaching of Building Science to Students attending Courses of Instruction in Building and the Building Trades. Pp. 16. (London: H.M. Stationery Office.) 3d net.

University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, 1926-1927. Pp. 24 (London: H.M. Stationery Office.) 3s. net.

Apia Observatory, Apia, Western Samoa. Report for 1925. Pp. 95+3 plates. (Wellington, N.Z.: W. A. G. Skinner.)

Reports of the Council and Auditors of the Zoological Society of London, for the Year 1927, prepared for the Annual General Meeting to be held on Monday, April 30th, 1928, at 4 p.m. Pp. 91. (London.)

FOREIGN.

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 19: State Laws and Regulations governing Teachers' Certificates. By Katherine M. Cook. Pp. v+296. 40 cents. Bulletin, 1927, No. 33: Statistics of Public High Schools, 1925–1926. Pp. 92. 10 cents. Bulletin, 1928, No. 1: Educational Directory, 1928. Pp. iii+144. 20 cents. (Washington, D.C.: Government Printing Office.)

Conseil Permanent International pour l'Exploration de la Mer. Journal du Conseil. Rédigé par E. S. Russell. Vol. 3, No. 1, Avril. Pp. 131. (Copenhague: Andr. Fred. Høst et fils.) 4.50 kr.

Peking Society of Natural History. Bulletin, Vol. 1, Parts 2 and 3: Chinese Bi ds, by Wilder, Gee and Moffett; and Yearly Proceedings with Reports. Pp. ix-xii+145-370+8. (Peking.)

Regenwaarnemingen in Nederlandsch-Indië. Acht en veertigste Jaargang, 1926. Pp. ii+133. (Weltevreden: Landsdrukkerij.)

The Eugenical Aspects of Deportation. Hearings before the Committee on Immigration and Naturalization, House of Representatives. Seventieth Congress, First Session, February 21, 1928 (including Testimony taken April 28, 1926, with eight Appendices). Statement of Dr. Harry H. Laughlin. Pp. ii+84. (Washington, D.C.: Government Printing Office.)

Ministry of Finance, Egypt: Coastguards and Fisheries Service. Report on the Fisheries of Egypt for the Year 1926. By El Miralai Ahmed Fouati Bey. Translated from the Arabic by Selim Eff. Khoury. Pp. x+91. (Cairo: Government Publications Office.) 5 P.T.

Smithsonian Miscellaneous Collections. Vol. 80, No. 7: The Aboriginal Population of America North of Mexico. By James Mooney. (Publication 2955.) Pp. 40. (Washington, D.C.: Smithsonian Institution.)

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 27: Flora of the Panama Canal Zone. By Paul C. Standley. Pp. x+416+67 plates. (Washington, D.C.: Government Printing Office.) 75 cents.

Smithsonian Institution: United States National Museum. Bulletin 142: Life Histories of North American Shore Birds. Order Limicolae (Part 1). By Arthur Cleveland Bent. Pp. ix+420+55 plates. (Washington, D.C.: Government Printing Office.) 85 cents.

Department of the Interior: U.S. Geological Survey. Professional Paper 150-C: A Section of the Kaibab Limestone in Kaibab Gulch, Utah. By L. F. Noble. (Shorter Contributions to General Geology, 1927.) Pp. ii+41-60+plates 12-14. Bulletin 795-G: Phosphate Rock in the Three Forks-Yellowstone Park Region, Montana. By D. Dale Condit, E. H. Finch and J. T. Pardee. (Contributions to Economic Geology, 1927. Part 1.) Pp. iv+147-209+plates 10-12. Bulletin 795-H: A Manganese Deposit of Pleistocene Age in Bannock County, Idaho. By D. F. Hewett. (Contributions to Economic Geology, 1927, Part 1.) Pp. ii+211-221. Bulletin 796-C: Geology and Coal Resources of the Salina Canyon District, Sevier County, Utah. By Edmund M. Spieker and Arthur A. Baker. (Contributions to Economic Geology, 1927, Part 2.) Pp. iv+125-170+plates 19-22. 15 cents. Bulletin 796-D: Geology and Oil and Gas Possibilities of the Bell Springs District, Carbon County, Wyoming. By C. E. Dobbin, H. W. Hoots and C. H. Dane. (Contributions to Economic Geology, 1927, Part 2.) Pp. iv+171-201+plates 23-27. (Washington, D.C.: Government Printing Office.)

Bulletin of the Bingham Oceanographic Collection. Scientific Results of the First Oceanographic Expedition of the *Pawnee*, 1925. Vol. 1, Art. 3: Mollusca from Tropical East American Seas. By Lee Boone. Pp. 20. Vol. 1, Art. 4: Echinodermata from Tropical East American Seas. By Lee Boone. Pp. 22+8 plates. Vol. 1, Art. 5: Coelenterata from Tropical East American Seas. By Lee Boone. Pp. 8+3 plates. Scientific Results of the Second Oceanographic Expedition of the *Pawnee*, 1926. Vol. 2, Art. 1: Elasmobranchii from Panama to Lower California. By C. M. Breder, Jr. Pp. 13+9 plates. Vol. 2, Art. 3: Nematognathi, Apodes, Isospondyli, Synentognathi and Thoracostraci from Panama to Lower California; with a Generic Analysis of the Exocoetidæ. By C. M. Breder, Jr. Pp. 25. (New Haven, Conn.: Bingham Oceanographic Collection, Peabody Museum of Natural History.)

CATALOGUE.

Bulletin des Publications nouvelles. 3e et 4e trimestres, 1927. Pp. 80. (Paris: Gauthier-Villars et Cie.)

Diary of Societies.

SATURDAY, APRIL 21.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Newcastle-upon-Tyne), at 2.30.—Dr. W. Cullen: Some Notes on Quarrying by the Well Drill Method.—R. J. Weeks: A Few Notes on an Explosion of Gunpowder.—Discussions on Electric Mine Lamps and Better Lighting, W. Maurice; A New Gas Detecting Miners' Electric Lamp, Prof. W. M. Thornton; and Notes on High Candle-power Lamps, H. Staples.

MINING INSTITUTE OF SCOTLAND (Annual General Meeting) (at Royal Technical College, Glasgow), at 3.—J. A. B. Horsley: Design and Maintenance of Flame-Proof Enclosures, with Special Reference to Coal Face Machinery.—Discussions on Supporting Underground Roadways with Steel Arches, D. C. Gemmell; and Life Saving in Colliery Explosions and Fires, T. A. Southern.

MONDAY, APRIL 23.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 6.30.—H. Heywood: Pulverised Coal Systems.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Annual General Meeting.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. S. G. Rendel: The Work of Temple Moore.

ROYAL SOCIETY OF ARTS, at 8.—A. G. Huntley: Applied Architectural Acoustics (Dr. Mann Lectures) (II.).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Dr. A. Livingston: Further Experiments on the Permeability of Enamel.—W. Rushton: Injection of Alcohol for Neuralgia and its Sequel.—L. Payne: A Paste for Obtunding Hyper-sensitive Dentine.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—F. Rodd: Journeys among the Southern Tuareg.

TUESDAY, APRIL 24.

ROYAL DUBLIN SOCIETY (at Ball's Bridge, Dublin), at 4.15.—Dr. J. H. J. Poole: A Simple Form of Photo Electric Photometer using a Neon Lamp to Measure the Current.

ILLUMINATING ENGINEERING SOCIETY (at Home Office Industrial Museum, Horseferry Road, Westminster), at 6.—J. S. Dow and others: Discussion on Daylight, Artificial Light, Artificial Daylight: their Merits and Drawbacks.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—G. Malin: A Motor Cycle World Tour.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—M. C. Burkitt: South Africa's Past in Stone and Paint.

WEDNESDAY, APRIL 25.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (in Prince Henry's Room, 17 Fleet Street), at 5.30.—L. F. Loree: Steamers of Lake Champlain, 1809 to Present Day.

INSTITUTION OF CIVIL ENGINEERS (Annual General Meeting of Association of London Students), at 6.30.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (Annual General Meeting) (at University, Birmingham), at 7.—Sir Oliver Lodge: The Revolution in Physics (Kelvin Lecture).

ROYAL SOCIETY OF ARTS, at 8.—Dr. J. M. Ritchie: The Education and Training of the Blind.

EUGENICS SOCIETY (at Royal Society), at 8.30.—Dr. Feldman: Eugenics in Ancient Hebrew Literature.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Anthropological Institute), at 8.30.—Drs. E. A. Bennet, D. Bryan, and T. A. Ross: Symposium on Fugue states. Discussion opened by Dr. T. W. Mitchell.

BRITISH ASTRONOMICAL ASSOCIATION (at Sion College, Victoria Embankment).

THURSDAY, APRIL 26.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—A Besicovitch and H. Bohr: On Almost Periodic Properties of Translation Numbers.—W. L. Ferrar: Conditionally Convergent Double Series.—R. M. Gabriel: An Additional Proof of a Theorem upon Rearrangements.—Margaret E. Grimshaw: A Contribution to the Theory of Uniqueness of Representation by Trigonometrical Integrals.—Prof. A. E. H. Love: Biharmonic Analysis especially in a Rectangle and its Applications to the Theory of Elasticity.—S. W. P. Steen: On Fermat's Last Theorem.—C. T. Preece: Theorems stated by Ramanujan. (I.) Theorems on Integrals.—Prof. G. N. Watson: Theorems stated by Ramanujan. (II.) Theorems on Summation of Series.—Rosalind C. Young: On Riemann Integration with respect to an Additive Function of Sets.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—C. Dornier: Flying Boats.

INSTITUTION OF CIVIL ENGINEERS (Yorkshire Association) (at Hotel Metropole, Leeds).—C. J. Chaplin: Railway Construction in the Pyrenees.

FRIDAY, APRIL 27.

ROYAL SANITARY INSTITUTE (at Guildhall, Worcester), at 4.—C. C. Duncan and others: Discussion on River Pollution.—Dr. M. Read and others: Discussion on Infant Mortality in Worcester from 1895 to 1925.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Prof. W. C. Baker: Experiments with Mercury Jets and the Phenomena exhibited at their Impact with Steel and Glass.—E. P. Perman and W. D. Urry: The Elastic Constants of Glass.—G. E. Bell: A Valve-maintained High-frequency Induction Furnace and some Notes on the Performance of Induction Furnaces.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section) (Annual General Meeting), at 6.15.—R. A. Brockbank: Super Tension Cables.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—J. C. Armstrong and others: Pulverised Fuel in Locomotive Furnaces.

INSTITUTION OF ELECTRICAL ENGINEERS (at Newcastle-on-Tyne), at 7.30.—E. T. Williams: The Electrical Equipment of the Singapore Floating Dock.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—C. H. Plant: The Manufacture of Structural Steel, etc.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Dr. R. W. A. Salmond: Observations on the Movements of the Duodenal Contents, with Special Reference to Antiperistalsis and Pyloric Regurgitation.—Dr. Bathurst: Treatment of Incontinence in Women.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. A. M. Tyndall: Carriers of Electricity in the Atmosphere.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Forresters' Hall, Dundee).—Dr. S. Z. de Ferranti: Electricity in the Service of Man (Faraday Lecture).

SATURDAY, APRIL 28.

ROYAL SANITARY INSTITUTE (at Guildhall, Worcester), at 10 A.M.—T. Caink and others: Discussion on The Worcester Activated Sludge Plant.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students' Section) (jointly with Students' Sections of North-East Coast Institution of Engineers and Shipbuilders, and Institution of Electrical Engineers) (at Neville Hall, Newcastle-upon-Tyne), at 3.—L. H. Forster: Notes on Main Pumping.

PUBLIC LECTURES.

THURSDAY, APRIL 26.

BIRKBECK COLLEGE, at 5.30.—Prof. P. Debye: The Electrical Theory of Molecular Constitution. (Succeeding Lectures on April 27 and 30.)

KING'S COLLEGE, at 5.30.—Dr. K. Bělař: The Mechanism of Mitosis.

SATURDAY, APRIL 28, 1928.

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The Charter of the British Association.

THE grant of a Royal Charter to the British Association is, at least indirectly, a testimony to the virility of a national institution nearly a century old. When the question of the application for a charter was brought forward last autumn, it appeared to surprise many people that the Association did not possess one. That in itself was a compliment; but when the subject had been considered on previous occasions the difficulty of meeting the necessary charges stood in the way. That difficulty was removed by the generosity of Mr. A. A. Campbell Swinton, who undertook to bear the costs; and the petition made by the president, Sir Arthur Keith, and the general officers on behalf of the Association, has now been granted by the King in Council. The recognition of the Association as a body corporate should further strengthen its position in the public view. 'Further,' because that position has been materially strengthened, at any rate since the period of the Association's jubilee in 1881, of which the 'Red Lions' of that time sang:

> "At York they thought she was sure to die,
> For she didn't seem to enjoy age,
> But at last the doctors bade her try
> The effects of an ocean voyage,"

which evidently was efficacious, for the song went on to celebrate the recovery which 'she,' the 'British Ass,' had accomplished by reason of 'her' first journey to a meeting overseas in 1884. Now, when it is commonly admitted that the public recognition of scientific advancement, restricted though it still be and not always well directed, is at any rate more widespread than it was when the Association was founded to assist in the spreading, it may reasonably be claimed that the recognition of the Association's work also has broadened and is broadening.

Internal signs of this increased public interest—such as the multiplication by four of the number of press cuttings received in the office in a single year—have not been wanting since, in 1919, the annual meetings were resumed after two years' enforced abstinence, not without some sense of apprehension as to the future. On the financial side the generous benefaction of Sir Charles Parsons and others, supplemented later by that of Sir Alfred Yarrow, went far to ensure the maintenance of the Association's activities under the changed conditions of present times; while as regards those activities themselves, the Association benefited by friendly criticism and suggestion in these columns.

There can be no doubt that the Association has in recent years adapted the proceedings of its annual meetings more closely to modern practice and expectation in the furtherance of its aim to obtain "more general attention for the objects of science." In former years the Association used to stage its big effects almost accidentally: there is no better example of this than the famous disputation between Wilberforce and Huxley and Hooker at Oxford in 1860. To some extent it does so yet: under the impenetrable calm of the inaugural meeting, the presidential address may still be received with nothing more than a decorous murmur of applause; yet the words then spoken may, and sometimes do, carry far farther, and arouse more attention and even heart-searching, than they used to do among the public at large—for an illustration we need go no farther back than last year's address. In these days the members and the public have at least some foreknowledge, through preliminary programmes of the meetings, of the leading topics to be brought forward, so that when, for example, the title of one of the evening discourses at the forthcoming meeting in Glasgow is announced as "The Mystery of Life," they will be enabled to indulge in pleasing speculation as to the next 'wonder' which science may have to reveal.

This sort of publicity used to be something to discredit, and certainly the Association would offer no commendation for the type of pseudo-scientific headline of which lurid examples were quoted in these pages not long ago. On the other hand, it is as true now as when Lyell wrote of the Association in 1838, that in Great Britain "no importance is attached to any body of men who do not make occasional demonstration of their strength in public meetings." There was an undercurrent of satire in those words; yet it cannot be accounted a serious national defect if a proportion of the public is willing to listen to the spoken word: many can do that more easily than they can read, and get some good of it. Moreover, the range of the spoken word broadens with the use of broadcasting—the microphone has already made its appearance at Association meetings—as the range of the printed word will likely narrow if books grow much more costly. So that the faculty of 'thinking on their legs' is one which scientific men and women cannot afford to neglect, but rather should cultivate; or, if that ability fail them, at least they should fall back upon practice in reading their own written words intelligibly and with life; for even that is no common art, as many who 'listen-in' can testify.

It is as a public body, and not only as a 'hotchpotch of philosophers,' that the Association will benefit most materially by the possession of the Royal Charter. More particularly so, in its relations with the many public authorities with which it is brought constantly into contact, both in the course of the organisation of its meetings and in advancing science by making recommendations and tendering advice to administrative bodies in the work of which science plays, or should play, a part. Occasions for such action arise out of the proceedings of every annual meeting. The dignity conferred by the grant of a charter is intangible and difficult to define, but the Royal warrant is the highest recognition of the joint efforts of those men of science who voluntarily undertake the maintenance of the Association's work. It constitutes them a body corporate; it recognises them as a legal entity. Finally, this last consideration makes it possible for the Association to undertake without difficulty the grateful charge laid upon it by Mr. George Buckston Browne, of holding as a national memorial the residence of Charles Darwin at Down. That house is at present in the very appropriate tenancy of a school; but whatever its future may be, Mr. Buckston Browne's generosity has given the Association a new duty consonant with the new status conferred by the grant of the Charter, and it is to be hoped that in its new century of existence the Association may find scope for additional and equally worthy extensions of its activities.

The Physiology of the Higher Functions of the Brain.

Conditioned Reflexes: an Investigation of the Physiological Activity of the Cerebral Cortex. By Prof. I. P. Pavlov. Translated and edited by Dr. G. V. Anrep. Pp. xv + 430. (London: Oxford University Press, 1927.) 28*s*. net.

FOR the first time a full account of the work which Prof. Pavlov and a devoted school of pupils and associates have been doing in Russia has appeared in English. The results of the work, though recognised to be of extreme importance by physiologists, have been known in England in only one or two of its aspects, as all the literature of the subject has been in Russian, except for some short accounts. Furthermore, although the apparatus required is apparently not very expensive, the necessity for well-constructed research rooms and space for keeping animals, together with the difficulty and the time required in getting experience,

have resulted in the confinement of the use of the method to the school of its origin. It is with special interest, therefore, that one surveys this translation of a comprehensive account of the method and its results.

The general principle of the method of 'conditioning' reflexes has been long known from early accounts of the work. Briefly, the method depends upon the temporary association of a stimulus of no particular meaning with an inborn reflex. Reflexes such as the secretion of saliva in response to the presence of food in the mouth are inborn and fixed and are present in animals in which the cortex of the brain has been removed. Such a reflex, therefore, does not require the presence of the cerebral cortex for its function, and like all the reactions of such an animal, it shows no evidence of intelligence except the purpose in its design; an inborn reflex is automatic. Prof. Pavlov and his pupils early showed that any particular signal, such as a flash of light, a sound, or a tactile sensation, can, by repeated association with the presence of food in the mouth, acquire temporarily the subsequent property of itself causing salivation without the accompaniment of food. The signal stimulus thus becomes the 'conditioned,' and the response it evokes is the 'conditioned reflex.' This temporary association was early demonstrated to be a true function of the cerebral cortex, and later work described in this volume continues to confirm that fundamental fact.

That the new response is a true reflex is maintained by Prof. Pavlov, but the reviewer is not at all convinced. A similar response from man would surely be inseparable from consciousness, and there is some evidence that this is indeed the case (Hamel). It is not proved in this book that the response in the dog is other than that of a mechanism in which a conscious factor is an essential part and in which the sole representative of the original reflex is its final common path. Protopopov has been reported to have conditioned the knee jerk, but there is no mention of this in the book under review. If a true knee jerk (latent period of 0·005–0·01 second and a single volley of efferent impulses) could be conditioned, then the conditioned response may be accepted as a true reflex.

Prof. Pavlov makes use of two inborn 'unconditioned' reflexes to serve as the basis of the study of conditioned reflexes. The first is the secretion of saliva caused by the presence of food in the mouth, and the second the secretion of saliva caused by the presence in the mouth of a substance which is automatically rejected. The wisdom in his choice is seen when it is realised that the whole investigation is quantitative, *i.e.*, under like external conditions the response is measurable and comparable. The animal is provided with a permanent fistula of one salivary duct, so that the whole secretion of saliva by one gland can be accurately measured during experiments without any discomfort to the animal, and experiments can be thus carried out, at intervals of a few days, for months at a time. It is not to be supposed that, because Prof. Pavlov uses these reflexes of salivation, his insight into the cerebral mechanism is confined to the nervous mechanism of alimentation or to the nervous mechanism of defence. The motor reactions of the animal are carefully observed at the same time, and the two basic reflexes are harmonised with the general behaviour.

Much information is given in this book on the varieties of stimulus used, and the methods are continually illustrated by examples. There are long periods of waiting in each day's observations, and the reader has much admiration for the patience of the investigator. As a result of such long experience and concentration, the method has so been perfected that none can cavil with its conduct, and fallacies in interpretation which have been detected are fully explained. It is much to be desired and hoped that the method will be introduced into Great Britain.

The investigation of the process of conditioning reflexes and the use of the conditioned reflexes for other investigations have developed side by side. A stimulus can be conditioned so as to inhibit an already established conditioned excitatory reflex. By means of differentiating closer and closer values from one another, one excitatory and one inhibitory, the power of sense discrimination in the dog was investigated to a degree never before possible. The demonstration of discrimination between tones 12 d.v. apart, the finding that the dog can appreciate tones which are inaudible to the human ear, and that it lacks colour vision, were all surprising, but the recent investigations of skin sensation and its differentiation from muscle sense and joint sensation open further great possibilities. Here is a purely objective method of investigating sensation.

In dealing with the central mechanism, Prof. Pavlov wisely refrained from identifying the loci of analysis of these sensations and of the establishment of the conditioned responses with the conception of 'centres' developed by earlier writers and their methods. He calls the central mechanism for each sensation an 'analyser,' and several lectures

are devoted to the investigation of the process of establishment and disappearance of localised excitation and inhibition. The 'investigatory reflex' which is discussed in several aspects is surely related to the property of 'attention' which is so conspicuous in animal behaviour.

Sleep, the mechanism of which has always seemed such a complete mystery, is identified as a variety of the process which Prof. Pavlov calls 'internal inhibition.' The investigations not only fully support this identity, but he also brings by them a great deal of light on intermediate states such as hypnotism. Prof. Pavlov brings forward evidence to show that the processes of inhibition and excitation as exhibited by conditioned responses are essentially the same nature as those processes as they are known in spinal reflexes. Inhibition is clearly not synonymous with exhaustion. The identity with spinal processes is only to be expected, but as inhibition in the spinal reflexes shows so much evidence of being an *active* process, the reviewer finds it difficult to reconcile sleep with a process implying cortical activity. But now that the process has been so brilliantly demonstrated, sleep and the intermediate states will surely become increasingly investigated by this method; we look forward to much further information of the mechanism of internal inhibition, especially as to the means of its localisation.

Subsequent lectures lead the reader to the investigation of pathological states. Here the work becomes of extraordinary interest to the neurologist and psycho-pathologist. With its facilities for comparable quantitative measurement, the method has a unique scientific value in investigating the temperament of an animal; the degree of 'stability' of behaviour becomes something definite and the physiological bugbear of 'nerve energy' appears in a new light. The interpretation is rightly most guarded, and few will deny the soundness of all the deductions. The results of experiments on functional interference with the cortex, indeed, bode serious rivalry to current psychological methods of attack on the problems of neuroses and psychoses. In analysis of the results of surgical interference with the cortex, the method also entirely replaces the old crude methods of appreciating defects in intelligence in animal conduct. One is surprised that some of the smaller operations should produce such large degrees of change attributable to scar tissue, and would like more detailed histological investigation of all the operated cases. Prof. Pavlov, however, realises this lack, and it is hoped that future work will fully remedy it.

The refutation of the doctrine of specific association centres is timely and well founded. The widespread representation of the visual and acoustic analysers will be a revelation to most of those interested in visuo-psychic disturbances, aphasia, and the psychic aspects of other special sense disturbances. The establishment of visual responses to luminosity and shape after extirpations of the occipital areas is not only a great advance in knowledge but also reflects the extraordinary sensitivity of the method. Prof. Pavlov points out the richness of speech in factors of intensity, time intervals, sound discrimination and discrimination of order in serial succession, each provocative of conditioned reflexes. A method for the physiological approach to the problems of aphasia at last seems indicated. Another striking result of the flexibility of the method is the proof that both hemispheres are necessary for the appreciation of direction of origin of sound, and the description of the extraordinary case of the dog showing symptoms of visual illusion following the appearance of strange objects in one field of vision and not when they appeared in the other.

The storing of past associations which forms the essential part of the process of conditioning would seem to form the greater part of the gulf between reflex action and conditioned response. The reviewer would like to have seen this discussed. The appreciation of relative time impresses the reviewer as being one of the fundamental properties of the cerebral cortex, and he considers it as another manifestation of the storage capacity of the nervous tissue of the cerebral cortex. The development of this storage factor is the fundamental process in the evolution of consciousness and memory.

The degree of precision in stimulus evaluation and measurement of effect, and the recognised high degree of intelligence of the dog in the study of conditioned reflexes, make maze learning and problem-box experiments with rats, as an approach to the problems of mind, crude and undifferentiated in comparison.

It is of vital interest to all who study the mind and the brain to become intimate with the developments described in this book. The wisdom of the Royal Society in enabling a translation to be made, and in the choice of translator, is manifest, and Dr. Anrep, a former pupil and collaborator of Prof. Pavlov, is to be congratulated on his excellent rendering into English, especially of the large new terminology.

D. Denny-Brown.

Hypothetical Ethnology.

Peoples and Problems of the Pacific. By J. Macmillan Brown. In 2 vols. Vol. 1. Pp. xiv + 327 + 65 plates. Vol. 2. Pp. x + 297 + 32 plates. (London: T. Fisher Unwin, Ltd., 1927.) 50*s.* net.

IN these two closely packed, well-illustrated volumes, Dr. J. Macmillan Brown has collected a number of articles written during the last fifteen years for various magazines, newspapers, etc., and it must be admitted that the book rather suffers from its journalistic origins. It is the record of many wanderings throughout the Pacific, and contains a great number of original observations and suggestions on the past, present, and future of the Polynesians. In this, as in his previous books, Dr. Macmillan Brown lays great stress on movements of upheaval and depression in the area, and refers to accounts of islands which later have become submerged. He heard in the Cook Islands that the island of Tuanaki had disappeared about the middle of last century. If this be so, W. T. Brigham had not been informed, as he describes it as being an uninhabited atoll ("Index to the Islands of the Pacific Ocean," 1900). An interesting reference is made (vol. 1, p. 188) to Malden Island; it is reported to contain ruined pyramid-temples and paved roads, and thus deserves careful investigation. Malden is quite incapable of supporting human life, and "the people who built the temples could not have lived on the island as it is. Probably they lived on fertile archipelagoes within canoe-distance of its shores," as uncharted shoals exist in its neighbourhood.

Dr. Macmillan Brown also is of opinion that the great ruins of Ponape in the Carolines "cannot be explained without assuming a submerged empire with millions of inhabitants." He argues that the culture of Ponape was due to a Polynesian migration bringing with it kava, father-right, and megalithism. It is true that kava drinking, which also occurs in Micronesia only in Kusaie and Ponape, is a characteristic Polynesian custom. Christian and Rivers have suggested that probably it was not an independent invention, but merely a retention of one element of betel chewing, which was developed in Oceania into a ceremonial rite. Kava drinking was unknown in Torres Straits (vol. 1, p. 104). Dr. Macmillan Brown adds, "Hereditary chieftainship could have come from Polynesia alone, the realm of father-right; but Williamson states that in most of the Polynesian islands women were qualified to succeed, and that the line of succession could pass through women" ("Social and Political Systems of Central Polynesia," 1924, vol. 3, p. 395), though, as a matter of fact, succession was practically invariably in the male line. Rivers says, "If the succession of women to the dignity of chief be put on one side as capable of special explanation, it becomes probable that such indications of matrilineal institutions as are found in Polynesia are to be connected with the earlier stratum of the population" ("History of Melanesian Society," 1914, vol. 2, p. 322). It therefore appears that the predominance of patriliny (father-right) in Polynesia is relatively recent. Hereditary chieftainship could as readily have come from the west, and W. J. Perry as easily disposes of hereditary chieftainship, megalithic remains, and many other matters as being brought into the Pacific from the west by the 'Children of the Sun'; but he has nothing to say about kava. The third argument is based on megalithic structures; such certainly occur in Polynesia, but they are also to be found in Melanesia, Indonesia, and Asia. However, our author goes on to say, "there are features in the architecture of this wonderful city [Metalanim] that never came from Polynesia"; these he traces to a later movement from Japan.

The author is a strong supporter of the thesis that there were great land masses in the central Pacific which have only recently disappeared. On these very hypothetical lands the Polynesians developed their civilisation, untouched by foreign cultures, and it was due to their submergence that the Polynesians migrated westwards. By a linguistic argument he comes to the conclusion that the Polynesian language was brought into the Pacific lands by the first migration in the "Old Stone Age . . . at least twelve thousand years ago" (vol. 2, pp. 175, 176), and with it came the race that contributed traces of blond hair that still persist in Polynesia; but apart from this "there is sufficient in the physique of the Polynesians to point to western Europe as their origin and home," and he suggests that "Polynesian physical characters point through Japan and Central Asia to Western Europe" (vol. 2, p. 153)! The facts upon which he bases many of his theories admit of other solutions, and in not a few instances the data themselves are open to question. The reader should be warned that specialists in the various subjects dealt with in this book do not regard Dr. Macmillan Brown as a safe guide to follow.

Many interesting and suggestive remarks are made by Dr. Macmillan Brown about the present and future economic and political problems of the Pacific. A historical sketch of ancient empires

paves the way to a consideration of Japan and what may happen there. He regards British Columbia and New Zealand as "the sure naval shields of the English-speaking peoples in the Pacific"; indeed, he prophesies a great future for New Zealand, but is pessimistic about the United States of America. The strictures on the condominium in the New Hebrides are outspoken and timely—if they are not too late; the present writer has recently had information from Malekula which shows the unsatisfactory nature of this compromise—but indeed it is generally admitted.

The decay of the native population in Oceania is discussed in several places, and our author comes to the following conclusion, for which there is much to be said: "If our paternal governments and our missionaries mean to save our primitive peoples from themselves and death, they must recognise the law of struggle and work as the only panacea. They must study their manners and customs and see how far they can modify these so as to make them methods and stimuli to work."

A. C. HADDON.

Crystal Surfaces.

The Nature, Origin, and Interpretation of the Etch Figures on Crystals. By Prof. Arthur P. Honess. Pp. xiii+171. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1927.) 17*s.* 6*d.* net.

IT is probably evident to many others besides specialists how greatly the science of crystals has lately progressed by the introduction of the X-ray method. Brilliantly created some fifteen years ago by Laue, and simplified and developed by Sir William and W. L. Bragg, the method early led to convincing deductions of the atomic arrangements within certain crystals; and almost immediately was also applied by Moseley to the elucidation of the atom itself. After a marked pause due to the War, the method has been systematically developed in many directions, not least actively in its original rôle as a crystal probe. The purely crystal development has in fact been so rapid that a general halt is now recognisable, not in the number of workers or of their results, but in the kind of results. It is probably true to say that there has been no advance in principle for the last three years.

It therefore seems possible to make an estimate of the present position without incurring much danger of its being upset by immediate developments. Divested of all qualifications, it may be said that the X-ray method illuminates the interior of a crystal and casts shadows on its surface. Dürer's picture of "Melancholia beholding a Crystal" possibly acquires prophetic qualities!

The second half of the above conclusion doubtless needs support. From time immemorial have crystallographers been concerned with the problem of structure, although possibly only with limited curiosity: they would pry into the inside mainly in order to understand the outside. A partial understanding was first allowed to Haüy, according to whom the plane boundary faces correspond to the simpler planes, drawn through a close-packed stack of the presumed structural units. But subsequent accumulations of material gradually led to a knowledge of scores, if not hundreds, of substances the external planes of which bear no thoroughgoing, simple relation to any conceivable structure. Bravais in the middle of the last century and Fedorov at its close had to leave much unsimplified. In this they have been strongly supported by the X-ray method, which adds considerably to the sum total of perplexities. A single example will serve as an illustration.

Early in his career, Haüy felt quite sure about the shape of the barytes unit—an orthorhombic prism, walled-in by cleavage planes and of a modest altitude. Later workers equally confidently doubled the height, as giving a slightly simpler correlation between boundary planes and structure. Fedorov was not so certain. In his "Krystallreich" (a catalogue critically arranged according to classical conceptions of structure) he places barytes here; its isomorph potassium perchlorate there; and potassium beryllio-fluoride elsewhere (others would have placed all three together). The X-ray results show that Fedorov was right for barytes and wrong for the perchlorate (for the beryllio-fluoride there is still no evidence). It must here be interpolated that Fedorov's treatment of barytes seems to have been guided by instinct rather than a close adhesion to his own expressed principles. In any case, the X-ray results prove that the crystal distances along the front-to-back direction of barytes are twice those advocated by any crystallographer, simpler-minded than Fedorov. Inferentially, structurally simple planes are not always observed on a crystal, giving place to complex planes. Conversely, omnipresent cleavage planes may be structurally complex.

The present-day position is now perhaps realisable. The relation between form and structure, after being deemed simple and then less simple, must be recognised as being complex now that

exact information concerning structure is available. It is of course not impossible that another Haüy may bring about a tolerable synthesis of cause and effect, but it seems more probable that another Laue must first appear—one who shall conceive of a method of examining surfaces as powerful as that which now penetrates into the interior.

In the meantime, crystallographers have obviously to carry on in their several spheres of work. Some, no doubt, will acquire the new X-ray technique in time to win results from simple compounds, while others, whose field of work lies in the investigation of complex molecules, may hesitate to ponder whether the results justify an expensive equipment. Perhaps the majority will remain on the surface; either investigating new substances in the classical way; or seeking to classify morphologically the existing crystal kingdom for purely utilitarian ends (the identification of substances by crystal measurement); or in the pursuit of truth by a more intensive examination of individual crystals—which brings us to the book under review.

It is now many years since students of crystal symmetry first recognised how important it is to supplement older observations on forms of growth by the more experimental method of a partial dissolution. The etch figures (plane or curved) thereby obtained frequently take up highly significant forms and orientations. The results are, however, only to be found in German monographs, so that any attempt to render them more generally available to English-speaking students is welcome, especially when it comes from one who has adopted this subject as his own province of work.

The work falls informally into two parts, general and special. In the former, divided into five chapters, the author presents a historical and well-documented discussion under the following main heads: introduction; methods; the process of growth of the etch figure and its interpretation; anomalous etchings; the etch figure and isomorphism. In the special section, occupying one long chapter of some eighty pages of text and illustrations (mainly photographs), are brought together the results of his own investigations on some ten mineral species, representing six classes of symmetry. A concise statement of conclusions brings the monograph to a close (except for a good index).

In offering any general criticism of the book, the reviewer is so conscious of its many good qualities that he would expressly ask a reader not to conclude from any indications of defects, that it is lacking in aim or achievement. Here and there one meets with doubtful expressions. The statement "theoretically, of course, a crystal cannot possess a curved face" leaves one guessing at the identity of the theory, which is sufficiently powerful to override a wealth of facts—if the author had extended his survey beyond the limits of the mineral kingdom, he would have been able to cite many cases of crystals making good their claim to develop curved surfaces under uniformly continuous conditions of growth. But quite apart from an occasional lapse, there seems to be more general grounds of dissatisfaction.

We are told in the preface that the book is a thesis offered by a candidate for the D.Sc. degree. Unfortunately, it has preserved not only the virtues but also the defects of its origin. It was no doubt originally advisable to bring together the author's own work and stress its importance by a wonderful series of photographs and diagrams, but now that the work is addressed to a wider audience, a less complete polarisation seems desirable. Many of the excellent photographs and diagrams of the special part seem badly needed in the first part, as well as others not included in the book. Anyone new to the subject might do worse than read the particular before the general.

Another element of weakness is possibly referable to the same antecedent. The author has elected to specialise in the older methods of investigation by microscope and camera, and there is no doubt still much to be done in this way. But much has also been done by the aid of the two-circle goniometer, the introduction of which first placed a three-dimensional measuring instrument in the hands of the crystallographer. A chapter on the results obtained by Goldschmidt, Wright, and others, would seem to be almost indispensable in any general account.

It is high time to turn, however, to the author's merits. Within his self-imposed limits he has covered much ground in an engaging way, the whole work being illumined by a simplicity of style which many will covet. He is ever cautious in drawing a conclusion, even if it be his own; and there is certainly no other such work in English (and probably not in German). The book can be confidently recommended to the attention of senior students, both on account of the importance of the subject and as a corrective to the text-book attitude that Nature is simple; and also to the researcher, as showing how one may hope to attain further information concerning surfaces by present-day methods. In any selection of material for such future work, a plea may perhaps be here

offered for the six thousand or so non-minerals catalogued by crystallographers. Although the kings and queens of the crystallographic pack may be minerals, there are surely not a few useful cards among the laboratory products the constitutions of which are known—not to speak of the embarrassing number of aces in the four hundred orthorhombic, monoclinic, and anorthic crystals, the symmetry classes of which are *a priori* fixed by the Pasteur principle. The extensive application of the etch method to such first-rate material would seem to be bound up with any serious attempt to define its standards. T. V. B.

Our Bookshelf.

Kostychev's Plant Respiration. Authorised edition in English with editorial notes. By Dr. S. Kostychev. Translated and edited by Prof. Charles J. Lyon. Pp. xi+163. (Philadelphia: P. Blakiston's Son and Co.; London: Arthur F. Bird; American Book Supply Co., 1927.) 2.50 dollars.

THIS book seeks to do what has not previously been attempted, namely, to outline the main features of plant respiration. There is no student of this subject better qualified to write on it than Prof. Kostychev. Trained by Palladin, among others, and long an active worker on the chemical problems associated with fermentation and respiration, he is in a position to present a balanced and authoritative discussion of a subject in which Russian workers have long been leaders.

As might be expected from the author's researches, attention is focused principally upon the biochemistry of respiration, and particularly upon the establishment of the theory of the connexion between the intermediate products of alcoholic fermentation and 'normal' respiration in the presence of oxygen. While the author expressly states that this is only a working hypothesis, he marshals his facts ably and presents a most attractive case in its support. Kostychev undoubtedly lays very great stress upon his discoveries that partly fermented sugar solutions not only greatly increase the rate of respiration in oxygen, but will also liberate carbon dioxide in quantity when acted upon by an oxidase system. He clearly regards the former fact as good evidence for the view that oxygen respiration starts with the intermediate products of alcoholic fermentation, and the second fact accounts for his preference for the Bach-Engler theory of oxidation. He states very clearly alternative explanations and theories.

It is in this broad statement of Kostychev's point of view that the great interest of the book will be found. It should not be assumed, however, that other aspects of respiration are ignored. Adequate space is given to the relation between external conditions and respiration, including fermentation, and there are valuable outlines of methods used in measuring the products of these processes. The translator and editor has judiciously amplified these, and has added many references which serve to bring the extensive bibliography up-to-date. The author has also added an account of Warburg's theory of respiration which was absent from the original German edition. There is, finally, an interesting attempt to co-ordinate the various processes in the respiration of different types of plants, on the basis of the ratios of oxidising to fermenting enzymes which are present. W. H. P.

Air Ministry: Meteorological Office. The Observatories' Year Book, 1924: comprising the Meteorological and Geophysical Results obtained from Autographic Records and Eye Observations at the Observatories at Lerwick, Aberdeen, Eskdalemuir, Cahirciveen (Valencia Observatory), and Richmond (Kew Observatory), and the Results of Soundings of the Upper Atmosphere by Means of Registering Balloons. (M.O. 289.) Pp. 366. 57*s.* 6*d.* net. *Year Book, 1925.* (M.O. 229.) Pp. 372. 63*s.* net. Published by the Authority of the Meteorological Committee. (London: H.M. Stationery Office, 1927.)

THE appearance during 1927 of two issues, for 1924 and 1925, of the "Observatories' Year Book" of the Meteorological Office indicates notable progress in overtaking arrears of printing due to post-War causes; it may be hoped and expected that a continuance of this acceleration of printing will soon lead to the attainment of the ideal practice of publishing each year's observations before the close of the following year. The volumes include an immense amount of standard observational data for meteorology, terrestrial magnetism, and seismology, made efficiently by good observers and published in concise, economical form. The period in question was marked by the retirement from Kew Observatory of Dr. C. Chree, who had been superintendent for thirty-two years; he was succeeded by Mr. F. J. W. Whipple. At the same time, 1925, the Kew magnetographs were discontinued, and their place was taken by Galitzin seismographs brought from Eskdalemuir; Kew thus succeeds Eskdalemuir as the official seismological station in the British Isles. The last-established observatory under the Meteorological Office is that at Lerwick, in the Shetlands; its work is almost wholly confined to atmospheric electricity, terrestrial magnetism, and auroræ; many experimental difficulties, not wholly overcome by the end of 1925, have been experienced with the instruments installed there.

Meteorology. By David Brunt. (The World's Manuals.) Pp. 112+8 plates. (London: Oxford University Press, 1928.) 2*s.* 6*d.* net.

THE aim of this book is, in the author's words, to give "a brief sketch of the physical principles underlying the phenomena which constitute 'weather,' in so far as this is possible without mathematical analysis."

The absence of mathematical formulæ and the small size of the book, together with a certain

simplicity of style, may combine to give the impression to a meteorologist who may casually glance at it, that he has before him one of those entertaining little handbooks in which the presence of numerous inaccuracies is regarded by the author, if he should happen to be aware of them, as a matter of small importance, seeing that few readers will be likely to detect them. A more careful perusal of the book will dispel this impression: not only will he find a high standard of accuracy, but he will see also that a serious effort has been made, and with a considerable degree of success, to give a picture of the development of meteorology as a branch of physics and some suggestion of the lines along which it may advance in the future.

There is no account of practical weather forecasting—a wise omission in view of the size of the book and the predominant part played by unsystematised experience in the 'science' of weather forecasting; on the other hand, a whole chapter is set apart for the important subject of the reception of solar radiation by the atmosphere. The general and local circulations of the atmosphere are admirably dealt with, having regard to limitations of space.

Some knowledge of physics is essential to anyone who wishes to appreciate fully the later chapters, but these chapters should nevertheless be very instructive to those whose only knowledge of physics is 'picked up' in the earlier chapters.

The printing and the illustrations of cloud forms and lightning are both exceptionally good, and the work can confidently be recommended for educational purposes.

A Handbook of the Birds of Iceland. By Masa U. Hachisuka. Pp. v + 128 + 7 plates. (London: Taylor and Francis, 1927.) *12s. 6d.* net.

THE Honourable Masa U. Hachisuka is a very young ornithologist, but his work—his first, we understand, of any magnitude—shows that he is keen, industrious and methodical, and, though it is an ambitious attempt for a first work, there is little doubt it will prove most useful. We congratulate the author, not only on his pluck in undertaking it, but also on the result itself.

The author admits a total of 141 birds actually found, either as straggler, regular visitor, or resident in Iceland. A few of the birds mentioned he admits as 'non-proven,' and one new species, *Calidris maculata*, the American Pectoral Sandpiper, he adds as new to the Iceland list. The author's remarks on the various geese sum up our knowledge of these birds to date and are interesting. He considers it reasonable to believe that the pink-footed goose breeds in Iceland, and, though he admits the Bean goose on very slender evidence, probably indeed quite insufficient, he agrees that it never breeds there.

The photographs with which this little book is fully illustrated are quite good, though we fear that the plate giving the comparative size in diagram form of the eggs of ducks and geese will not be of very much use, as the overlapping of dimensions in big series of these eggs is very great. We shall look forward to further works on birds by Mr. Hachisuka, and recommend this, his first, to all those who intend to visit Iceland to study ornithology. It summarises in a compact form much scattered information and will save Icelandic visitors an immense amount of research and trouble.

The Crustaceans of South Australia. By Herbert M. Hale. (*Handbooks of the Flora and Fauna of South Australia*, issued by the British Science Guild (South Australian Branch), and published by favour of the Honourable the Premier.) Part 1. Pp. 201. (Adelaide: Harrison Weir, 1927.) *5s.*

FULL descriptions and good illustrations of all the South Australian Malacostraca are given in this useful book. It is intentionally written in a popular way, and quite untrained naturalists should be able to identify any species, whilst the specialist is greatly helped in having this book for reference. The malacostracan fauna of South Australia is large and of great interest, and obviously many problems are only waiting for the worker to elucidate them. This seems specially the case with the life histories, so little being known about the larval forms and the few notes given suggesting so much. Some of the Reptantia hatch in a very late stage of development. It is well known that members of the family Potamonidæ hatch as forms very like the parent, the truly larval stages taking place within the egg. In South Australia we find other crabs with the same peculiarities. Thus some of the Dromiidæ are known to hatch as tiny crabs, having no free-swimming stage and sheltering under the body of the parent; other species with very large eggs are probably similar.

Notes on habits and biology make the book readable as well as valuable, and the low price places it within reach of anyone interested in the group.

Proceedings of the London Mathematical Society. Second Series. Vol. 26. Pp. ii + 558. (London: Francis Hodgson, 1927.) n.p.

THIS volume of *Proceedings* maintains the usual high standard of the London Mathematical Society's publications. Of the thirty-two papers it contains, twenty deal with various aspects of the modern theory of functions, four with geometry, and three with applied mathematics. This preponderance of function theory should be regarded more as an indication of the tendency of present-day mathematical research in Great Britain than as a sign of the relative importance of the subject. When Cayley and Sylvester, Clifford and Smith, dominated mathematical development, papers on geometry and invariants were paramount, while recent volumes of the *Transactions of the American Mathematical Society* contain a large proportion of papers on non-commutative algebra, a subject which has scarcely been touched by British mathematicians. Meanwhile, the higher function theory is enjoying a protracted run which is likely to continue until there arises an outstanding leader inspired to direct research activities into some other branch of pure mathematics. W. E. H. B.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Relations of Nile and Faiyum in Pliocene and Pleistocene Times.

DURING the past winter we have had an opportunity of investigating, under the auspices of the Oriental Institute of the University of Chicago, the Pliocene and Pleistocene geology of that part of the Nile Valley adjacent to the Faiyum depression, and it has occurred to us that some of the results may interest readers of NATURE who followed some time ago a discussion of certain archæological problems of the Faiyum and its lakes.

It has long been known that the northern part of the Nile Valley was occupied by an arm of the sea in early Pliocene times and that a marine fauna was succeeded by an estuarine one, which lasted until the close of the Pliocene epoch. This indicates a Lower Nile Valley cut to much its present form in pre-Pliocene times.

Fossiliferous marine strata have now been found to a height of 100 metres above sea-level, resting on the old valley side, with a gulf stretching into the southern part of the Faiyum basin. They had been eroded before the deposition of the estuarine beds, which are found upon them and filling hollows in them. The deposits have now been connected with a remarkable system of lateral valleys, which drained a part of the Libyan plateau and in Upper Pliocene times became choked with boulders and gravel. The fossil valleys are in all stages of dissection, some standing out as the most prominent ranges of hills in a soft Eocene country, eroded below their base, others still retaining substantially their original form. Some of the valleys flowed across the region which is now the Faiyum, some draining directly into the Nile Valley and one or more into the southern Faiyum gulf already partially filled with marine and estuarine strata. Part of the northern side of the basin is now bounded by one of these dissected Pliocene valleys, cut along the boundary of the Eocene and Oligocene beds. While the Eocene marls on the southern side of this old valley have been entirely removed by erosion, the harder Oligocene rocks on the north still stand as a high escarpment above the Pliocene filling. The Faiyum basin, as such, did not exist in Pliocene times, and the southern gulf was probably but a flooded pre-Pliocene tributary of the Nile.

The Nile Valley returned to normal fluvial conditions in Plio-Pleistocene times, when a magnificent series of terraces was cut along its western side, the river at times meandering over the eastern part of the region now the Faiyum. The terraces with Nile gravel first appear at 470 feet above Nile, and below this three successive river channels may be identified to 150 feet, which stage seems immediately to have preceded Pleistocene times (assuming for convenience that the incoming of Lower Palæolithic man marks the beginning of that epoch in Egypt).

There follows the most extensive remaining channel, with a marginal level of about 60 feet. This contains Lower Palæolithic implements, while at a similar level a fragment of terrace or beach containing implements has been found inside the eastern boundary of the basin.

Prior to the Middle Palæolithic, the Faiyum seems to have been dissected by normal processes of stream and river erosion, in harmony with the rest of the Libyan plateau. But, owing to the extremely soft strata locally exposed, a broad plain had been formed at a low level, and the drainage of this could only escape into the Nile by cutting a narrow passage (the Hawara Channel) between two of the Pliocene valleys choked with virtually indestructible materials. In Middle Palæolithic times this plain first appears definitely as a lake, and for the first time we find a reversal of drainage. In the Nile Valley a Middle Palæolithic terrace has been found at about 25 feet, sweeping through the Hawara Channel and falling as it does so. On the inside it passes into shoals, a beach, and a storm-beach, which have been followed and mapped along the eastern side of the Faiyum. Implements and fossil Mollusca have been found *in situ* throughout this series.

At a slightly lower level, with an increased tilt towards the Faiyum, another similar series has been found, of Sebilian, probably Lower Sebilian, age. (Sebilian is the term applied by M. E. Vignard to a post-Mousterian industry of Capsian affinity in Upper Egypt, and we now find it *in situ* at this level in Lower Egypt.)

Succeeding stages in the Nile Valley and in the Hawara Channel are hidden below the level of recent alluvium, but it will be remembered that the extremely valuable work of Miss E. W. Gardner proved the existence of two lower lakes in the Faiyum. Miss Caton-Thompson showed the more recent to be Neolithic, but the age of the older remained in doubt. On the east side of the Faiyum, where its magnificent storm-beach first appears, such evidence as we have collected is suggestive of a probable Upper Sebilian age. Accurate levelling was carried to the point of meeting with Miss Gardner's lakes on the north and south sides of the basin.

There is no sign of desert conditions in Palæolithic times in the region with which we have dealt; on the contrary, the rainfall was heavy. Levels set certain bounds to the size of any lake, and in view of the climate and the essentially fresh-water fauna of the Palæolithic lakes, it would appear that the water flowing in from the Nile returned to it at times, with the local drainage water, by the Hawara Channel. No evidence has been found that there was ever any other inlet from the Nile. The presence of the fresh-water fauna at a sufficiently low level on the divide between the Faiyum and Wadi Rayan to the south-west leads us to suppose that the latter was flooded in Mousterian times.

The excavation of that part of the Faiyum basin below sea-level must, in view of the above, be relegated to late- or post-Sebilian times, when the Nile cut a deep channel, now choked with alluvium of unknown thickness. The rise in the bed of the Nile, with the deposition of this alluvium, seems to have synchronised with the inception of desert conditions. The cutting off of rainfall prevented local detrital material from silting up the Faiyum basin and it became a 'sump' of the rising Nile, with a bottom below the new sea-level. The evidence recently published by Miss Gardner that the old lake bed was drained and eroded before the advent of the Neolithic lake here acquires new significance.

We find it difficult to believe that the Faiyum was excavated by any other means than fluvial erosion, although the modifications to which it has been subjected since the incoming of desert conditions are obvious. In view of this, the conclusion seems to be inevitable that a gorge of about the same depth as the Nile Valley was cut beneath the

Hawara Channel and has since been filled with alluvium.

The work will be published in full by the Oriental Institute of the University of Chicago.

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The Origin of the Spectrum of the Solar Corona.

THE arguments which have been brought forward to explain the origin of the spectra of nebulæ may be used with certain modifications to explain the spectrum of the solar corona; for it must be composed of such atoms thrown out by radiation pressure or other agencies from the general atmosphere of the sun. On account of the lower temperature of the sun, the atoms concerned should be non-ionised, or such as can be easily ionised. They should also be light. All these considerations narrow down the choice to a very few elements like Li^+, Be^+, B^+, C, N, O . . . Si, P, S, P^+, and S^+, etc. It is the object of this note to discuss how these elements can give rise to the coronal spectrum.

It is now generally recognised that matter above the solar photosphere is largely supported by radiation pressure acting in a selective way. Prof. Milne has shown from transition probabilities of the Ca^+-atom (or the average life), that Ca^+ emitting the H-K lines is subjected to such a large radiation pressure that it almost overcomes the force of gravity. If this argument be true, the logical consequence would be to extend it to other elements. We can leave out H and He because their resonance lines are in the extreme ultraviolet and their normal atoms would be subjected only to slight radiation pressure. But such is not the case with Li. The resonance line of Li is at 6708 A., the corresponding $E_\lambda = 0{\cdot}8\ E_m$, the maximum emission E_m of the sun regarded as a black body at 6500° K; hence the force of radiation would more than balance the force of gravity; it would be expelled entirely from the solar atmosphere. It can be retained only in the ionised form. The entire absence of Li-lines from the Fraunhofer spectrum seems to support this view. If Li^+ be present, it may or may not be detectable, as the fundamental lines are in the Schumann region, and the excitation required to bring out the next important lines will be too large. The only favourable line is λ5484·69, or λ5484·90 (Rowland's Scale—a very weak line is given at 5484·846 in Rowland's Table, but the identification is doubtful), which belongs to the singlet system of Li^+ $(2S - 3P)$. Similar considerations would apply to Be^+ and B^+.

In carbon we come across a new feature. This new feature is best explained by taking the case of Si, for which the full details of the spectrum are known. Si has five fundamental levels, $^3P_{0\,1\,2}$, $^1D_2$, $^1S_0$, all arising out of the combination pp (or M_2M_2). The next combination is $ps(M_2N_1)$, and it gives rise to $^3P_{0\,1\,2}$, $^1P_1$. The lines are shown in the accompanying table, the figures being taken from Fowler, *Phil. Trans.*, vol. 225, p. 45. The table shows that the $(^3P - {}^3P)$ lines are the most fundamental, but their wave-length is at λ2514 - 2528, while the less fundamental $^1S_0 - {}^1P_1$, $^1S_0 - {}^3P_1$ lines are at λ4103, λ3905. Si is in fact detected in the sun by those two lines, some other subordinate lines, and some lines of Si^+. The problem now arises that if we *heat Si to incandescence, to say 4000° C., so that the* corresponding wave-length of the maximum emission is towards the red, will the group at λ2514-2528 be more intense or the lines λ4102, λ3905? Laws of temperature radiation demand that λ4102, λ3905 will be more intense, while the theories of spectra require that λ2514-2528 will be more intense at all temperatures, *as the $^3P_{0\,1\,2}$ states will be much more numerous* than the $^1S_0$-states $\left(n_{1_S}/n_{3_P} = e^{-\frac{22000}{T}}\right)$, and there is always a greater tendency on the part of the higher excited $^3P_{0\,1\,2}$, $^1P_1$ states to revert to the more fundamental state.

L_2L_3. L_2M_1.	$^3P_0$.	$^3P_1$.	$^3P_2$.	$^1D_2$.	$^1S_0$.
$^3P_0$		2524·118 39605·89(8)			
P_1	2514·331 39760·04(7)	2519·210 39683·03(7)	2528·516 39537·01(9)	2987·65 33461·39	4102·945 24365·89(5)
P_2		2506·904 39877·83(9)	2516·123 39731·73(10)	2970·35 33656·27(1)	
$^1P_1$	2438·782 40991·64(3)	2443·378 40914·54(3)	2452·136 40768·42(3)	2881·585 34692·97(10)	3905·515 25597·61(9)

An experiment was performed at this laboratory by Messrs. Majumdar and Kichlu to decide this question. They did not work with silicon, but with the more easily manageable thallium. This has two fundamental states, $2p_1$, $2p_2$, separated by a large interval $\Delta\nu = 7793$, so that $n_{2p_2}/n_{2p_1} = \frac{1}{2}e^{-\frac{25011}{T}}$. They heated thallium in a vacuum graphite furnace to about 2500° A. and photographed the spectrum of thallium vapour. The $2p_1 - 3s$ line has the wave-length λ3775·72, the $2p_2 - 3s$ line has the wave-length λ5350·46. As the $2p_1$ state is about a hundred times more in abundance, we expected that the line λ3775·72 would be more intense; at any rate it would not have less than half the intensity of λ5350·46 (because the weights of $2p_1$ and $2p_2$ states are as 1 : 2). But λ5350·46 was at least ten times more intense than λ3775·72. This fact is therefore more in accordance with the view that thallium vapour is partly in equilibrium with temperature radiation from the walls. But still we have to find out why the larger proportion of the $2p_1$-atoms is maintained. This is met by assuming that the prohibited transition $2p_1 - 2p_2$ occurs in large proportion—in other words, under the influence of the existing field of radiation, most of the thallium atoms in the $3s$-state return first to the $2p_2$-state, and then from the $2p_2$-state they return by the prohibited transition to the $2p_1$-state, so that the equilibrium between the proportion of atoms between the $2p_1$- and $2p_2$-states is maintained by the prohibited transition, which marks the emission of the line $\nu = 2p_1 - 2p_2$.

Turning now to the case of silicon in the sun, we find that the same argument can be applied. The emissivity of the sun is almost a maximum at λ4102 and λ3905; at λ2500, the emissivity is about 0·57 of the maximum. When silicon atoms are traversed by a radiation field of this type, we shall find that transitions corresponding to the emission of $^1S_0 - {}^1P_1$, $^1S_0 - {}^3P_1$ of silicon will be very frequent, while the transitions $^3P_{0\,1\,2} - {}^3P_{0\,1\,2}$ will be too small. The proportion between the fundamental ^3P and metastable $^1D_2$, $^1S_0$ levels will be maintained by the prohibited transitions $^3P_1 - {}^1S_0$, $^3P_{1\,2} - {}^1D_2$. Also it follows that if the transitions from the excited $^1P_1$, $^3P_1$-state to the $^1S_0$-state are as numerous as in the case of calcium, then silicon, being much lighter

than calcium, would be thrown out into the corona in the metastable state $^1S_0$. Hence the coronal spectrum would show the prohibited transition.

If these hypotheses regarding the presence of silicon be correct, we should expect the following deductions to be verified:

(1) The Fraunhofer spectrum of the sun should show the line corresponding to $^3P_1 - {}^1S_0$, $\lambda = 6527{\cdot}05$ (Rowland Scale). Rowland's table shows a line at $\lambda 6526{\cdot}89$, intensity zero. The agreement is not satisfactory.

(2) The coronal spectrum should also show this line. There is a line of approximately this wave-length in Father Cortie's table of coronal lines; the wave-length is given as $\lambda 6528{\cdot}9$.

(3) The silicon lines $\lambda 4103$ and $\lambda 3905{\cdot}67$ should be high chromospheric lines. This is not quite confirmed; in Mitchell's tables they are stated to reach only heights of 500 km. and 800 km. This may be due to paucity of transitions from the $^1P_1$-state to the $^1S_0$-state.

Excited silicon atoms may or may not (in the $^1S_0$-state) form a constituent of the corona. But the above arguments will apply to other suitable elements. I have chosen silicon for illustration because we know all about its spectrum. The same cannot be said of carbon, nitrogen, and oxygen, to which similar arguments can be applied, because in these cases the differences in value between the metastable states are only roughly known. To take carbon; this has an ionisation potential of about 11·3 volts; the spectrum is in all respects similar to silicon. The fundamental $^3P - {}^3P$ lines are at $\lambda 1656$-1658, but the metastable $^1S_0 - {}^1P_1$-line is probably the line $\lambda 2478$. Hence it can be stated that metastable carbon atoms, being very light, would be thrown into the corona, and there give rise to prohibited transitions $^3P_1 - {}^1S_0$, $^3P_{1\,2} - {}^1D_2$. The electrical field in the corona would increase the number of transitions. The frequencies of such lines are of the same order as the frequencies of the more intense coronal lines, but whether they agree absolutely will depend upon the exact determination of the value of these terms.

Similarly, prohibited transitions between the fundamental levels of N and O, P and S, P^+ and S^+, may account for some of the coronal lines. The present spectroscopic knowledge of the metastable states of these elements is so meagre, and the wave-lengths of the coronium lines are so roughly known, that I have not yet tried to institute any search for their origin amongst these states.

Meghnad Saha.

Mammoths and Man in the Transvaal.

Prof. Dart's paper in the Supplement to Nature of Dec. 10, 1927, on "Mammoths and Man in the Transvaal," followed by Dr. R. Broom's letter in the issue of Mar. 3, 1928, under the same title, renders desirable the immediate description of two elephant teeth kindly sent to me by Curator Wilman, of the McGregor Museum at Kimberley, South Africa, in 1926 and 1927.

The first type (represented in Fig. 1) I name *Archidiskodon subplanifrons*; it is a low-crowned, broad-plated, heavily cemented tooth, apparently a third inferior molar of the right side (McGregor Mus., 3920). The specific name *subplanifrons* refers to the fact that the crown height—from 2 to 2½ inches—is about equal to that of the low-crowned types of *Elephas planifrons* Falconer of the Siwalik Hills, India; in some of Falconer's Upper Siwalik specimens the crown rises from 3½ to 4½ inches. The present specimen accordingly is believed to be of Upper Pliocene age.

In the second type (Fig. 2) the anterior half of a third superior molar, probably of Pleistocene age, we observe a far more progressive stage, with lofty ridge-plates, the sixth attaining a height of 5 inches, equal to that of certain specimens of *Archidiskodon meridionalis* in which the ridge-plates equal or exceed 5 inches. This relatively high-crowned type (McGregor Mus., 3682) I name *Archidiskodon broomi*, in honour of Dr. Robert Broom, who, after the specimen was named in MS. and figured by myself, requested that one of these molars should be named after Mr. W. Millett, who discovered the type of *A. subplanifrons* at a depth

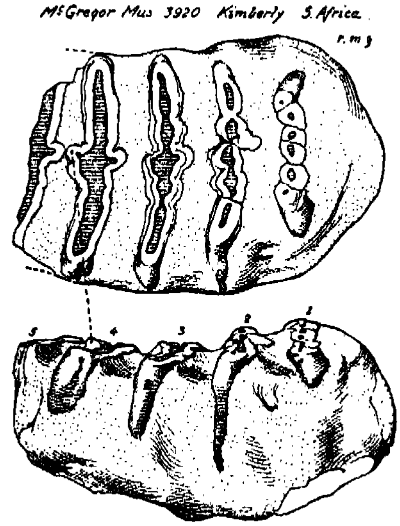

Fig. 1.—Type third inferior molar of *Archidiskodon subplanifrons* sp. nov., from the Upper (?) Pliocene, Sydney-on-Vaal, Vaal River diggings, South Africa, one-sixth natural size. McGregor Mus. 3920, Kimberley, South Africa; cast Amer. Mus. 21924.

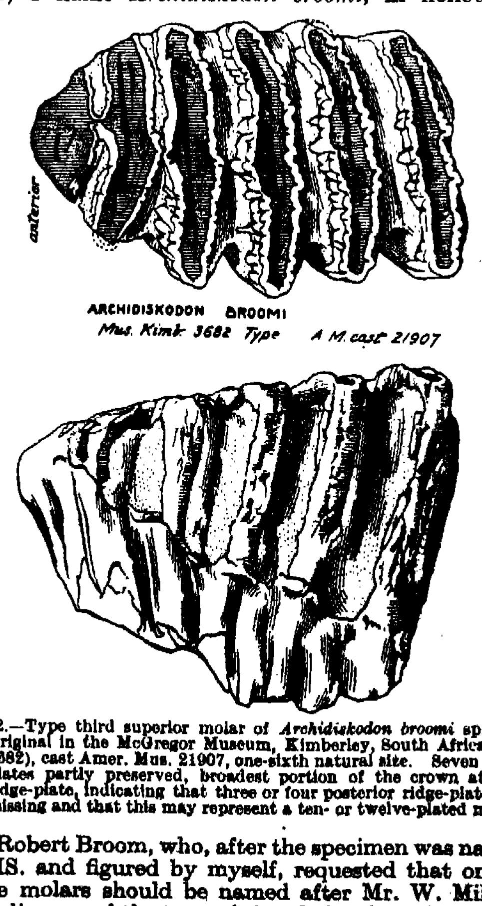

Fig. 2.—Type third superior molar of *Archidiskodon broomi* sp. nov. Original in the McGregor Museum, Kimberley, South Africa (No. 3682), cast Amer. Mus. 21907, one-sixth natural size. Seven ridge-plates partly preserved, broadest portion of the crown at fifth ridge-plate, indicating that three or four posterior ridge-plates are missing and that this may represent a ten- or twelve-plated molar.

of from 50 to 60 feet in the Vaal River diggings near Sydney-on-Vaal.

Neither of these new types is as progressive or as elevated in crown structure as the types of *Archidiskodon transvaalensis* Dart, 1927, or *A. sheppardi* Dart, 1927, in which the posterior portion of the crown of the third superior molar in *A. transvaalensis* attains a height of 247 mm., or 9¾ inches, far exceeding the height recorded even for the corresponding molar of *A. meridionalis*; it also exceeds the height of the American species *A. columbi* (7 inches), but is far below the height of the very tall ridge-plates of *A. imperator* (10½ inches). Consequently we attribute a relatively recent Upper Pleistocene age to *A. transvaalensis*.

THE AFRICAN CENTRE.

Apart from this evidence of at least three progressive stages in the evolution of Archidiskodon, a genus hitherto known only in the northern hemisphere, is the increasing proof of the existence in southern and central Africa of many different kinds of proboscideans,[1] which will shortly be reviewed by Mr. Arthur T. Hopwood, of the British Museum (Natural History). Pending this thorough examination of past and original materials, I am inclined to summarise the previous discoveries, including the present descriptions, as follows:

ORIGINAL DESCRIPTION.	PRESENT REFERENCE.
Loxodonta griqua Haughton, 1922, type, Griqualand West, Transvaal	= *Archidiskodon griqua*.
Elephas (*Loxodon*) *zulu* Scott, 1907, type, Zululand	= *Loxodonta* (*Pilgrimia*) *antiqua zulu*.
Elephas zulu, referred by Hopwood, 1926, Kaiso bone beds, near Lake Albert	= *Loxodonta* (*Pilgrimia*) *antiqua zulu*.
Elephas antiquus Recki Dietrich, 1916, type, Oldoway, British East Africa	= *Loxodonta* (*Pilgrimia*) *antiqua recki*.
Elephas aff. *meridionalis* Nesti, 1825, referred by Hopwood, 1926, from Kaiso bone beds, near Lake Albert	= *Archidiskodon meridionalis*.
Archidiskodon transvaalensis Dart, 1927, type, lower Vaal River gravel terrace	= *Archidiskodon transvaalensis*.
Archidiskodon sheppardi Dart, 1927, type, lower Vaal River gravel terrace	= *Archidiskodon sheppardi*.
Archidiskodon subplanifrons sp. nov., upper (?) Vaal River gravel terrace	= *Archidiskodon subplanifrons*.
Archidiskodon broomi sp. nov., lower (?) Vaal River gravel terrace	= *Archidiskodon broomi*.
Mastodon (*Bunolophodon*) sp. Felix, referred by Beck, 1906, Waldeck's Plant	= *Mastodon* (*Bunolophodon*) sp.

The absence up to the present time of the distinctive lozenge-shaped grinding tooth which distinguishes the existing African elephant as the genus Loxodonta, is a striking circumstance. All the above new types belong either to the broad-plated and broad-crowned Archidiskodon or to the narrow-crowned type of tooth with much more numerous ridge-plates for which I proposed (1924) the generic name Pilgrimia, typified by *Elephas falconeri* Busk from Malta, also by *E. antiquus Recki* Dietrich, from Oldoway, northern British East Africa; numerous species of small elephants with grinders of this type have been described, extending northwards throughout Africa into the islands of the Mediterranean, none of which presents the true Loxodonta molar.

HENRY FAIRFIELD OSBORN.
The American Museum of Natural History,
New York, Mar. 21.

[1] A. T. Hopwood, "On some Mammalian Remains from Lake Nyasa," *Quart. Jour. Geol. Soc.*, London, vol. 83, pt. 3, pp. 442-444; 1927.

Natural Reactivity and the Origin of Species.

DARWIN'S theory of the origin of species presupposes the occurrence of occasional variants from the parent stock, of which some are preserved and fostered by natural selection. The cause of this natural variation has been sought in various quarters; and indeed it is to be presumed that it is due not to one cause, but to many. It is our purpose in this note to direct attention to an agency which must play an important, and may prove to play the predominant, part in producing variations among plants and animals.

It has been demonstrated for two forms of animal and plant life the antecedents of which have been known for many generations, namely, the fruit fly (Muller, *Science*, **66**, 84; 1927) and the tobacco plant (Goodspeed and Olson, *Proc. Nat. Acad. Sci.*, **14**, 66; 1928), that treatment with X-rays produces new and permanent varieties which far exceed those which occur normally, both in number and in degree of departure from the parent. Thus, when a bud of the tobacco plant was X-rayed, eighty per cent. of the resulting seeds which germinated were decided variants, and the extent of variation in this one planting was greater than had been observed in a study of the normal plant lasting over a quarter of a century. Some of these variants were not fertile, but many were, and in particular one giant form seems more fertile and more vigorous than the normal plant. Equally striking results were obtained with the fruit fly.

In Nature, all living things are exposed throughout the whole of their existence to gamma rays of low intensity which are due to widely distributed radioactive substances. It therefore occurred to us at the time the experiments with the tobacco plant were begun, to inquire what part this feeble gamma radiation might play in causing naturally occurring variations. This question has also been asked by Muller, but his data did not suffice for an answer. The tobacco experiments, however, were so planned as to permit a direct comparison with natural radiation.

It is true that the relative effect of rays of different frequency upon the production of variants has not been experimentally ascertained. However, since the rays can only be effective when they are absorbed, and thus produce ionisation, it seems safe to assume that the various rays will produce biological effects in proportion to the ionisation which they cause.

In one cubic centimetre of air, natural radiation produces per second about six ionisations, while the X-rays used in the tobacco experiments produced $2{\cdot}8 \times 10^8$. This ratio of about 5×10^7 will not be materially changed when we consider the ionisation in living tissue. The exposure to X-rays lasted about ten minutes and resulted in eighty per cent. of variants. We may substitute these figures in an equation based simply upon the law of probabilities, namely, $\log(N/N_0) = kIt$. Here N_0 is the original number of germ cells exposed, N is the number remaining unaffected at the end of the time t, and I is the intensity of the radiation in terms of ionising power. We thus obtain k, the constant of the process. From this equation we calculate that the same plants exposed to natural radioactivity for one year would produce two variants per thousand.

In this calculation we have considered only the surviving plants, no account being taken of the

occasional lethal effect of the rays. If the cells which have been killed are to be regarded merely as one type of variant, the calculation is unaffected. However, in the experiments with the intense X-rays a large fraction of the cells experienced several ionisations. This would be likely to increase relatively the number of cells destroyed, a view for which there seems to be some experimental evidence (for example, the work of Wood, quoted by Crowther, NATURE, **118**, 86; 1926). Any allowance made for this effect would increase the calculated number of variants produced by natural radiation.

We may, therefore, conclude that the number of variants caused per year in the tobacco plant by natural radiation is greater than two per thousand. The number of variants in the normal plants actually found per year in a prolonged study of this plant is estimated as lying between two and four per thousand. It seems, therefore, not altogether extravagant to assume that such variations as actually occur in Nature are due largely to the radioactivity of the environment. It becomes an extremely interesting task to ascertain whether, in those places where an exceptional accumulation of radioactive material occurs, any unusual variability of fauna and flora is to be observed.

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What becomes of Stellar Radiation?

ON the occasion of Dr. Jeans's magnificent lecture (NATURE, Mar. 24, pp. 463-470) Sir Oliver Lodge (*ibid.*, p. 462) asked: "What becomes of the radiation which the stars are continually pouring into space? . . . No one has yet been able to hazard even a plausible guess as to where it goes or is destined to go in a possible finite space." Formerly we should have been obliged to assume that it vanished into infinite space. Einstein's theory of relativity has, however, entirely changed this point of view, and to-day space must be regarded as finite. If a straight line starts from a star it does not go straight to infinity, but returns to the original source. I beg to conjecture or suggest that the radiation from a star may behave like the straight line and be brought back to its origin again, after having travelled around the universe.

According to Dr. Jeans, *light* would require for this return 100,000 million (10^{11}) years. As the stars are much older, some 10^{13} years (Jeans), a great part of their *radiation* might have been brought back to them, or to other stars in its way, which will again provide other stars with their energy, so that the energy which they have lost would be partly renewed in this way. The stars might be regarded as a kind of *perpetuum mobile*—to some degree, like a mill on the river. Thus the lives of the stars would be prolonged.

BOHUSLAV BRAUNER.
Bohemian Academy, Prague,
Mar. 27.

IT is, I think, generally recognised that light can travel round and round an Einstein universe in the way described by Prof. Brauner. Alternative universes have of course been imagined in which this cannot happen; that of de Sitter, for example, expands so rapidly that light can never get back to its starting point.

If light goes round and round, a certain fraction must inevitably re-enter the stars, but the faintness of the night sky seems to show that the fraction must be very small; if it were nearly unity we should see a star in every direction in space, and the sky would be a uniform blaze of light. The sun occupies about a hundred-thousandth part of the half-sky, so that if even one part in 100,000 of their light fell back into the stars, the night would be half as bright as the day. Or, if the radiation were transformed into heat on its journey, the heat received from the night sky would be equal to that received from the sun. The actual fraction, then, must be very minute.

Personally, I do not feel the difficulties of Sir Oliver Lodge and Prof. Brauner as to the ultimate fate of stellar radiation. Hubble estimates the average density of matter in space to be $1{\cdot}5 \times 10^{-31}$, so that the total annihilation of all the matter in the universe would produce an energy-density of $1{\cdot}35 \times 10^{-10}$ ergs per c.c., which would only raise the temperature of space from 0° abs. to 11·5° abs. The total annihilation of all matter outside the solar system would only raise the temperature of the earth's surface by 0·00018 of a degree centigrade, so that the radiation of ten thousand dead universes may be eternally wandering round space without our suspecting it. Space is so vast by comparison with the matter it contains, that discussing the ultimate fate of radiation seems rather like discussing the ultimate fate of a few lumps of sugar dropped into the Atlantic.

It is particularly hard to see how stray stellar radiation could create new matter. The creation of a single electron and proton, or of a hydrogen atom, requires a quantum of energy 0·0015 erg. Quanta *of this energy do not begin to appear until a temperature* of the order of 7,500,000,000,000 degrees is approached. Then, and not until then, there begins a free (reversible) transformation of energy between its two forms of matter and radiation. The statistics of such a process have been discussed by Stern (*Zeits. f. Elektrochem.*, **31**, 448; 1925; and *Zeits. f. phys. Chem.*, **120**, 60; 1926) and Jordan (*Zeits. f. Phys.*, **41**, 711; 1927), but in view of the foregoing figures the interest would seem to be academic rather than astronomical. A simple calculation shows that if the present universe were left to itself long enough for its total energy to distribute itself in thermodynamical equilibrium between atoms and radiation, the expectation of the total number of non-permanent atoms in the final steady state would be of the order of $e^{-mc^2/RT}$, or $10^{-420,000,000,000}$. The reciprocal of this, raised to a power equal to the total number of non-permanent atoms in the present universe, may be interpreted as the odds (relative to our present knowledge) in favour of the universe being a special creation and not a mere fortuitous concourse of atoms and radiation.

Apart from all calculation, the widely desired cyclic universe in which just as much matter is created as destroyed, would seem to be a universe already dead. Its entropy must be a maximum, otherwise the system could and would increase its entropy by irreversibly disturbing the balance between creation and destruction of matter. With universes, as with humanity, the only possible life is progress to the grave.

J. H. JEANS.

The Branchial Gland of the Cephalopoda: a Possible Endocrine Organ.

UP to the present day, no definite endocrine organs have been discovered in any invertebrates, though some evidence of adrenalin production in annelids has been obtained by Gaskell,[1, 2] and of an internal secretion of the testis in turbellarians by Vandel,[3, 4]

[1] *Phil. Trans. Roy. Soc.*, B, **205**; 1914.
[2] *J. Gen. Physiol.*, **2**; 1919.
[3] *C. R. Acad. Sci.*, 170; 1920.
[4] *Bull. Biol. Fr. Belg.*, **55**; 1922.

and in oligochæts by Harms.[5] The purpose of this letter is to direct attention to the probable endocrine significance of the branchial gland of the cephalopod molluscs.

The branchial gland is found in all the dibranchiate Cephalopoda, lying beneath the gill on each side and clearly visible from the mantle cavity. It is stated by Huxley and Pelseneer[6] to be absent in Spirula, but in a specimen of that rare mollusc which I examined through the kindness of Mr. G. C. Robson at the British Museum, it appeared well developed. The 'gland' has a rich blood supply which has been studied in detail by Joubin.[7] A capillary network can be demonstrated by injection. No lumen or duct exists, the organ consisting of cells in a connective tissue meshwork and of syncitial tissue perhaps derived from the degeneration of such cells. The histology was chiefly investigated in Sepia, but is essentially similar in Octopus. Sections of material fixed in Bouin and stained by the methylene blue and eosin method advocated by Lim[8] show irregular polygonal cells with large vesicular nuclei. Most of the peripheral cytoplasm is filled with a fine basiphil suffusion or granulation. In some cells, frequently found in groups, one or more vacuoles containing highly eosinophil bodies are found; such bodies may also be found in the intercellular spaces, and it is hard to avoid the conclusion that they have been extruded from the cells.

The gland can be extirpated in *Octopus vulgaris* unilaterally, through a slit in the mantle. In one such individual which survived 62 days, very marked hypertrophy of the remaining gland was noticed. The hæmocyanin content of the blood of this specimen, determined by the refractometric method of Quagliariello,[9] was identical with that of its control.

The Cephalopoda are in many respects of the same grade of organisation as the lower vertebrates, and it is among them that we should most probably find endocrine organs if they exist in invertebrates. Such histological evidence as is presented above suggests that some substance is produced by the branchial gland and liberated into intercellular spaces where it might be taken up by the blood stream. The branchial heart appendix, another organ of unknown function in the Cephalopoda, may also be worthy of investigation along similar lines.

My investigations of the branchial gland were made at Naples, October 1925–May 1926, while holding an International Research Fellowship of the Rockefeller Foundation and occupying the Cambridge table at the Stazione Zoologica. My very best thanks are due to Prof. R. Dohrn and his staff for every help and encouragement during my stay in Italy; also to Prof. Quagliariello for demonstrating to me the use of the refractometer in the physiological laboratory of the University of Naples. If opportunity occurs of continuing the work, a detailed account will be published.

G. EVELYN HUTCHINSON.

Department of Zoology,
University of the Witwatersrand,
Johannesburg, Mar. 8.

[5] "Experimentelle Untersuchungen über die innere Secretion der Keimdrüsen" (Jena, 1914).
[6] *Rep. Sci. Res. H.M.S. Challenger, Zool.*, 83; 1895.
[7] *Arch. Zool. Exp. Gen.* (2), 3; 1885.
[8] *Q.J.M.S.*, 63; 1919.
[9] *Arch. Sci. Biol.*, 1; 1920.

Investigation of a Mercury-Thallium Molecule.

EVIDENCE has been obtained which seems to prove the existence of mercury-thallium molecules when the vapours of the two substances are mixed. The evidence is the result of two quite different methods of attack.

In the first method, two evacuated pyrex U-tubes were prepared, one of which contained a small amount of thallium in one branch, and a small amount of mercury in the other. The second U-tube contained only a small amount of thallium in one branch, the other branch being empty. The tubes were placed together in a vertical furnace with their ends down, and were heated to 600° C. The amount of mercury was so small that it was entirely volatilised at this temperature, while only a small part of the thallium was vaporised. The ends which had not contained the thallium were then cooled simultaneously for thirty seconds by means of an air blast, and the tubes were removed from the furnace. The ends which had been cooled by the air blast were analysed for thallium. More thallium was found in the end which had contained mercury than in the end which had been empty. The experiment was repeated once, giving the same result. While it might be possible to explain this result on the grounds of lack of temperature equilibrium or of a mechanical entrainment of the thallium molecules in the mercury vapour, neither seems at all likely under the conditions of the experiment. The more probable explanation is that mercury-thallium molecules were formed, and that these molecules were more volatile than thallium.

A more convincing proof of the existence of such molecules resulted from the study of the absorption spectra of mixtures of thallium vapour and mercury vapour. The region investigated extended from about 2200 A. to about 7000 A. The vapours were studied at temperatures ranging from 300° C. to 1100° C. A number of bands have been photographed in the ultra-violet and one in the green. In no case has the resolving power been sufficient to show the fine structure. These bands have not been observed in the spectra of pure mercury or of pure thallium, hence it seems that their origin must be a mercury-thallium molecule. Most of the bands are sharp on the side of shorter wave-length and shaded toward the longer wave-lengths. With rising temperature most of the bands broaden more on the long wave-length side than on the short. The results confirm an early experiment on the ultra-violet absorption spectra of mixtures of mercury vapour and thallium vapour (Wood and Guthrie, *Astrophysical Journal*, **29**, 211; 1909).

The problem was undertaken at the suggestion of Prof. R. W. Wood, and the work carried out under his direction and with his assistance.

R. K. WARING.

The Johns Hopkins University,
Mar. 12.

Prof. A. Abetti and the 1874 Transit of Venus.

As a supplementary note to the obituary notice in NATURE of April 14 of my old friend, Prof. Antonio Abetti, of the Arcetri Observatory, Florence, may I direct attention to a remarkable observation of his made in India at the transit of Venus in 1874? This consisted in viewing the planet projected against the solar chromosphere on the *C*-line through the open slit of his spectroscope. The observation, which is figured in the *Mem. Soc. Spett. Ital.*, and which he described to me on one of my visits to Arcetri, was considered most remarkable at the time and, by some, was scarcely credited. Venus, however, remained visible through the slit for four minutes, while the chromosphere appeared with its usual brightness interrupted only by the dark body of the planet. A similar observation in the case of a transit of Mercury was suggested a few years ago by the late Mr. Thorp.

W. ALFRED PARR.

St. Albans, April 18.

An Inexpensive Solar Telescope and Spectrohelioscope.

By Prof. GEORGE E. HALE, For. Mem. R.S., Mount Wilson Observatory, Pasadena, California.

IN previous numbers of NATURE I have described some of the new possibilities in solar research afforded by the spectrohelioscope.[1] Since their publication I have developed a cœlostat telescope and spectrohelioscope which can be built at such small cost that I trust it may come into general use. At least eight spectrohelioscopes will soon be systematically employed at solar observatories distributed around the world, thus permitting the sun's atmosphere to be observed frequently throughout the astronomical day. It is hoped that under this scrutiny few important eruptions will be missed, and that their connexion with auroræ, magnetic storms, and other terrestrial phenomena such as radio transmission can thus be more certainly determined.

In the well-known method of Lockyer and Janssen, the form as well as the spectrum of a prominence can be seen at the sun's limb. Suppose the narrow slit of a spectroscope to be tangent to an image of the sun, across the base of a prominence. The bright lines of hydrogen and helium will then be seen against the spectrum of the sky, which is due to scattered sunlight, weakened by the dispersion. Consider only the red hydrogen line $H\alpha$, which is nearly monochromatic if the prominence is free from irregular motions in the line of sight. The form of this line then corresponds to that of the straight narrow slit. When the slit is widened the brightness of the prominence remains unchanged, while that of the sky spectrum increases. If the prominence is of average brightness, and not too high, the slit can be opened sufficiently to show its entire form against the background of the sky spectrum. If, however, the sky were as bright as the sun's disc, the prominence, except in rare cases, would be rendered invisible by its overpowering brilliancy.

Prof. Charles A. Young, one of the ablest and most experienced of solar observers, stated the case as follows in his well-known book, "The Sun": "In a few instances the gaseous eruptions in the neighbourhood of a spot are so powerful and brilliant that with the spectroscope their forms can be made out on the background of the solar surface in the same way that the prominences are seen at the edge of the sun. In fact, there is probably no difference at all in the phenomena, except that only prominences of most unusual brightness can thus be detected on the solar surface." Secchi also remarked in "Le Soleil," after describing the use of the spectroscope for the observation of the *spectra* of objects on the sun's disc: "Ce qui serait à désirer maintenant pour faciliter encore davantage ces recherches, c'est la découverte d'un milieu parfaitement monochromatique pour les raies de l'hydrogène. On verrait alors l'image de ces flammes rouges comme on voit celles des taches." The spectrohelioscope has some important advantages over such a medium, even if it were attainable, because of the ease of changing the wave-length of the transmitted light, thus rendering visible rapidly moving flocculi, and at the same time indicating their velocity in the line of sight.

Prominences observed in projection against the sun's disc (flocculi) usually appear dark, because their comparatively cool gas absorbs the light of the hotter photosphere. Bright flocculi also occur, due to hotter hydrogen, usually found at lower levels. When these flocculi are intensely bright their forms can be made out roughly against the disc with a spectroscope by widening the slit, as noted by Lockyer, Secchi, and Young in 1869–70. Extremely dark flocculi may also be seen imperfectly in the same way; but these are exceptional cases. Most of the flocculi, bright or dark, disappear when the slit is widened sufficiently to include their forms. The weakening and disappearance of most of the lines of the solar spectrum, observed when the purity is decreased by widening the slit of a spectroscope, illustrates this effect. The spectrohelioscope retains the strong contrast given by a narrow slit, and thus renders visible the flocculi, both faint and intense, against the brilliant disc. It also shows the prominences at the limb with greater contrast than is obtainable with a wide slit. Moreover, as a narrow slit prevents the overlapping of images observed in white light with a wide slit, the spectrohelioscope renders visible the structure of sunspots, which can be sharply seen with light from any part of the solar spectrum away from the dark lines.

The spectrohelioscope consists of a spectroscope of considerable dispersion, provided with a slit in the focal plane of the spectrum, which permits only the light of the line in use to reach the observer's eye. If the first slit, on which the solar image is focused, is moved in the plane of dispersion, the spectrum will move a corresponding distance. To remain on the line, the second slit must be displaced accordingly. The first and second slits are therefore carried at the opposite ends of a very light metallic bar, mounted on a bearing half-way between them. This bar is oscillated rapidly by a small electric motor, through an amplitude (usually about a quarter of an inch) which is limited by the brightness of the spectrum. The observer, looking through the oscillating second slit, which remains exactly on the $H\alpha$ line, sees by persistence of vision a hydrogen image of a portion of the sun. This may include a part of the limb, where a prominence appears bright against the sky, and at the same time a part of the disc, upon which a portion of the same prominence may extend as a dark flocculus.

High velocities in the line of sight produce distortions of the $H\alpha$ line, towards the violet when

[1] "Some New Possibilities in Solar Research," NATURE, July 3, 1926; "The Fields of Force in the Atmosphere of the Sun," NATURE, May 14, 1927.

the gas is approaching, toward the red when it is receding. To see a mass of hydrogen receding at a velocity of say sixty kilometres a second the second slit must be set, not on the normal position of the Hα line, but at a position completely outside of it toward the red. A simple 'line-shifter' is employed for this purpose. A graduated arc indicates the displacement of the line from the zero position, and thus gives the radial velocity of the portion of the flocculus under observation.

As in the case of the spectroheliograph, a monochromatic image can be produced either by motion of narrow slits with respect to the solar image, or by motion of the solar image with respect to the slits. The chief difference between the two instruments lies in the fact that the spectroheliograph builds up its image gradually, slit-width by slit-width, by a slow motion of the slits or of the solar image with respect to the photographic plate, while the spectrohelioscope must reveal a considerable area of the image at once to the eye, which obviously could not see the forms of the flocculi through slowly moving slits a few thousandths of an inch wide. Hence the rapid motion of the slits or of the solar image required for the spectrohelioscope.

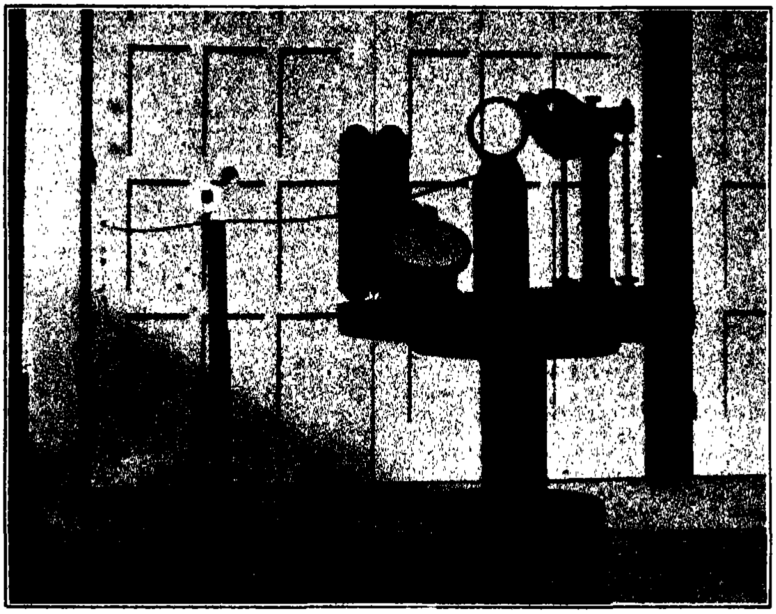


FIG. 1.—Solar telescope. The cœlostat mirror at the left, driven by clockwork, reflects the sunlight to the second mirror, which is provided with slow-motion screws for directing the solar image. This is formed by the simple lens (centre), adjustable by a screw for focusing the image on the slit of the spectrohelioscope 18 feet away, within the building.

I have tried successfully three systems of moving slits, as follows:

(1) An oscillating bar carrying single slits at each end.

(2) An oscillating bar carrying three or more slits at each end. By increasing the number of slits the rate of oscillation necessary to avoid flicker may be reduced, with corresponding reduction in any effects of vibration.

(3) A rotating disc carrying fifty radial slits.

Three means of producing rapid motion of the solar image with respect to fixed slits have also been devised:

(1) An oscillating plane mirror, so mounted in conjunction with a second plane mirror that the second slit can be viewed in another part of the same mirror system. This was suggested by Dr. Sinclair Smith.

(2) A square prism of glass, mounted before each of the slits, rotating uniformly about an axis parallel to them. The portion of the solar image under observation reaches the first slit through one prism, while the resulting fixed monochromatic image is seen in an eye-piece focused through the other prism on the second slit. This device is due to Dr. J. A. Anderson.

(3) An oscillating right-angle prism, mounted with its edge parallel to the slits and its hypothenuse surface normal to their plane. In this arrangement, previously used in somewhat different form on the spectroheliographs of our 60-foot and 100-foot tower telescopes, the solar image moves at twice the speed of the prism.

All three of these devices are here supposed to be used with a spectroscope in which the apparent motion of the solar image, as observed through the second slit, is opposite in direction to the actual motion of the solar image across the first slit. In this case, when looking at the second slit through an extension of the oscillating or rotating optical system which causes the motion of the solar image, the effect of this motion is exactly compensated and the monochromatic image appears at rest. The same devices can be adapted for use with spectroscopes of other types.

THE SOLAR TELESCOPE.

The small solar telescope, temporarily mounted in conjunction with a horizontal spectrohelioscope, is shown in Fig. 1. A wooden tripod serves for support, but in a permanent arrangement the cœlostat, second mirror, and lens should be mounted on a solid pier of brick or concrete.

The cœlostat, with plane mirror $5\frac{1}{2}$ inches in diameter, is driven by an ordinary two-dollar clock movement. With the low powers employed the intermittent motion is not perceptible. The second mirror, $4\frac{1}{2}$ inches in diameter, receives the parallel beam of sunlight from the cœlostat and reflects it due north to a 4-inch single lens, of 18 feet focal length. This forms a solar image 2 inches in diameter on the first slit of the spectrohelio-

scope. A crossed lens is here employed, but a plano-convex lens (or, with a modified arrangement, a concave mirror) would serve well. On account of the small angular aperture and the use of monochromatic light, an achromatic lens is unnecessary. By means of cords or rods leading to the position of the observer (not shown here in the case of the second mirror), any portion of the solar image can be brought upon the slit by tipping the second mirror, and focused by sliding the lens.

The 4-inch lens is sufficient for a 13-foot spectroheliosсope with a 4-inch grating (ruled surface about 2½ inches × 3 inches). When a smaller grating or prisms are employed, a lens of 3 inches aperture and the same focal length (18 feet) will serve equally well.

The Spectrohelioscope.

Last August I completed and tested a simple spectrohelioscope of 3 inches aperture and 13 feet focal length, designed for use with this solar telescope. A 4-inch grating was an essential part of its optical equipment, but unfortunately such gratings are not easily obtained, and all our efforts to secure satisfactory reflecting grating replicas have proved futile. Moreover, the length and mass of the oscillating slit-bar (7 inches between centres in the chosen design) rendered it difficult to push the vibration rate to a point sufficiently high to eliminate flicker without jarring the instrument. Excellent images of the flocculi were obtained with this spectrohelioscope, but the above considerations, and my desire to decrease the cost of construction, made further study of the problem advisable. A few weeks later Dr. Anderson and Dr. Sinclair Smith suggested the ingenious devices already mentioned, and I determined to make a comparative test of a variety of designs, in the hope of reaching a simple and inexpensive solution.

Several of these designs have proved satisfactory, including one in which the monochromatic image is produced with the aid of a revolving glass disc, cut in the milling machine, on a surface of silver or of "Duco" paint, with fifty radial slits; as well as one employing the revolving prism device of Anderson, which can be adapted to any suitable spectroscope of sufficient dispersion provided with fixed first and second slits. These instruments will be described in detail elsewhere; my object here is merely to mention briefly the simplest and least expensive spectrohelioscope that I have found to give excellent results.

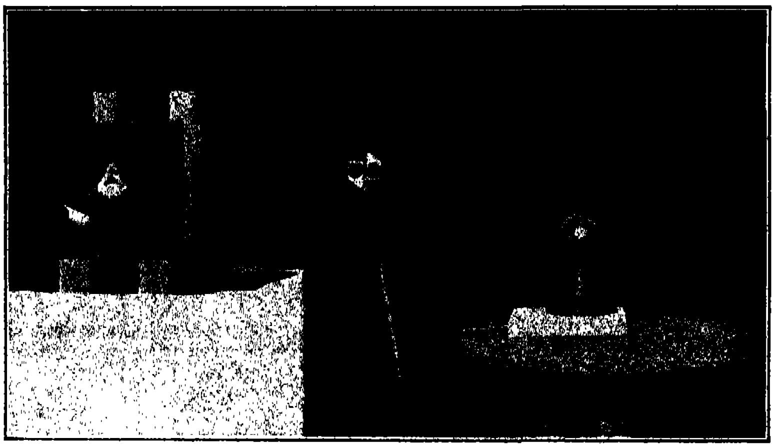


Fig. 2.—Spectrohelioscope of 13-feet focal length. Sunlight passing through the first slit (right) falls on the collimating mirror, which returns a parallel beam to the grating, mounted above the slits behind the casting. An image of the Hα line of hydrogen in the first order spectrum is formed by the left concave mirror on the second slit. When the slits are rapidly oscillated by the motor, a portion of the solar atmosphere is seen in hydrogen light through the eyepiece on the left (here turned aside to show the second slit).

The oscillating slits are shown in Fig. 2, a general view of the spectrohelioscope temporarily set up in a garage. As their centres are only 3½ inches apart they are mounted horizontally, so as to permit direct observation through the second slit by the right eye without obstruction of the solar image on the first slit by the observer's head. The bar that carries them, like the slits themselves, is extremely light and stiff. An upward extension of this bar is pierced by a fibre-lined vertical groove, in which a steel pin, fixed eccentrically in the head of a horizontal shaft, serves as the driving device. A small electric motor, belted to a pulley on this shaft, causes the slits to make thirty or forty single oscillations per second. The amplitude is about a quarter of an inch or less, and the motion is smooth and quiet.

Light from any part of the 2-inch solar image given by the cœlostat telescope passes through the first (right hand) slit and diverges until it meets a 2-inch concave spherical collimating mirror of 13 feet focal length, which returns a parallel beam to the dispersing system (not visible), consisting either of a plane grating, ruled with about 15,000 lines to the inch, or a pair of 60° prisms of flint glass, through which the light passes twice. The plane of dispersion is vertical, and the grating (or the mirror behind the prisms) is set at such an angle that the Hα region (of the brightest first order spectrum, if the grating is used) is returned to the centre of a second concave mirror. This is exactly like the collimating mirror, and is mounted with it on an adjustable support with screw for focusing. The centres of the mirrors are opposite the centres of the slits, and the second mirror is adjusted so as to cause the Hα line to coincide with the second slit. This is viewed through a positive eyepiece magnifying from two to four diameters. The line-shifter, a strip of plane parallel glass, is mounted behind the second slit on a short shaft, provided with a large milled head for easy rotation by the observer and a divided arc showing the displacement in angstroms or the equivalent radial velocity. An important adjunct is a screen to prevent the diffuse light of the collimating mirror from reaching the eye of the observer.

I have found by experiment that with slits 0·004 inch wide, oscillating with an amplitude of $\frac{3}{16}$ inch, the bright and dark hydrogen flocculi can be well seen on the sun's disc when the grating aperture is reduced to $1\frac{3}{16} \times 2$ inches.[2] A larger grating naturally gives a brighter image, in which more detail can be seen, but the above will serve for most classes of work.

Suitable gratings, even of the smaller size just mentioned as a minimum, may not be obtainable. I have therefore tried a less expensive arrangement, which may be adopted by amateurs who wish to build their own instrument and are content (until a good grating or replica can be obtained) to see only the more conspicuous phenomena. This is a pair of 60° prisms,[3] which should be of very dense flint, and may be only just large enough to transmit a beam 1 inch in diameter, though a somewhat larger aperture is preferable. The dispersion of two ordinary flint prisms (here equivalent to four) is less than that of the first order of a (15,000) grating, and their performance is much inferior to that of a good grating; but with suitable slit-widths they will show the stronger bright and dark flocculi, as well as the prominences at the limb. If, as I greatly hope, a satisfactory method of producing cheap reflecting grating replicas of excellent definition can be found, these may ultimately become available in place of original gratings or prisms.[4]

The ingenious rotating prism device of Dr. Anderson, which is used with fixed slits, is shown in Fig. 3. This is more expensive than the oscillating slits, and seems to show no details of the flocculi not visible with them. However, the elegance of this method, and the complete freedom from vibration and flicker which it affords, make it an attractive alternative for oscillating slits. It can be readily attached to any Littrow spectroscope of suitable dispersion, but I have found this type of spectroscope much less satisfactory for the purposes of the spectrohelioscope than the two-mirror form illustrated, because of the impossibility of excluding from the eye the light due to the illumination of the collimating lens and grating by sunlight from the first slit. The reflected light can be excluded, by using a suitable lens for the collimator, but the remaining diffuse light, superposed upon the Hα line, materially reduces the contrast of the flocculi, even when a red glass is placed over the eyepiece.

The spectroheliosope shown in the illustrations was built from various parts that happened to be available, and does not represent the final design. Thus the casting that carries the slits, line-shifter, and eyepiece will be considerably reduced in size in the finished instrument. The working drawings now in preparation will also show a more compact support for the two concave mirrors, and various other improvements. These will soon be published in a series of articles, intended for those who wish to build and use their own instruments.

Use of the Spectroheliosope.

I have indicated in previous papers some of the many possible applications of the spectroheliosope. Mr. Buss (Nature, May 28, 1927) and M. Deslandres (Nature, Oct. 8, 1927) apparently think that a solar spectroscope would serve equally well for such work, but as all the astronomers and physicists who have observed the sun with my instrument seem to agree with me as to its usefulness, I am quite willing to leave this question to the future. If one wishes to see the characteristic structure of most of the dark hydrogen flocculi, the slit-widths must be kept below one-hundredth of an inch, even when very high dispersion is employed. As already remarked, the prominences at the limb are also shown in greater contrast by the spectroheliosope than by the spectroscope with wide slit. As for the line distortions caused by the radial velocities of the hydrogen flocculi, which have been known since

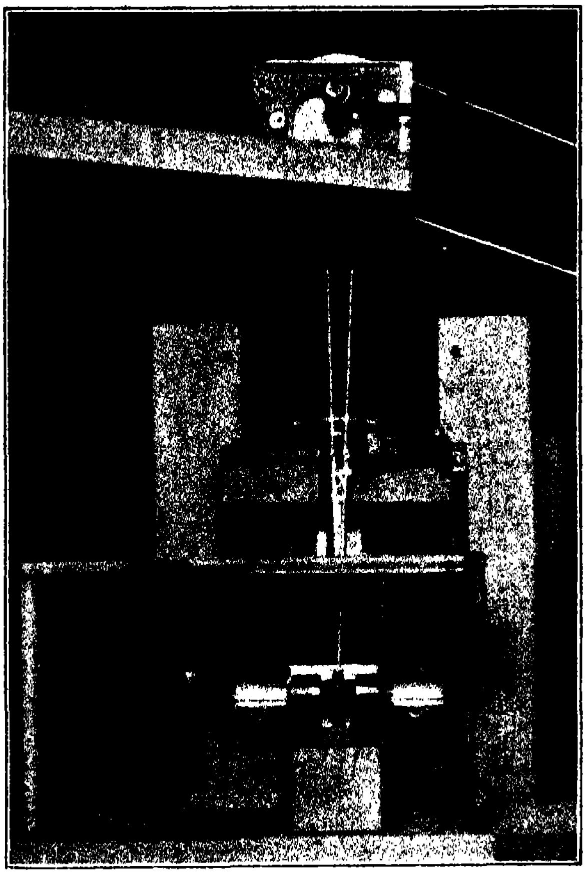


Fig. 3.—Anderson's rotating prism device for use with fixed slits. A square prism of glass, rotating uniformly, causes a succession of images of a part of the sun to move across the first slit at the rate of four per revolution. When the second slit (set on Hα) is viewed through a similar prism, rotating at the same rate, a stationary image is seen in hydrogen light.

[2] This is nearly the size of Hilger's plane grating K14, ruled with about 14,400 lines per inch at the National Physical Laboratory on a surface 3·5 cm. × 5 cm.

[3] Loaned me by the Massachusetts Institute of Technology, through the kindness of Dean Goodwin.

[4] The most promising means of reproducing reflecting gratings appear to be either an electrolytic process or the method described by Merfield (*Proc. Roy. Soc. Victoria*, vol. 38, 1926). The latter can perhaps be used for copying speculum metal as well as glass gratings by adopting means of preventing firm adhesion of the cathode deposit.

the earliest days of solar spectroscopy, the advantages of the spectrohelioscope in quickly interpreting them must be seen to be appreciated. The line-shifter serves in somewhat the same way as the 'blink' device of a Zeiss stereocomparator, but instead of merely indicating, in a very striking way, any differences between two photographs, it shows at a glance the connexion of a series of related phenomena by linking them into a sequence. This is what I referred to in my last article when describing "a new effect of inflow," by which I meant the motion of the maximum of intensity along a flocculus due to progressive differences in radial velocity, at once interpreted by the line-shifter.

In M. Deslandres's remarkable theory of the sun, "tout se passe comme si le rayonnement corpusculaire de nos orages émane d'une couche solaire profonde qui tourne comme un corps solide ; et cette couche offre au moins 24 volcans permanents, répartis uniformément autour de l'axe de rotation, et d'activité variable, qui rejettent au dehors la matière ionisée ou radioactive des masses intérieures. Cette division régulière est celle des corps à symétrie circulaire qui se refroidissent." This theory involves so many considerations that it cannot be discussed in the space at my disposal. In any event, such a discussion would be premature, as the theory rests upon M. Deslandres's belief in a regular sequence of terrestrial magnetic disturbances which Messrs. Chree and Stagg, after an exhaustive study of the international magnetic data for twenty years, have been unable to confirm.[5]

[5] "Recurrence Phenomena in Terrestrial Magnetism," *Phil. Trans.*, Series A, vol. 227, pp. 21-62.

The New Vision.[1]

By Prof. G. Elliot Smith, F.R.S.

THE recent researches of Minkowski, Brouwer, and Woollard have brought to light the remarkable fact that in man and his nearest allies such revolutionary changes have been effected in every part of the visual system as to justify the statement that a new visual instrument has been evolved. Considering these facts from the point of view of function, we may speak of the emergence of a new vision, which differs profoundly from that enjoyed by all other living creatures. It may be of interest to discuss the nature and meaning of these changes, which are intimately related to the evolution of intelligence and the attainment of what in colloquial language we know as insight, foresight, and the wider vision.

A quarter of a century ago the term neopallium was introduced to express a new conception of the nature of the essential evolutionary changes that transformed the brain of a primitive reptile into that of a mammal, and conferred upon the latter enormously enhanced powers of learning from experience and modifying behaviour. Incidentally, the development of the new cortical area provided a means whereby vision for the first time secured representation in the cerebral cortex, which created fuller opportunities for the confluence of visual with other kinds of perception. On the anatomical side it inaugurated a series of interesting structural arrangements which marked the transference to the neopallium of functions which in all other vertebrate animals are carried on in the mid-brain and other lower centres. The new light recently thrown on this interesting process of transformation reveals the fact that the transference of functions did not occur at one time, but in progressive stages. Magnus showed experimentally that the optic-righting reflexes in mammals were not acquired until binocular vision developed. Still later the development of the macula lutea in the retina (in monkeys and man) brought about the further changes in the brain which I am attempting to define.

In all vertebrates the nerve fibres proceeding from the retina cross (wholly or only in part in most mammals) to the other side of the brain, where they end in two masses of grey matter, the lateral geniculate body, which is part of the thalamus, and the superior quadrigeminal body, which is part of the mid-brain. The former connexion is concerned with the awareness to vision, the phenomena of consciousness, and the latter (mid-brain), with such unconscious functions as the reflex actions of the eye muscles and the general musculature of the whole body. Brouwer has shown that in a lowly mammal such as a rabbit the four quadrants of the retina have a topographical representation in the quadrigeminal body. Wilson (of Cairo) has recently demonstrated that the corresponding quadrants in a lizard's brain control definite movements or postures of the body—a kind of autonomous mechanism for the analysis and functional expression of optic influences analogous to the analytic functions of the semicircular canals in connexion with equilibration.

In mammals the lateral geniculate body, for the first time in the vertebrate series, emits a large strand of fibres (optic radiation) to provide a path for visual impulses to the cerebral cortex. But the neopallium also begins to assume some of the motor control, which hitherto has been a function of the quadrigeminal bodies. It is interesting to note that, according to Allen, this process is not completed in the rabbit. Its cerebral cortex, according to him, controls the movements of the head, fore-limbs, and body, but the control of the hind-limbs is still retained by the mid-brain. In most mammals, however, the transference of motor control to the cerebral cortex is complete.

With the acquisition of binocular vision (in mammals such as the cat or, better, monkeys) the fibres of the optic tracts become rearranged. The fibres from the lateral part of each retina no longer

[1] From the Bowman Lecture delivered on April 20 to the Ophthalmological Society of the United Kingdom.

cross to the other side of the brain, but become connected with the same side, so as to bring into connexion the terminations of the fibres coming from the medial side of one retina and the lateral side of the other, which in binocular vision necessarily act together so as to merge in consciousness the two images of one object.

But this rearrangement of the optic tracts necessarily affects the endings of these tracts in the geniculate and quadrigeminal bodies. Instead of a modification of the retinal localisation in the quadrigeminal body to adapt it to the new conditions, the cerebral cortex seems more fully to usurp its motor-controlling functions. With the loss of such functions the quadrigeminal body also loses most of the direct connexions with the optic tracts, and the cerebral cortex acquires a correspondingly enhanced control of the quadrigeminal body.

In monkeys and man further profound changes occur in the whole of the visual system. A definite macula lutea develops in the retina, and each of the percipient cells in the area of acute vision transmits its impulse (indirectly) to a separate fibre of the optic nerve. In the rest of the retina and in the retinas of other mammals groups of sensory cells (rods) transmit their impulses into one granule and ganglion cell, so that there are far more percipient elements than nerve fibres in the optic nerve. Hence, when the macula develops in monkeys and man, this small area adds a contribution to the optic nerve and tract that is out of all proportion to its size. The macular fibres form more than a third of the optic nerve, and there is added to the geniculate body a new formation as a macular receptive mechanism.

With the atrophy of the quadrigeminal fibres of the optic tract and the sudden increase of the geniculate connexion in monkeys and man, practically the whole (more than ninety per cent.) of the optic fibres go to the lateral geniculate body. But with the enormous increase of the latter the body loses much of its autonomy. Its ventral nucleus, which in other vertebrates controlled the quadrigeminal body, atrophies in the Primates. In its place the cerebral connexion is still further strengthened. The geniculate body becomes more and more an intermediary between the retina and the neopallium, and almost the whole function of visual perception becomes concentrated in the cerebral cortex.

The development of macular vision confers upon man the ability to see the world and appreciate its meaning in a way that no other living creature is able to do. His new vision depends upon powers of visual perception as distinctive as the use of articulate speech to give expression to what he sees and thinks. The late Dr. Henry Watt, of the University of Glasgow, expressed the opinion that

"Of the conditions which enrich the sensory basis of the human mind and so provide the greater wealth of material by which it attains levels beyond those of the animal mind, probably the most important are the functions of the fovea (macula lutea), of accommodation, and of static stereoscopy, and the development of a delicate skin and prehensile hands. All these make in some way for a differentiation that is the first form of abstraction. The fovea refines and distinguishes positions and forms, while accommodation sharpens the objects of attention and dissipates the rest; stereoscopy adds a new character to a group of forms that may persist for indefinite periods of observation; delicate skin gives greater sensitivity to variations of pressure, and the prehensile hand implies a very great refinement in the positions and forms of the derived articular sense. In the hand this becomes a fine mobile tridimensional sense that, like the stereoscopic eye, can go round and through things, so almost isolating them from their surroundings. At the same time the articular sense is the conscious correlate of action and of the individual's share in his experiences."

All these conditions that confer upon man the fuller vision to see and understand the world and interpret what is happening around him, can be shown to be the results directly or indirectly of those profound structural revolutions which have given man what is virtually a new instrument of sight and with it a new vision.

News and Views.

MR. G. H. WILKINS, accompanied by Mr. C. B. Eielson, left Point Barrow, Alaska, on April 15, and flew across the Arctic Ocean to Spitsbergen, a distance of 2200 miles, in a little over twenty hours. The machine used was a Lockheed monoplane with a 220 h.p. Wright Whirlwind engine. The start was difficult and a long snow runway on the frozen surface of a lagoon had to be made. For the first five hundred miles the weather was clear; then a hundred miles of cloud were passed through before the visibility again became good. In lat. 84° N. long. 75° W., dark clouds were seen to the north, described as possibly land clouds, but as this was near one of Peary's tracks, on which he reported no land, Mr. Wilkins did not turn aside. Landing-places on the pack-ice which might have served in an emergency were seen, but no attempt was made to descend, since the ascent would have been a very difficult matter. A view of Grant Land (Ellesmere Island) was obtained, and then the course was set for Spitsbergen. This course, it will be noted, did not pass over the North Pole itself. Strong winds were experienced and there was much cloud to the south over Greenland, but one high peak of the land was seen. The temperature was then about − 48° F.

WITHIN 200 miles of Spitsbergen, flying conditions became more trying. The open water and high temperature to the south were associated with great cloud masses, and even at 8000 ft. they could not be avoided. The difficulty was to locate King's Bay, Spitsbergen, where it was hoped to land. The weather became worse and flying was difficult. Petrol was running short when a landing was made on fast ice near the shore at the northern entrance to Ice Fjord. The reports mention an island, but there is

no island off the plains of Dödmandsören. The arrival was followed by four days of bad weather, during which the airmen lived in the cabin of their machine. At length, on April 21, the fifth day after landing, the conditions improved sufficiently for the flight to be resumed. There were only 20 gallons of petrol left and the start proved difficult. At a height of 3000 ft. the mast of the wireless station at Green Harbour was seen and the station was reached shortly afterwards. Mr. Wilkins will leave for Europe as soon as a vessel is available. The shipping season in Spitsbergen opens shortly. The flight scores a new track over the unexplored Beaufort Sea to the east of Amundsen's track of 1926. No new land was seen, but it must be remembered that low islands, the only possible land in that sea, would be snow-covered and not easily distinguishable at this season, even if the weather were clear. Meteorological observations were taken throughout the flight. The pilot is to be congratulated on the accuracy of his navigation, especially in view of the bad weather between Greenland and Spitsbergen.

THE following official records of earthquakes have been received from Kew Observatory: A violent earthquake was recorded at 19 hr. 27 min. 22 sec. G.M.T. on April 18. The epicentre is estimated to be 1360 miles away at a bearing of 115° from true north from Kew, which locates the disturbance in the Balkan States. The size of the disturbance recorded is quite as big as that of the destructive earthquake which occurred in the same region on Saturday, April 14. A further disturbance of very much milder character, and estimated to be at the same place, was recorded later at 23 hr. 19 min. 21 sec. G.M.T. Another earthquake was recorded on April 22 at 20 hr. 18 min. 41 sec. G.M.T. The epicentre is estimated to have been 1470 miles away and probably in Bulgaria. The intensity of the disturbance was about one quarter of that produced by the two destructive earthquakes which recently occurred in that region.

THE earthquakes felt in southern Bulgaria during the latter half of April have been remarkable for their number as well as their intensity. The first occurred on April 14. Its epicentre was evidently close to Chirpan, which was almost entirely destroyed. The area of damage was of wide extent, for it includes Plovdiv (Philippopolis), nearly 30 miles to the west. Another violent earthquake occurred on the evening of April 18, the centre having shifted to the neighbourhood of Plovdiv, where more than five thousand houses were damaged and many persons lost their lives. Even at Sofia, more than 80 miles from Plovdiv, houses were injured. So far, the most interesting features of the earthquakes are the westerly migration of the focus along a line parallel to the Balkan ranges, and the great size of the areas over which damage occurred in the principal earthquakes, the latter feature pointing to a great depth of focus. The Athens correspondent of the *Times* reports that the earthquake of April 22 wrecked Corinth, and that Kalamaki and Loutraki, near Corinth, have also been much damaged. It is estimated that 15,000 people are homeless.

ALTHOUGH the Society of Chemical Industry is this year holding its annual general meeting in New York, and is combining that function with interesting visits in Canada and the United States, distance is not yet so completely annihilated as to render it possible for all to take part who have a mind to do so. Numbers of members will therefore welcome arrangements enabling them to meet in Great Britain and discuss matters of common concern. The Society, in co-operation with its London section, the Chemical Engineering Group, and the Institution of Chemical Engineers, has organised a conference to be held in London on May 11-15. On the first day the Chemical Engineering Group will hold a business meeting, followed by the annual dinner; Mr. F. H. Carr, president of the Society, will afterwards deliver an address entitled "Some Chemical Engineering Aspects of the Fine Chemical Industry." Rothamsted Experimental Station, Harpenden, is to be visited on the second day. On Monday morning Sir Arthur Duckham, the first president of the Institution of Chemical Engineers, will discuss "The Fuel Industries and the Work of the Chemical Engineer," and Prof. G. T. Morgan will deal with "The Chemical Study of Low-Temperature Tar," the chairman being Sir Hugo Hirst; in the afternoon Lord Desborough will preside, and Sir Alexander Houston will speak on "Water Purification," and Mr. J. H. Coste will give an account of "The Pollution of Tidal and Non-Tidal Streams." On the same evening there will be a dinner, preceded by a reception by Mr. and Mrs. F. H. Carr, and followed by dancing. The British Science Guild has been invited to participate in the final sessions of the Conference on May 15, when Sir Alfred Mond, the president of the Guild, will deliver an address entitled "Scientific Research as applied to Industry," and Sir John Russell will describe "The Part Played by British Workers in the Application of Fixed Nitrogen to the Soil." The afternoon session, over which Lord Bledisloe will preside, will be devoted to a consideration of "Developments in the Heavy Chemical Industry," by Lieut.-Colonel G. P. Pollitt.

PROF. J. H. BREASTED has issued an account of the work accomplished by the Oriental Institute of the University of Chicago, of which he is director, during the eight years of its existence. A summary of the report appears in the issue of the *Times*, April 12. It records an activity in the archæological field, especially in the later years, which reflects great credit on the organisation of the Institute. During the past two years an expedition to Asia Minor has discovered fifty-five new and unmapped Hittite sites. By its excavations at Alishar Huyuk it has established clearly a pottery sequence and the criteria for dating levels on Hittite sites. Further evidence of Hittite influence in Palestine has been found at Megiddo. Human occupation there has been traced back to the Stone Age, and a monument has been found recording the victory of Sheshonk (Shishak) over the son of Solomon and the capture of Jerusalem. It is expected that the excavations of the present season will reach the Egyptian Imperial levels. Reference is made to

the researches of Dr. Sandford and Mr. Arkell on the pliocene and pleistocene history of the Nile, and the finding for the first time of stratigraphically dated palæolithic implements on the borders of the Red Sea. Reference is also made to the alabaster vessel workshop discovered in the Fayum, originally over-hastily attributed to the palæolithic, which more careful examination has shown to be dynastic. The Institute is devoting itself to two valuable and extremely important pieces of work in recording the wall paintings and carvings of the Egyptian temples, beginning with Medinet Habu, and in the compilation at headquarters in America of a dictionary of cuneiform.

DURING the past winter, Miss G. Caton-Thompson has continued her work on the archæology of the Northern Fayum Desert under the auspices of the Royal Anthropological Institute, to which body a concession to excavate was granted by the Antiquities Department of the Egyptian Government. Miss Caton-Thompson was accompanied by Miss E. Gardner, who continued her researches in the geology of the area with special reference to the question of lake levels at different periods. The main object of the expedition was to search for cemeteries which might afford material for dating the 'Fayum industry.' Reports of the season's work received to date, of which a partial summary appears in a letter from Miss Caton-Thompson in the *Times* of April 17, indicate that, while the main objective has not yet been attained, results of no small importance have been achieved. Of these the most interesting is, perhaps, the discovery of an unsuspected irrigation system in the Fayum of Ptolemaic date, which has aroused considerable interest in Egypt, and has secured the practical co-operation of the Irrigation Department in the provision of workmen and monetary contributions through H. E. Osman Pasha Moharram, late Minister of Public Works, and Ahmed Bey Ragheb, of the Irrigation Department. The examination of neolithic mounds and granaries has carried the investigation of the Fayum flint industry a step further, and it is now divided on stratigraphical and typological grounds into two well-defined stages. A big gypsum quarry and alabaster vase factory of the early Old Kingdom have been discovered and explored, the site including a village of hut circles belonging to the workers. Investigation of the lake levels has fixed the Fourth Dynasty shore-line at about O.D. zero, or 145 feet above the present lake. The remaining weeks of the season are to be devoted to work on new ground. In order that these plans may be carried out, a further amount of £250 is required towards the cost of the expedition. The Royal Anthropological Institute has issued an appeal for subscriptions, which may be sent to the Honorary Treasurer, 52 Upper Bedford Place, W.C.1.

THE number of passengers arriving and departing from the Croydon Aerodrome, which is London's terminal port for the Anglo-Continental transport service, was last year more than 20,000, and the value of the goods exported and imported amounted to ten million pounds. As a modern air liner accommodates eighteen passengers besides a crew of three, it is necessary that all precautions be taken for their safety. A new radio telegraph and telephone equipment has just been installed at Croydon by the Marconi Co., Ltd. The control tower is 80 feet above the ground and gives a clear view of the aerodrome on all sides. The radio officer is in control of the receiver and direction finder. He also operates three of the four transmitters at the sending station at Mitcham, which is 2½ miles from the aerodrome. One of the transmitters is for telegraphy, another for telephony, and the third is a spare one in case of need. Some distance from the control tower is the receiving station, which has a 200-foot long horizontal aerial. The receiving and transmitting officers work quite independently of each other. A radio goniometer is used to determine the bearings of aircraft. When the pilot of an aeroplane sends a request to Croydon for his position, Pulham and Lympne, at which stations constant watch is kept, simultaneously take his bearings and transmit them by radio to Croydon. At Croydon these bearings, together with the local bearings, are plotted on a large map, the point of intersection of the three bearings giving the position of the aeroplane. This reading is at once communicated to its pilot, the whole process taking less than one minute. The transmitters at Mitcham are brought into action from the control tower. An ingenious device makes it impossible to damage the transmitting valves by switching them on in the wrong order. The valves are kept constantly alight, as it is found that continual switching on and off shortens their lives more than when they are left to burn continuously.

THE first elaborate attempt to light a theatre by electricity was carried out at the Opera House, Vienna, in 1886 by Col. Crompton and other Englishmen. A few months afterwards the electric light was installed in the Theatre Royal, Drury Lane, and the Savoy Theatre. During the last few years theatre lighting has been revolutionised. We learn from a paper on the subject by H. D. Wilkinson, read to the Royal Society of Arts on April 6, that high candle-power gas-filled lamps (1000 c.p. and above) are now almost invariably used instead of arc lamps. The factor of safety has been very greatly increased. The long-standing problem of controlling the auditorium lighting from the stage has been solved. The fuses are grouped in readily accessible and fire-proof positions. In the early days they used to be scattered over the house in order to economise on the expense of wiring. The L.C.C. Regulations prescribe that the lighting of the auditorium and all parts of the house open to the public shall be from two independent sources of power supply. Half the total number of lights is supplied from each source, and so far as possible alternate lamps are supplied from a different supply. The stage lighting, both the overhead lights (battens) and the footlights (the float), must be from a third and independent source. Pleasing lighting effects are sometimes produced by ultra-violet rays falling

on objects covered with fluorescent paint. It seems probable that a still higher degree of illumination on the stage will be used in the future. An ingenious mechanism for the production of moving clouds from photographs has recently been developed. It is called the cyclorama, and has been much used abroad. Apparatus of British manufacture for producing sky and horizon effects quite equal to the cyclorama is, however, now available.

IN the April number of the *Electrical Age for Women*, Mrs. Lawson writes an interesting article on electricity at the London Zoo. In the new buildings great difficulty was experienced in regulating the heat so as to suit the individual requirements of each inmate. The average temperature maintained is 80° F. The temperature of each cage and department is separately controlled, electrically. Should the temperature rise or fall 5°, this is at once detected by a coloured lamp lighting on a board, the number beside the lamp indicating the cage. A red light indicates that the temperature is too high, and a green light that it is too low. The tropical humid heat is confined to the cages, the corridors being independently ventilated. In the new reptile house 20 miles of electric cable were required. The monkey house is roofed with vita-glass which is transparent to the ultra-violet rays from the sun. The monkeys sit on swinging perches underneath ultra-violet ray lamps. The swamp and the rocks and sand for the crocodiles are all electrically heated. About two hundred connexions are necesssary to heat and control the temperature of this cage. In some cases bowl electric fires are fixed in the roof to warm the air. The new aquarium is electrically heated and the water is pumped, filtered, and aerated electrically. Hygienically, the new arrangement is greatly superior to the method of heating by steam pipes formerly used.

AN interesting gathering of the members of the Research Association of British Paint, Varnish, and Colour Manufacturers took place at the laboratories of the Association at Waldegrave Road, Teddington, Middlesex, on Wednesday, April 18. It will be remembered that these laboratories were officially opened on Sept. 21 of last year by Dr. Weidlein, the head of the Mellon Research Institute of Philadelphia. At the meeting on April 18 a lecture was given by Mr. R. A. Coolahan upon "Cellulose Lacquers," which was illustrated by a short cinema film. After the lecture a tour of the laboratories was made, when it was soon apparent that considerable development has taken place since last September; a useful extension has been made by adding rooms for colorimetry, constant temperature and humidity, and for the testing of paint and varnish films by accelerated methods. In addition, a small open laboratory has been built to accommodate varnish and oil-treating plants. This should prove of great value in the examination of these and like products. Demonstrations were given of the investigations in hand. It is clear that this laboratory is rapidly becoming of first-class importance to the industry and will in time be the chief centre of all new developments.

THE Italian Arctic expedition in the airship *Italia*, under General U. Nobile, left Rome for the north on April 15. The *Times* reports that the route to be followed was by Fiume, Zagreb, Vienna, Stolp, and Vadsö to King's Bay, Spitsbergen. The *Italia* reached Seddin near Stolp on the following day, after sustaining some injuries in bad weather. A vessel of the Italian Navy will await the airship in King's Bay. General Nobile has with him several Italian scientific men, and the Swedish meteorologist, Prof. Malmgren. From the base in Spitsbergen several flights will be made during the two months of summer. These will include observations at Nicholas Land, Crocker Land, if that land exists, and at the Pole itself. The inability of the airship to descend at these little-known parts of polar regions will, however, militate against the scope and value of the scientific observations.

COL. THE HON. FL. VERNON WILLEY, of Messrs. Francis Willey and Co., Ltd., Bradford, has been elected chairman of the British Research Association for the Woollen and Worsted Industries. Col. Willey is a past president of the Federation of British Industries and president of the Wool Textile Delegation. He succeeds Sir James P. Hinchliffe, who has presided over the Association since its establishment in September 1918 and has been responsible for the administration of an expenditure of more than £100,000 on research work for the wool textile industry during the past nine years.

AT the meeting of the London Mathematical Society on May 10, at 5.0 P.M., at the rooms of the Royal Astronomical Society, Burlington House, Prof. W. E. H. Berwick will give a lecture on "Some Recent Advances in the Theory of Equations." Members of other scientific societies are invited to attend the meeting.

THE eighteenth annual May Lecture to the Institute of Metals will be delivered by Prof. Cecil H. Desch, on "The Chemical Properties of Crystals," at the Institution of Mechanical Engineers, Westminster, S.W.1., on Tuesday, May 8. Cards of invitation to the lecture can be obtained on application to Mr. G. Shaw Scott, 14 Members Mansions, Victoria Street, London, S.W.1.

AT the annual general meeting of the Physical Society, held on Mar. 23, the following officers for 1928–29 were elected: *President*, Dr. W. H. Eccles; *Hon. Secretaries*, Prof. A. O. Rankine and Mr. J. Guild; *Hon. Foreign Secretary*, Prof. O. W. Richardson; *Hon. Treasurer*, Mr. R. S. Whipple; *Hon. Librarian*, Mr. J. H. Brinkworth. Prof. Albert Einstein was unanimously elected an honorary fellow of the Society.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A head of the Nautical College department of the Liverpool Central Technical School—The Director of Education, 14 Sir Thomas Street, Liverpool (April 30). A temporary research assistant to the advisory mycologist of the University of Reading—The Dean of the

Faculty of Agriculture and Horticulture, The University, Reading (May 1). A lecturer and demonstrator in organic chemistry in the University of Sydney—The Agent-General for New South Wales, Australia House, Strand, W.C.2 (May 7). An assistant keeper of the City Museum and Art Gallery (Natural History Department), Birmingham—The Keeper, City Museum and Art Gallery, Birmingham (May 11). Lecturers in philosophy (psychology), physics, and mathematics in University College, Rangoon—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1 (May 12). An assistant entomologist and an assistant mycologist at the Imperial Forestry Institute, Oxford—The Secretary, Imperial Forestry Institute, Oxford (May 12). An experimental officer in the acoustical section of the Air Defence Experimental Establishment, Biggin Hill, Kent—The Secretary, Royal Engineer Board, 14 Grosvenor Gardens, S.W.1 (May 18). A lecturer in botany at the University College of Wales—The Secretary, University College of Wales, Aberystwyth (May 31). An assistant lecturer in mathematics at the University College of North Wales—The Secretary, University College of North Wales, Bangor (June 2). A Research Officer at the Punjab Veterinary College, Lahore—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1 (July 31). A head of a new department of the British Cotton Industry Research Association to deal with fundamental scientific problems arising out of the use of artificial silk in conjunction with cotton—Dr. R. H. Pickard, Director of Research, Shirley Institute, Didsbury, Manchester. A physicist for work in connexion with explosives — The Manager, Research Department, Nobel's Explosives Co., Ltd., Ardeer, Stevenston, Ayrshire. A head of the explosives research branch, two assistants, and some junior assistants, in the Research Department, Woolwich (Directorate of Explosives Research)—The Chief Superintendent, Research Department, Woolwich, S.E.18.

Our Astronomical Column.

NOVA PICTORIS.—Further telegrams from Johannesburg and the Cape announce that this star has further subdivided and is now in four nebulous portions; these are too small to be photographed separately, and the observations of them are wholly visual. On the other hand, the large rings round them are only observable by photography. They are three in number, the outer one having a diameter of 3′. It was at first thought that these were due to the outward travelling of the light waves rendering visible nebulosity that was already there, as in the case of Nova Persei in the autumn of 1901.

It is now suggested (according to the *Times* of April 21) that the star is much nearer than was supposed, and that the rings are the matter blown off the star by the outburst. On this supposition its distance from us is estimated as 40 light-years or 12 parsecs. This supposition would quite negative the suggestion of a collision of two stars; in that case the proper motion at such a small distance would be much larger than it is. In fact, the sun's motion foreshortened would give a shift of 5″ in 24 years, which is four times the observed shift, so that if the star is at that distance it must be travelling at a speed about the same as the sun's, in the same direction. Also its absolute magnitude before the outburst was about 12, so that it was an extreme dwarf (perhaps a white dwarf). The star has been put down for parallax measures, which apparently have not yet been made. Measures during the next few months may throw further light on the question.

ϵ AURIGÆ.—*Harvard Announcement Cards 59* and *63* deal with the expected minimum of this star. At the Washburn Observatory it was observed to decline 0·12 mag. between Jan. 22 and Mar. 4. Measures at Detroit Observatory give a decline of 0·18 mag. between Jan. 17 and Mar. 16. On the other hand, Margarete Güssow at Neubabelsberg gives the decline as only 0·04 mag. between Jan. 25 and Mar. 20 (*Astr. Nach.*, 5555). She concludes that the real approach to minimum has not yet commenced, and that the present oscillation is one of shorter period. *Harvard Announcement Card 63* also directs attention to the fact that there is an oscillation of 150-day period superimposed on the principal one, of much longer period. The star should be carefully watched. Mr. McLaughlin at Detroit notes that on Mar. 16 the Hγ line had a well-marked satellite on the side towards the red, not seen on earlier plates.

THE EBRO OBSERVATORY.—Father Puig has written an interesting volume on the work of this observatory, which has been in existence for more than twenty years ("El Observatorio del Ebro. Idea General sobre el mismo." By the Sub-Director, P. Ignacio Puig, S.J. Tortosa, 1927). Its work embraces seismography, terrestrial magnetism, and earth-currents, solar radiation, meteorology in all branches; solar physics, both visual and spectroscopic; time determination. The observatory was in the totality track in the eclipse of 1905; the results have been already published, but are briefly summarised.

An interesting investigation carried out at the Observatory is the apparent influence of the earth on the birth and development of sunspots; it was first suggested by Mr. E. W. Maunder in 1907 that such an influence exists; the present investigation tends to confirm it. The records show that the majority of spots registered had their birth on the hemisphere away from the earth; the actual ratio should be still higher than the observed one, since it would include short-lived spots that formed and disappeared on the invisible hemisphere. Further, the number of spots born on the eastern half of the visible hemisphere exceeds by 20 per cent. the number born on the western half. There seems to be a slight excess of spots when the earth is in aphelion; also, the northern hemisphere has an excess when the earth is south of the sun's equator, and vice versa. It is noted that it is very difficult to understand how the earth can have such an effect on the spots (which extends to the faculæ and prominences, as Evershed and others have confirmed). A magnetic or electrical interaction between sun and earth is suggested as the most probable explanation.

The curve of sunspot activity from the Ebro Observatory records shows a very flat minimum in 1913 (the preceding and following years being nearly as low), a sharp maximum in 1917, a slight hump on the downward curve in 1919, a sharp minimum in 1923, and a rapid, steady rise in the three following years. The volume is well illustrated with photographs of the buildings and instruments, solar prominences, etc.

Research Items.

The Dalleburra Tribe, North Queensland.—Mr. M. Bennett has published in the *Journal of the Royal Anthropological Institute*, vol. 57, pt. 2, an account of the Dalleburra, a tribe virtually extinct, from notes made by Robert Christison, who settled among them in 1863, and whose collection of Dalleburra weapons, with a series of fine photographs of members of the tribe, is now in the British Museum. It is probable that the Dalleburra had never seen a white man before. Christison got into touch with them only with extreme difficulty, but secured great influence through healing the broken leg of a small boy whom the tribe expected to die. The incident revealed the existence of a custom by which on occasions of both extreme sorrow and great joy the women gashed themselves with stone knives. He could not discover that they believed in one supreme being, though they did believe in supernatural beings. Tribal government was in the hands of headmen, and the chief offences were marrying within the prohibited degrees, abduction, and encroaching on others' hunting grounds. Message-sticks and smoke signals were the chief means of communication. The headmen pretended to be able to call down rain and to cure disease. They determined the distribution of food, getting the best for themselves, and indeed some of the tribe had never tasted emu. There was a regular marriage system, for which purpose the tribe was divided into four divisions, classified in pairs. The children belonged to different sections from their parents. Members of the same section of the same generation were brothers and sisters. All members of the Ko-bro section had the first joint of one forefinger cut off. Incest was punished by the death of the guilty parties, but the child was abandoned. Indicative of their intense feeling on the point is the fact that one case was still regarded with the greatest shame by a member of the tribe thirty years after the event. The youths of the tribe had to go through various trials and courses of instruction before they were regarded as grown-up men and qualified to marry; but no account of the initiation ceremony could be obtained.

The Coffee Mealy-bug in Kenya.—The common coffee mealy-bug (*Pseudococcus lilacinus* CK11) is prevalent in the most important coffee-producing area in Kenya Colony. It is very easily confused with the closely allied species *Pseudococcus citri* Risso, and it is probable that some of the records relative to the latter insect may really refer to *P. lilacinus*. In *Bulletin 18* of the Colony and Protectorate of Kenya, Nairobi (1927), Mr. T. W. Kirkpatrick provides an interesting and very practical study of this insect. In addition to coffee, it affects a wide range of other host-plants and is largely spread by the whirlwinds or 'dust devils,' especially prevalent in the warmer seasons. A whole complex of other insects live in association with the mealy-bug, including ants which attend that insect for the honey-dew it yields, together with various parasites and predators. The damage entailed to coffee by mealy-bug was estimated to amount to £100,000 during the first six months of 1927: the flower buds and young berries form an ideal food and in severe attacks all the leaves may be shed, the crop being ruined. One of the most important factors concerned in the life of the mealy-bug is the ant *Pheidole punctulata*, which attends and protects it in various ways, besides destroying large numbers of other insects which normally prey upon it. Since the presence of this ant involves grave risk of rapid spread and severe injury by the mealy-bug, and in its absence it is unlikely much damage will occur, control measures aim at excluding the ant from the coffee plants. It was found that if the Pheidole is kept off the trees, the mealy-bug is always almost completely destroyed by its natural enemies. Various methods of exclusion are discussed, and the most feasible is the use of paper cones soaked with a high boiling-point tar oil. The cones are fastened round the stems, where they should require no attention for two or three months, and they act as effective barriers to the progress of ants up the trees.

Liver Fluke Disease of Sheep.—The Ministry of Agriculture and Fisheries has issued a revised edition (January 1928) of *Leaflet No. 89* on this subject. A brief account in simple language is given of the life history of the fluke and of the symptoms of the disease. The destruction of the snail (*Limnæa truncatula*), which is the intermediate host of the fluke, is the obvious preventive, and this may be accomplished by drainage or by dressing the land and treating the water of ditches, ponds, etc., with copper sulphate. Dykes should be cleaned out and their sides made vertical, so as to do away with dead water under the banks in which the snail is commonly found. The details of treatment with copper sulphate are clearly set forth in the leaflet. The sheep should be kept on good, well-drained land during the autumn and winter months, the period when infection is likely to be acquired. Curative treatment with extract of male fern and with carbon tetrachloride is advocated and described. The last serious outbreak of liver fluke disease occurred during the winter of 1920–21, when in four counties in North Wales alone 60,000 sheep died or were killed. In a pamphlet on liver fluke disease recently issued by the Council for Scientific and Industrial Research of the Commonwealth of Australia, the loss directly attributable to this disease in Australia is estimated at £100,000 per annum. Treatment by carbon tetrachloride is strongly advocated, and various methods of administration are briefly described.

Hawaiian Barnacles.—Mr. Henry A. Pilsbry ("Littoral Barnacles of the Hawaiian Islands and Japan," *Proceedings of the Academy of Natural Sciences of Philadelphia*, vol. 79; 1927) describes some collections of littoral barnacles from the small islets and reefs strewn over the Pacific for two thousand miles between the Hawaiian group proper and Japan, and also some species from the larger Hawaiian Islands. As these regions, particularly the smaller islands, are practically unexplored for cirripedes, there is here a fertile field for naturalists. Among the many interesting species recorded is a new form, probably belonging to Darwin's *Pœcilasma fissa*, which is named *Trilasmis fissum hawaiense*, the genus Trilasmus having priority over Pœcilasma. Darwin's species, based on a single individual attached to a spinose crab from Bohul, Philippines, is much larger than the Hawaiian form which was found frequently on the mouth parts of the crab *Dromia dromia*, and differs in other respects also. It is a question, however, whether these small specimens may be the young of a larger barnacle not yet found.

Burmese Myxophyceæ.—In the *Journal of the Burma Research Society*, vol. 15, pt. 3, vol. 16, pt. 3, and vol. 17, pt. 3, Dr. S. L. Ghose makes considerable contributions to our knowledge of the Indo-Malayan Myxophyceæ. At the present time, identification of the various genera and species of the group can only be carried on with the expenditure of a large amount of labour on account of the rather rare and much

scattered condition of the literature. Dr. Ghose has taken upon himself the laborious task of making as complete a descriptive record as possible of the blue-green algæ of his region, so that the work of future systematic and ecological investigators will be considerably lightened. The species are listed according to locality, those treated so far being, Myxophyceæ from Rangoon 1, 2, and 3, Myxophyceæ from Maymyo, and Myxophyceæ from Mergui and some neighbouring islands. Genera and species are described critically, and illustrated by means of good plates with line drawings. A few new species and several new varieties are included in the lists.

Agricultural Research in Connecticut.—The fiftieth *Report of the Connecticut Agricultural Experiment Station* (for the year 1926) is a volume of more than 600 pages dealing with the various activities of that Institution. A large part of this publication is occupied by the report of the State Entomologist. The Asiatic beetle which appeared in 1925 in New Haven has received a good deal of attention as it is a new pest in the United States. Up to the present, its injury to plants is confined to grass lawns, where the larvæ live. Many experiments have been conducted with the view of finding a method of control of the oriental peach moth, while the birch leaf skeletoniser is the subject of a long and detailed paper on its biology. On the botanical side one of the most interesting facts brought to light is the discovery that tobacco leaves dried and preserved for twenty-four years still retain the active principle of mosaic disease and can be used to infect living plants. With regard to soil research, the subject of the phosphorus requirements of tobacco with particular reference to old soils is given special prominence. The Report mentions that the library of the Station now contains 16,400 volumes, and that 48,000 copies of bulletins were mailed during the year.

The Upper Waters of the Blue Nile.—An important addition to our knowledge of the Nile drainage system was made by Major R. E. Cheeseman in 1926–27 in his survey of the Abbai River, one of the Abyssinian headstreams of the Blue Nile. Major Cheeseman's account of his explorations and his map of the river from Lake Tana to the Wanbera country is contained in the *Geographical Journal* for April. Previous knowledge of the river and earlier maps were fragmentary, and based mainly on the routes of travellers who had crossed it at various fords. The explorations included an examination of the Tisisat falls, some twenty miles below Lake Tana.

Regional Survey.—An addition to the growing number of regional studies of Great Britain is made by Miss C. Pugh and Mr. G. E. Hutchings in " Stockbury : a Regional Study in North-East Kent," published by The Hill Farm, Stockbury. The study is divided into five sections : Geology and physical features, vegetation, animal life, historical geography, and the Stockbury district. The plants and animal life occupy more than half the book, and while a great deal of valuable matter occurs in these pages, much of it has little real bearing on the regional study of the area in the geographical sense which such work is generally taken to imply. The human part of the study, on the other hand, is disappointingly brief, but the work with its good maps is a careful introduction to the subject.

A Fossil Medusa.—Very few traces of the existence of Medusæ have been found in rocks of earlier date than the Upper Jurassic, so that interest attaches to the discovery of a specimen in the Carboniferous Limestone at Denée in Belgium, and described by V. Van Straelen (*Acad. R. Belg. Bull. Classe des Sci.*, p. 952 ; 1927). It is a cast of the upper convex surface, nothing being known of the oral surface. The specimen is provisionally referred to the Rhizostomidæ.

Protons in Metals.—In a letter in *Die Naturwissenschaften* of Mar. 16, Prof. A. Coehn announces that he has succeeded in effecting an electrolytic transport of hydrogen through palladium. A wire of the metal was charged with gas at the cathode of a cell containing decinormal sulphuric acid, and the subsequent diffusion of the hydrogen was followed by measurement of the electrode potential at various points on the wire. When an electromotive force was applied to the ends of the latter, the hydrogen passed preferentially towards the negative terminal, and could be moved to and fro by reversal of the field. The conclusion that Prof. Coehn draws from these results is that the hydrogen atoms, like those of the metal itself, are partly ionised, but that the resulting protons, not being bound in a space lattice, are free to be affected by an electric field.

Simple Microscope Projection Apparatus.—A simple and useful accessory to the microscope has recently been designed by Mr. J. F. Marshall, director of the British Mosquito Control Institute, Hayling Island, by means of which the enlarged image of any object inserted under the microscope can be projected directly upon a screen either for the purpose of demonstration, drawing, or photography. The apparatus, which is known as the 'Moscon Macrograph,' consists of a projection screen attached to a vertically adjustable rod carried in a light but rigid framework which may be clamped to any table, shelf, or other convenient support. The microscope and the illuminant are placed on the floor and the image of the object is focused on the screen. As the screen is horizontal and can be fixed at a convenient height, the apparatus is extremely well suited for drawing, the tracing paper being easily fastened on the clear glass screen by means of the frame clips. For photographic purposes a light-tight bag of black cloth is attached to the frame of the screen and to the tube of the microscope, and a plate carrier is substituted for the glass screen after the image is focused. In this carrier the plate is covered by a hinged lid which opens downwards and works more smoothly than the usual sliding shutter. The macrograph, which costs £5, complete with carrying case and two projection screens, but without the photographic accessories, is marketed by Messrs. W. Watson and Sons, Ltd., 313 High Holborn, London, W.C.1.

Thermal and Electrical Conductivity.—The paper on the thermal and electrical conductivity of some aluminium alloys and bronzes read by Ezer Griffiths and F. H. Schofield at the annual meeting of the Institute of Metals on Mar. 7 is of considerable practical importance. It is frequently stated that the Lorenz law, namely, that the thermal conductivity varies as the product of the electrical conductivity and the absolute temperature, fails when applied to data obtained with alloys. The results obtained by the authors prove, at least, that as a generalisation, this statement is erroneous. The error has probably arisen from the fact that the values usually given for the thermal conductivities of alloys are untrustworthy. The primary object of the research was to obtain the thermal conductivities of the alloys employed in the construction of aero-engines. Two different sets of alloys were investigated. The first group consisted of alloys rich in aluminium, and the second group

those rich in copper. For the second group, it was found that the Lorenz coefficient had practically the same value within $\pm 2{\cdot}5$ per cent. from 75° to 250° C. This is probably within the limits of experimental error. It appears, therefore, that the thermal conductivity can be deduced from a measurement of the electrical conductivity. As the determination of the latter quantity presents far less difficulty than that of the former, this result will be of great practical use. For the twenty-one aluminium alloys experimented on, very consistent results were obtained, except with a 13 per cent. silicon alloy. A determination of the Lorenz coefficient for a single crystal of aluminium (99·6 per cent. aluminium) gave the value $5{\cdot}46 \times 10^{-9}$. This is in good agreement with that obtained for the alloys. The value of the Lorenz coefficient for very pure copper was $5{\cdot}89 \times 10^{-9}$, which is in close agreement with the values obtained for the bronze alloys, but is decidedly higher than that obtained for the aluminium alloys.

An Ultra-violet Lamp with New Electrodes.—The 'Uvir' lamp, made by Messrs. Bellingham and Stanley, Ltd., is interesting and of unusual design. The arc is formed between two parallel metallic electrodes mounted vertically in front of a radiator which constitutes the series resistance. The heating elements of this radiator are solid rods of a special composition which reach a higher temperature when running than is possible with wire spirals, and hence yield a greater percentage of radiant heat. The electrodes are rigidly mounted in a simple clamp, so that the arc has to be lit by placing a carbon rod across the points. A rod mounted in an insulating handle is supplied with each lamp. The electrodes are made of a special alloy which has been selected as giving an intense radiation over the range of wave-lengths 2900 A.–3100 A. For use on an A.C. supply, the metallic electrodes are replaced by carbon cored with the same alloy, but even so the starting of the lamp is found to be more difficult than on D.C. Both arcs burn steadily with less fume and oxide than tungsten, and can be blown out like a candle, but the electrodes require adjustment and turning round in the holder from time to time to keep them at the same height. The cost of the alloy electrodes is about half that of tungsten. The radiation generated by this lamp is of an unusual character, as a great percentage is concentrated round the wave-length 3000 A., a range which is generally regarded as being of great therapeutic activity. Further, the shorter wave-lengths, of more dubious value, are not present to any marked degree. The 'Uvir' lamp may therefore be described as an efficient source of ultra-violet radiation of therapeutic value. It is for that reason to be regretted that more attention has not been given in the electrical design to safety devices. The radiator heating elements are protected by a wire grid, but the arc, which reaches a higher temperature and may be equally 'alive,' is outside the grid and entirely exposed. It is claimed that the somewhat crude method of striking the arc described above has the advantage of eliminating moving parts which are likely to corrode or oxidise, and in one way or another get out of adjustment. It may be found that the public is shy of taking such liberties with the ordinary type of mains and will require some form of switch on their ultra-violet lamps. The current consumed is approximately 3 amp. and the price is £5 5s.

The Inflammability of Hydrogen.—The January number of the *Journal of the Society of Chemical Industry of Japan* contains a further account of the work of Y. Tanaka and Y. Nagai upon the inflammability of hydrogen–air mixtures. They have found that, as would be expected, the tetra-methyl compounds of tin and lead act as anti-knocking agents in internal combustion engines, but these substances do not produce so great an effect upon the limits of inflammability of hydrogen mixtures as do the corresponding ethyl compounds. This is attributed to the smaller cross-sectional areas, and hence the smaller probability of collision with activated hydrogen molecules, of the molecules of the methyl derivatives. The theory of active collisions in combustion, and a derivation of the effects of pressure on the limits of inflammability, have already been given by Y. Nagai in the *Journal of the Faculty of Engineering of the Tokyo Imperial University*, vol. 17, No. 3, 1927.

Developer Stains.—It is well known that in developing a photograph the oxidation products of the developer are deposited with the silver of the image and form a secondary 'stain image,' unless sufficient sulphite is present to prevent it. Messrs. Lumière and Seyewetz (*Brit. Jour. of Photography*, Mar. 11, p. 172) find that the colour of this image varies with the nature of the developer and sometimes with the alkali used, being orange yellow with pyrogallol and various shades of brown with other developers. The amount of anhydrous sodium sulphite necessary to prevent the formation of this stain image is generally 2 gm. to the litre, but pyrogallol requires 11 gm., pyrocatechin 6 gm., and glycin needs none, as it does not give this image at all. The formation of the stain image renders the gelatin insoluble in proportion to its intensity. This image is a mordant for basic dyes, and may be intensified by such dyes to a density even exceeding the density of the original image as developed. To isolate the stain image, the silver is dissolved away by means of ferricyanide and hypo.

Electrical Hardening and Annealing Processes.—Electric salt bath furnaces have been found to be very useful for heating metals up to the exact temperature required for hardening in the shortest possible time. They are largely employed for hardening cutting tools. The tool to be hardened is placed in the salt which is to carry the electric current. When the salt melts it makes good thermal contact with the metal, the required temperature being attained very quickly. The salt bath also serves as a heat accumulator. Air is not in contact with the heated metal, and so it is not oxidised on quenching. Owing to the excellent way they retain their heat, salt bath furnaces are particularly suitable for hardening metals on a large scale. In *A.E.G. Progress* for December, a description is given of electrical welding and hardening processes. The furnaces for 800° C. are used for hardening carbon steels, and those for 1300° C. for high alloy steels. The salt used for temperatures from 750° C. to 1000° C. is composed of a mixture of barium and potassium chlorides, and that from 1000° C. to 1300° C. of barium chloride only. Electric annealing furnaces are also described. For these furnaces chrome nickel has been found most useful for the conductor which converts the electrical energy into heat. These furnaces are generally designed for temperatures up to 950° C. and are specially useful for heating processes which have to extend over long periods. They are sometimes equipped with automatic temperature regulators and can be used for annealing metals in hydrogen and other gases. The tempering of hardened tools can also be effected in electric salt bath furnaces even when the temperature required is so low as 220° C. In this case the conducting salt is a mixture of sodium and potassium nitrates.

Pharmacological Research in Great Britain.

THE second Annual Report of the Pharmacological Laboratories of the Pharmaceutical Society of Great Britain (1927) gives a brief summary of the research work carried out during the year, and indicates the part the laboratory is beginning to play in the physiological standardisation of different drugs for commercial manufacturers. In February of last year the Vitamin-testing Department, under Dr. Katharine H. Coward, was ready to carry out its first tests, and these now occupy an important place in the laboratory's work.

The director, Dr. J. H. Burn, has continued his researches on the metabolism of rats on a fat diet: he has found that in summer the excretion of acetone bodies in the urine of a 100-150 gm. rat reaches a maximum of 50 mgm. in a day, whilst in winter the maximum may not be greater than 5 mgm. The summer acetonuria can be inhibited by injection of pituitary extract or adrenalin, indicating that these hormones control the metabolism of fat as well as that of carbohydrate. On the other hand, daily injections of insulin, after a day or two, increase the winter acetonuria, and this increase is not simply related to the fall in the blood-sugar, since the latter occurs to about the same extent on all days on which the injections are given.

Some work has been carried out on the assay and preparation of extracts of ergot, and also, in conjunction with Mr. A. Bourne, on the clinical value of pituitary and ergot extracts. It was found that during labour a dose of 2 units of pituitary extract was quite sufficient to hasten its conclusion, and also that of the possibly active substances present in extracts of ergot, the specific alkaloid ergotoxine or ergotamine produces, after a short latent period, a prolonged contraction of the uterus *postpartum*, whilst histamine causes an immediate powerful but short-lived contraction, and tyramine is inert.

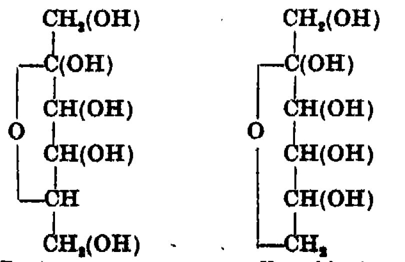
A paper on the œstrus-producing hormone has been published by Drs. Burn and Coward: it was found that the individual variation between different rats or different mice is as much as 1000 per cent. The authors therefore define the unit as the dose necessary to produce œstrus in 50 per cent. of ovariectomised animals. They have constructed a standard curve relating the percentage of rats in which œstrus occurs to the dose injected from observations on a group of 90 animals. A curious point that emerged from this work was that the mouse unit has exactly the same value as the rat unit, in spite of the difference in body weight between the two species.

In the vitamin department, a stock colony of Wistar rats is in process of being built up, by inbreeding the animals and maintaining them on a constant diet: the most suitable diet, however, has not yet been determined. A sample of irradiated ergosterol is being used as a standard for vitamin D assay: a unit has been defined as the amount of antirachitic activity contained in 0·0001 mgm. of this sample. This definition has been rendered necessary by the fact that certain workers are defining the unit of vitamin D as the least amount which will cure rats of rickets, when they are maintained on a rachitogenic diet: such a unit may vary by 400 to 500 per cent. in different experiments. It is hoped to use a sample of the unsaponifiable matter of cod-liver oil as a standard for vitamin A in the near future. The report also gives the number of samples of the different preparations which have been assayed during the year: approximately 170 were tested.

The Synthesis of Cane Sugar.[1]

By Prof. AMÉ PICTET and H. VOGEL.

THE fine researches of Haworth and of Irvine have shown that fructose (levulose) does not possess the same chemical composition when it is in one of its natural combinations (cane sugar, inulin) as when it has been extracted. Hence it must be admitted that it can exist in two isomeric forms, one of which, to which the name of γ-fructose has been given, is unstable and changes spontaneously into the other, called normal fructose, as soon as it is set free. Haworth and his collaborators have made it very probable that the formulæ which should be attributed to these two forms are the following:



γ-Fructose. Normal fructose.

It follows from these facts that if it is attempted to realise a synthesis of saccharose by the union of its two constituents, glucose and fructose, it cannot be effected by utilising the second of these sugars in its normal form, the only one available. It would be necessary to start with one of the artificial derivatives in which it occurs in the γ form. Some of these are known (methyl, ethyl), but none of these would be available for the operation in question, since the substituted groups that they contain are too firmly fixed to the rest of the molecule to permit of their being detached, once the condensation with the glucose had been carried out.

Hence the synthesis of saccharose necessitates the preliminary preparation of a derivative of γ-fructose containing only substituent groups relatively easy to remove. The following observation has furnished us with a substance which fulfils this condition.

We have found that when the tetracetate of normal fructose is prepared by the method of Hudson and Brauns (*Jour. Amer. Chem. Soc.*, **37**, p. 2739; 1915), that is, by treating fructose at a low temperature with acetic anhydride and zinc chloride, on crystallising the product from alcohol, a second compound is formed in small quantity which remains in the mother liquors. On evaporating these in a vacuum a thick syrup is obtained which, on contact with cold water, is slowly converted into a solid vitreous mass. Up to the present, this substance has not been obtained in the crystalline condition, but its analysis, and the fact that it easily reduces alkaline copper solutions, proves that it consists of a second tetracetate. Moreover, its rotatory power, much lower than that of the normal tetracetate, would suggest that it belongs to the γ series.

The formation of a derivative of this nature would be explained by admitting (as already suspected by

[1] Translated from *Comptes rendus* for Mar. 19 of the Paris Academy of Sciences.

Ohle) that when fructose goes into solution, an equilibrium is established between its normal form and the γ form. This would take place in acetic anhydride as in any other solvent and each of these forms would then be acetylated on its own account. Under the conditions of our experiment, the equilibrium would appear to be approximately 97 parts of normal fructose and 3 parts of γ-fructose.

It would have been easy to prove the γ nature of the new acetate by methylating it, and then saponifying the product; the methyl-γ-fructoside prepared by Irvine should thus have been obtained. But there was another method, more simple still, and that was to combine it with glucose tetracetate: it should then, if really derived from γ-fructose, give rise to the octacetate of saccharose.

Glucose tetracetate + γ-fructose tetracetate = saccharose octacetate + water.

This experiment was carried out by dissolving in chloroform equal weights of our tetracetate and that of glucose (prepared according to the method of E. Fischer and Delbrück), and this solution was shaken for 15 hours with phosphorus pentoxide. On evaporation in a vacuum, it left a syrupy residue, which, taken up in warm alcohol, deposited fine crystals on cooling. These presented the principal characters of saccharose octacetate

Melting-point of our crystals	70° C.
,, ,, of saccharose octacetate .	70° C.
,, ,, of their mixture . . .	70° C.
Rotatory power in chloroform solution .	+59°·4
,, ,, of saccharose octacetate	+60°·0

It may be noted that the same substance was obtained in two series of experiments, in one of which a fructose prepared by inversion of saccharose was the starting-point, and in the other a fructose extracted from inulin.

The saponification of the synthetical octacetate, carried out by Zemplen's method, finally gave an anhydrous, non-reducing disaccharide, of crystalline structure and very sweet taste. The comparison of its principle properties with those of cane sugar gave the following figures:

Analysis (per cent.) . .	C 42·3, H 6·6 (calculated for $C_{12}H_{22}O_{11}$: 42·1 and 6·5).
Cryoscopy in water . .	Molecular weight found: 344 (calculated 342).

Melting-point of our sugar	183° C.
,, ,, of saccharose	184° C.
,, ,, of their mixture . . .	184° C.
Rotatory power in aqueous solution	
of our sugar (C = 5·07)	+66°·3
of saccharose at the same concentration	+66°·5
of our sugar after inversion	−20°·6
of saccharose after inversion . . .	−20°·7

From the concordance of these figures the identity of these two substances must be regarded as proved.

We still have to clear up certain points concerning the intermediate products of this synthesis, and to give an account in greater detail of the whole of our operations. These results will be published in due course.

The Development of Cyclonic Depressions.

In the *Monthly Weather Review* for November 1927, two articles by W. J. Humphreys appear, both of which deal with the growth of cyclonic depressions in the United States and Canada.

The first article gives an explanation of the great increase in size and intensity of a depression that so often takes place when it moves north-east across the eastern parts of the United States or of Canada. Since such an increase of intensity with increasing latitude is not a world-wide phenomenon, the idea that it may be due to change with latitude of the deflective force of the earth's rotation is rejected. If, on the other hand, contrast of temperature is regarded as essential for cyclonic development, an obvious explanation is afforded by the fact that the farther north the depression goes, the shorter is the distance through which the incoming supply of polar air has to pass, and the colder that air will be on arrival, while the high temperature of the equatorial air is largely maintained by latent heat set free by condensation of its water vapour, even when the distance travelled from equatorial regions is very great, the result being an increase of temperature contrast between the parts of the depression fed, respectively, by these two supplies of air. Such opportunities for increasing temperature contrast as exist over eastern North America and the western part of the North Atlantic are available in few if any other parts of the world.

The second article seeks to explain why depressions moving north-eastwards across the United States in winter increase in size and intensity more rapidly by night than by day. Thermal considerations are again made use of: it is pointed out that the cold portions of the depression have as a rule clearer skies than the relatively warm portions, and consequently are far more strongly cooled by radiation at night, an increase of temperature contrast due to this effect being added to the general effect of latitude mentioned above. During the daytime, on the other hand, not only is the polar air with its clearer skies warmed more than the equatorial air, so as to reduce the contrast of temperature, but also, being so warmed, thermal convection will normally set in and obstruct to some extent the simple cyclonic wind-system.

It may be pointed out that the effect dealt with in this second article is not generally regarded as characteristic of depressions crossing the British Isles. This is not surprising, however, when we consider how comparatively small the nocturnal fall of temperature is in polar air that has been charged with water vapour, if not with cloud, during a long passage across the North Atlantic, as generally happens with polar air reaching the British Isles.

Earthquakes in the Crimea in 1927.

Prof. A. V. Voznesensky in *Priroda* (No. 12, 1927) gives the preliminary results of observations on the Crimean earthquakes of last summer. The data on which the account is based are admitted to be somewhat fragmentary and inexact, since the Crimea was considered not to be subject to earthquakes and there was no seismological station there before, though one is established now in Feodosia. Apart from that, observations on the spot during the earthquakes were not organised properly and have been made without system or knowledge.

The first tremor occurred on June 26, when many buildings were partially destroyed, and afterwards slight tremors were experienced for five months, until

November; during this period the second great earthquake occurred, on Sept. 12, which was still more destructive than that in June. The strength of the earthquake was estimated by local observers as 8, but the author is inclined to regard this figure as exaggerated and not exceeding 6, since not more than 20 per cent. of buildings were damaged, and those only partially and owing to their unsatisfactory state. The area of the June earthquake covered by the isoseist 6 occupied the south-western extremity of the Crimean peninsula; the area covered by the isoseist 2 is more or less triangular in shape and stretches from Kiev to Batum (1280 km.). The axis of the September earthquake was almost perpendicular to that of the June one, and the area of the isoseist 2 was about half as long again, but the epicentre could be determined as practically in the same spot, while the strength increased more than twice.

A comparative study of records from seventeen Russian and foreign observatories permitted the author to determine the epicentres in a preliminary way, for the June earthquake at 44° 30′ N. and 35° 50′ E., for the September one 44° 30′ N. and 35° 10′ E. Both these points are in the Black Sea; the first 53 km. from the shore south of Cape Tchaudr: the second 43 km. south of the mouth of the River Otusa; both at the depth of 1·5 km. The depth of the epicentres is suggested by the author as about 25 km. Preliminary data of a hydrographical survey of these areas showed considerable alterations in the state of the sea bottom, since instead of soft mud found on previous occasions the survey discovered stony bottom. The probable cause of the earthquakes was purely tectonic, since there was absolutely no indication of volcanic action, though some vague rumours to that effect circulated amongst the panic-stricken population. Losses of life were negligible, which was explained by the fact that strong tremors were preceded by slighter ones and nearly everybody left buildings. On the other hand, the moral sufferings of the population were great, owing to the enormous number of successive tremors keeping the people in permanent suspense. During the first month as many as 265 tremors were registered, or 8·2 tremors daily, while on the first day their number was 41, and it is easy to understand the assertions of inhabitants that there was an incessant trembling for many days.

University and Educational Intelligence.

Glasgow.—At the Ceremony of Graduation held on April 21, the degree of doctor of science (D.Sc.) was conferred on Dr. R. C. Smith, for a thesis on "The Stability of Emulsions, with Additional Studies in Rates of Reaction."

Nottingham.—In our issue of Feb. 4, p. 190, reference was made to the opening of the new buildings by H.M. the King in July next. It is now announced that the opening ceremony will take place on July 10.

Sir Jesse and Lady Boot are making further contributions to the new buildings. Sir Jesse will bear the cost of the great hall, and Lady Boot the expense of a women's hall of residence.

Dr. W. B. Crow, lecturer in botany at the University College, Cardiff, has been appointed head of the Department of Biology at the Technical College, Huddersfield, in succession to Dr. T. W. Woodhead, president of the British Ecological Society, who, at the end of the present session, will be retiring from the headship after thirty-two years' service.

Following upon the Hackett bequest of about £550,000 to the University of Western Australia, the Government has resolved to celebrate the centenary of the State in 1929 by erecting such buildings as will enable the entire University to be moved to its 165-acre site at Crawley. The Departments of Engineering, Biology, and Geology are now in their permanent buildings, and a building for physics, to be erected at a cost of about £32,000, should be completed by August 1929. The Anglican Church has commenced the erection of St. George's College—a residential college for students—the foundation stone of which was laid on Mar. 8. The central Winthrop Hall, with its adjoining administrative buildings and Students' Union, is being erected in accordance with a design by Messrs. Alsop and Sayce of Melbourne, whose plans were awarded the first prize last August in an Empire-wide competition. The late Mr. R. J. Gledden, who died towards the close of 1927, left his entire estate to the University for the promotion of the study of applied science, and this bequest will, when the property is realised, amount to nearly £100,000.

The eighteenth annual report of the University of Leeds on adult education work gives particulars of thirteen university extension lecture courses and forty-five tutorial classes, which cost £373 and £4931 respectively. Among the tutorial class subjects the natural sciences were represented by biology only. In this subject there were five classes with ninety-five members. As an indication of the interest aroused, mention is made of two public exhibitions of their work arranged by the students. The tutor in biology, Mr. Norman Walker, has demonstrated by the continuance of his classes for more than three years the effectiveness of his methods, an account of which is given in the recently published Report on Natural Science in Adult Education by the Board of Education's Adult Education Committee. He insists, above all, on the teaching being practical and never losing contact with life. "This aspect possesses great inspiration and is effective in mind training, while the intellectual satisfaction obtained secures the adult student's devotion and attention over several years, if not for a lifetime."

The Carnegie Trust for the universities of Scotland has published its twenty-sixth annual report, which gives particulars of grants made during 1926–27 as follows: grants to universities, £39,700; grants to other institutions, chiefly colleges, £8345; grants in aid of post-graduate study and research, £16,829; assistance to students by way of payment of class fees, £58,664. Among the new buildings for which some of the largest grants to universities were made are students' hostels and a students' union. Apart from a research lectureship in Scottish history, the assistance rendered to research by the Trust is in three forms: research fellowships, scholarships, and grants; the laboratory of the Royal College of Physicians; and teaching fellowships. A pleasing feature of the report regarding assistance to students is the unprecedentedly large amount (£2575) of voluntary repayments of their class fees by former beneficiaries. Of the total amount thus repaid since the trust began its operations, nearly half has been contributed by former students of the faculties of medicine. The policy of the trustees in dealing with applications for admission as Carnegie students has recently been modified. Instead of accepting without question declarations by applicants and their parents or guardians purporting that without the assistance of the Trust university education would be impossible, the Trust now inquires into the financial circumstances of the family. It finds that the circumstances of the great majority of applicants clearly justify any assistance which can be rendered to them.

Calendar of Customs and Festivals.

April 30.

Rood Mass. Walpurgis Nacht.—Believed to be one of the greater, if not the greatest, of the occasions on which a witches' Sabbat took place. According to one version, witches from all parts had to fly to the Sabbat on the Brocken, those arriving late being sacrificed to provide the ceremonial meal.

May 1.

May Day.—Among European peoples the first day of summer is, or was until quite recently, marked by customs, practically everywhere identical, which can be traced back over a considerable period of time. Ceremonies which can be paralleled in every particular among recent observances, including the ceremonial contest between representatives of summer and winter, are recorded by Saxo Grammaticus.

On the eve of May Day, or in the early hours of May morning before sunrise, parties went out to collect green or flowering branches, and brought them back to place before the doors or hang them on either their own houses or those of others. The fetching of the May was an occasion for merrymaking, not always too decorous, and was accompanied by music and the blowing of horns welcoming the summer. The custom in olden days was common to all classes. In Malory, Queen Guinevere goes a-maying with all her knights, and so did Henry VIII. with his Queen Katherine.

At times a sapling or tree took the place of green boughs and was erected in the middle of the village with more or less ceremony, in some places being brought in by teams of gaily decked oxen. From this grew the custom of erecting a more or less permanent maypole, gaily coloured in stripes and decorated on the day with flags and streamers and sometimes a doll. Several such maypoles existed in London, the most frequently mentioned long standing in the Strand. The origin of the maypole, however, as the annual revival of vegetation, continued to be indicated by a bunch of fresh leaves or a garland fastened to the top. The garland, conventional in form, was similar to those carried by children, one or two small hoops or wreaths of flowers and leaves, if two in number fastened at right angles to one another. These the children carried at the end of a stick or wand from door to door, singing a May song, with the object of collecting pence.

The maypole was the centre of the day's rejoicing, which embraced various forms of sport and Morris dancing. The Morris dances invariably included a principal man, a female character, a fool, and often a hobbyhorse. The best-known example of the last named was the Padstow hobbyhorse with its special song. In England the characters of the May Day dances are usually Robin Hood, Maid Marian, and their traditional followers, Little John, Friar Tuck, and Scarlett. Maid Marian became a travesty as the character was taken by a male dancer. At the same time she originally represented the female principal of Nature, which found more graceful expression in the election of a May Queen. The May Queen sometimes held authority not for the day only, but in all assemblies of young people throughout the year. The male principle was represented not only by the chief male character, but was also expressed in the pole itself, which undoubtedly had a phallic significance similar to that of the *lingam* in the religious observances of India.

A figure in the May observances to which reference is frequently made is 'Jack in the Green'—a man disguised and completely hidden in a framework of greenery. A pyramidal garland, six feet high, carried in the procession of the May Queen in Huntingdonshire, has clearly taken his place. The career of Jack in the Green sometimes ended by his being thrown into a pond or stream. Obviously he is a materialisation of the vegetation spirit and his end a rain charm.

The special virtue of the dew of May morning was recognised in the custom of dabbling the feet in the dew, and bathing the face and hands, the latter a beauty charm, but the whole observance originally a rite to secure fertility. A similar custom, to name an example, is the May Day evening practice of the women of the island of Syra in the Ægean, who go in parties to the seashore to bathe their feet, possibly as a tribute to ensure the blessing of fertility from the sea goddess Aphrodite.

Bealltainn or Beltane.—In both Scotland and Ireland, May Day was celebrated by observances similar to those of England and other European countries. It was also the first day of summer—Beltane, in the Celtic calendar, being, however, not the first, but the middle day of the month Céitein, which included fourteen days of April and fourteen days of May.

Beltane was pre-eminently a fire festival among the Celtic peoples, and akin to the Easter fires previously mentioned and the midsummer fires. Indeed it has been explained as meaning the Fires of Bel or Baal. The meaning is obscure, and an alternative, the separation or parting of the seasons, has been suggested. It is a time of purification by fire from the evil influences of the past winter in preparation for the summer of fertility and growth. On May 1, whatever the weather, the cattle had to be driven out to the summer grazing grounds. Before this could be done they were purified by fumigation or by being driven through the flames of burning straw, as in the south of Ireland. Pennant records that the herdsmen of the Highlands of Scotland, while standing round a fire built on turf in a surrounding trench, first poured a libation of eggs, butter, oatmeal, and milk on the ground, and then threw offerings of oatmeal cake over their shoulders with a request for the protection of their flocks, herds, and horses from eagles, crows, and noxious animals. In a similar observance by boys in Perthshire, one of the number had to leap through the flames of the fire.

May 2.

St. Helen's Day, Rowan Tree Day.—In Yorkshire rowan tree branches were collected in a certain prescribed manner and planted over each door and window of the homestead as a protection against witches. Small pieces were carried in the pocket or purse with the same object. In Aberdeenshire the twigs were made into crosses and suspended at windows and doors. Witches and fairies were especially feared at this time, and in Scotland on May Day eve the cattle were protected by tar smeared behind the ear and on the root of the tail. A churning and a cheese made before sunrise protected the dairy produce against fairies in the coming year. If fire or rennet were given away on May Day, it gave the receiver power to take away the substance of the donor's milk.

May 3.

The Day of Avoidance.—In Scotland during the May Day week it was considered unlucky to undertake field operations, but the third day of summer was considered particularly unlucky for any undertaking. This may be connected with the fact that it was sometimes believed that the great witches' Sabbat took place on this day instead of on April 30.

Societies and Academies.

LONDON.

Geological Society, April 4.—**G. W. Tyrrell**: The analcite-syenites and associated rocks of Ayrshire. These rocks occur in differentiated intrusions along with analcite-olivine-dolerites or crinanites, as strati-form bands, schlieren, and veins. The principal occurrence is at Howford Bridge, Mauchline, where analcite-syenite forms a considerable part of the sill. In the remaining three described occurrences (Dippol Burn, Trabboch Burn, and Prestwick) the analcite-syenite is restricted to schlieren and veins. They all belong to the widespread suite of analcite-bearing igneous rocks of late-Carboniferous and Permian age in the west of Scotland. The most noteworthy mineralogical feature is the abundant occurrence of analcite, thomsonite, natrolite, and prehnite, which must be regarded as late primary crystallisations from the magma. A hypothesis for the development of schlieren and veins in the sills by the effects of the varying incidence of the pressure due to the superincumbent column of rock, upon a crystal mesh filled with interstitial liquid, is framed. The liquid is believed to be progressively driven towards the centre of the sill, and also laterally towards those places where the pressure is compensated in various ways, so that free contraction of the crystallising mass can take place.—**J. Parkinson**: A note on the Pleistocene history of western Buchivacoa (Venezuela). The area consists of alternating estuarine or fresh-water false-bedded sandstones, and sandy clays, folded along east-north-easterly axes in many places. Burdigalian and Aquitanian fossils occur in the eroded centres of the folds. There is an unconformity between the Miocene and the overlying strata, which appear to be of Lower or Middle Pliocene age. The Tertiary deposits are covered by Pleistocene pebble-beds. The latter are probably an old sea-beach. Subsequent elevation during a pluvial period allowed of a 'creep' of the pebbles northwards. Redeposition in successive stages was effected by eastward-flowing rivers of the Indus type. Since Pliocene times, an elevation of about 1000 feet has taken place along the southern edge of the district.—**A. Tindell Hopwood**: *Gyrinodon quassus*, a new genus and species of toxodont from western Buchivacoa (Venezuela): with a note on the reptilian remains by **W. E. Swinton**. Gyrinodon differs from Toxodon in its more primitive dentition, and in the characters of the skull-cap. It differs from Alitoxodon in the characters of the mandibular symphysis. This is the northernmost locality for toxodonts hitherto recorded in South America. Apparently the toxodonts followed a northward dispersal.

Royal Statistical Society, April 17.—**Major P. Granville Edge**: Vital registration in Europe. Modern public health work is largely directed and controlled by the conclusions reached after the study and analysis of data resulting from the careful collection of the vital facts of human life. Such records constitute a national system of book-keeping. Accurate and complete vital statistical records provide a means of discovering the principal factors responsible for the wastage of human material, the degree of success attending the introduction of various health measures, and promote research with the view of reducing sickness, controlling disease, and prolonging the average span of human life. Although vital statisticians of various countries are engaged upon the study of similar problems, the information sought by the various national schedules, and the methods of procedure and classification, etc., differ so essentially that the resulting data are not comparable between one country and another. The official records of many European States contain serious and remediable defects, which increase the difficulties of securing comparability of data between one country and another.

DUBLIN.

Royal Dublin Society, Mar. 27.—**H. H. Dixon** and **T. A. Bennet Clark**: The influence of temperature on the responses of plant tissues to electrical stimulation. The view is put forward, on the basis of the work of Höber and McClendon in particular, that the sudden change in the electrical resistance of a tissue, brought about by the passage of an electric current through it, is caused by an increase in the permeability of the protoplasmic membranes and not by alterations in the concentrations of ions. Previous work on the relationship between the voltage and energy-content of the stimulus and the magnitude of the resulting change in permeability has been confirmed and extended. The sensitivity decreases extremely rapidly during November and increases as rapidly in December and January, after which a rather slow increase in sensitivity occurs. The response is of a dual nature. At a temperature of 0° C. the negative reaction is the greater; as the temperature is raised to 20° C. the positive reactions are increased more than the negative; further raising of the temperature causes marked predominance of the negative reactions. Continued previous exposure to various temperatures does not alter the sensitivity of tissues at a fixed temperature of experiment. It does, however, temporarily alter their resistance.—**W. D. Davidson**: (1) The rejuvenation of the Champion potato. The downfall of the Champion and other old varieties was, in all probability, due to the presence of one or more of the diseases included in the mosaic group. Almost all Champion stocks had become affected to the extent of 100 per cent. In an effort to propagate a healthy nucleus stock, nine plants were with great care selected from the best stocks procurable. These plants were apparently healthy, and were dug early to minimise the risk of infection. A tuber from each plant was tested for freedom from mosaic. The produce of all plants found to be healthy were grown in units among turnips well isolated from each other and from all other potatoes. This system of planting was followed for three seasons. During the first two seasons no trace of any of the mosaic diseases was discerned. In the third season a few plants had to be removed from three units. It is confidently believed that the selected stock is now quite as healthy as when it was put in the market more than fifty years ago. (2) A review of literature dealing with the degeneration of varieties of the potato.

PARIS.

Academy of Sciences, Mar. 19.—**J. Costantin**: Contribution to the biological study of *Picea excelsa*. Two fungi would appear to grow in symbiotic association with the roots of this tree, *Polyporus ovinus* and *Pholiota caperata*. The fact was noted in the Savoy Alps, but direct experiments are necessary to prove the influence, if any, of the mycelium of each of these fungi on the development of the trees.—**Ch. Lallemand**: Against the legal creation of a new gold franc of reduced value.—**Amé Pictet** and **H. Vogel**: The synthesis of cane sugar (v. p. 689).—**Alex. Froda**: The ensemble of discontinuities of the first species.—**A. Kovanko**: Some generalisations of nearly periodic functions.—**G. Vranceanu**: Periodic solutions with very long periods.—**Belzecki**: The case of equilibrium of elasticity of a hollow cylinder.—**R. Wavre**: The figures of

equilibrium of a heterogeneous fluid mass.—**V. G. Siadbey**: The orbit of Finsler's comet, 1924 II. For this comet several systems of parabolic elements, and one hyperbolic, have been calculated by various authors. Taking the whole of the published data, a recalculation of the elements has been made. The most probable system appears to be hyperbolic, the constants of which are given.—**Al. Proca**: Some reflections on the foundations of dynamics. The fifth dimension.—**Nageotte**: The Brownian undulations of thin plates and of filaments in myelinic formations.—**Mlle. M. Chenot**: Higher order oscillations in an oscillating circuit.—**Mlle. St. Maracineanu**: Phenomena resembling those of radioactive substances presented by metals.—**A. P. Rollet**: The existence of the oxide of silver Ag_4O_3. The anodic oxidation of silver in an alkaline electrolyte of higher concentration than normal gives a peroxide Ag_4O_8, which is very stable in alkali solution.—**Paul Mondain-Monval** and **Paul Schneider**: The temperature of transformation of liquid sulphur into viscous sulphur. Curves are given showing the viscosity of sulphur, and of sulphur containing various proportions of various organic substances in solution, as functions of the temperature. The temperature of transformation of pure sulphur is 160° C., and this is raised by the presence of organic substances in solution.—**Mlle. Suzanne Veil**: Yellow ferric hydroxide, the result of the controlled oxidation of ferrous sulphide in suspension. An application of the changes in the magnetisation coefficient to the study of ferric hydroxides produced under differing conditions.—**P. Vaillant**: The composition of the Kundt displacements in an absorption spectrum with several maxima.—**Pierre Auger**: The directions of emission of the photo-electrons.—**Maurice Billy**: The composition of titanium peroxide. In an earlier paper the author indicated that the hydrate precipitated from a pertitanic salt had the composition Ti_2O_5, Aq. Schwartz and Sexauer, repeating these experiments, come to the conclusion that the composition is TiO_3, provided that the temperature is kept about 0° C. Additional experiments are given showing that at 0° C. there is more oxygen than corresponds to the formula Ti_2O_5, although far removed from TiO_3.—**A. Duboin**: The introduction of bromine and iodine into silicates. Definite crystals have been prepared of the composition KBr, K_2O, CoO, $4SiO_2$, and KI, K_2O, CoO, $4SiO_2$.—**Raymond Quelet**: The action of magnesium on some parabromoethylene derivatives of benzene.—**Marcel Godchot** and **Mlle. G. Cauquil**: The dehydration of the pinacone of cycloheptanone.—**J. Orcel** and **Gil Rivera Plaza**: The microscopic study of some metallic minerals of Peru.—**Louis Barrabé**: The tectonic of the region comprised between the Manambao and the Manambolo (west of Madagascar) and on its relations with eruptive phenomena.—**J. Thoulet**: The densimetric study of Humboldt's current and of the sea of Easter Island.—**J. Aloy** and **Jacques Aversenq**: The radioactivity of some springs in the Pyrenees region.—**L. Éblé** and **J. Itié**: The values of the magnetic elements at the Val-Joyeux station (Seine-et-Oise) on Jan. 1, 1928.—**A. Eichhorn**: The various stages of mitosis of *Hyacinthus orientalis* and, comparatively, of *Allium cepa*.—**H. Belval**: The genesis of starch in cereals, glucides of leaves, and the stems of rice.—**Volmar** and **Jermstad**: Sclareol, the principal constituent of essential oil of sage. This substance, of the composition $C_{34}H_{68}O_3$, is a tertiary, polyhydric alcohol, unsaturated and similar to the phytosterins and cholesterins.—**Lucien Daniel**: New observations on the variations of descent in grafted Jerusalem artichokes.—**Cl. Fromageot**: The deviations which may occur in the hydrogen ion concentration of the soil at points close together.—**Tchéou Tai Chuin**: The absence of strobilisation and persistence of budding during the winter in artificially fed scyphistomes.—**E. Roubaud**: The reactivating anhydrobiosis in the evolutive cycle of the Pyralis of maize.—**A. Giroud**: The structure of the chondriosomes.—**Mme. Phisalix**: The power of destroying the virus of rabies *in vitro* of the venom from the aspic viper. This snake poison, heated to a temperature which destroys its toxic power, still possesses the power of destroying the virus of rabies *in vitro*.—**A.** and **B. Chauchard** and **J. Hurynowicz**: The measurement of the excitability of the vaso-constrictor nerves in man.—**Marcel Brandza**: Morphological and experimental researches on the sclerotes of the calcareous Myxomycetes.—**J. Magrou** and **Mme. M. Magrou**: The action at a distance of *Bacterium tumefaciens* on the development of the egg of the sea urchin.—**Lecomte du Noüy**: A spontaneous modification of the viscosity of blood serum. Some results obtained with an apparatus permitting a continuous observation of the variation in viscosity.—**H. Carré**: Acute parasitic infections.—**Ed.** and **Et. Sergent** and **A. Catanel**: A new parasite of paludism of birds.

GENEVA.

Society of Physics and Natural History, Mar. 15.—**R. Wavre**: The deviation from the vertical with depth. The author extends the formula of the deviation from the vertical to the case where there may be movements in the interior of the planet.—**Pierre Dive**: A generalisation of a formula useful in geodesy. The author shows that the rigorous formula for the increase of gravity with depth given by M. Wavre extends to any permanent rotation of a planet round its polar axis.—**R. Chodat** and **H. Evard**: The distribution and localisation of tyrosinase in the higher plants. By means of the reagent *p*-cresol in 10 per cent. sugar solution, the authors have been able to prove the presence of tyrosinase, which is found localised in different parts of plants (leaves, peduncles, roots).—**R. Chodat** and **A. Senglet**: The *sapécage* of 'Maté' and the presence of ferments in *Ilex paraguariensis*. True 'Maté' is furnished by *Ilex paraguariensis* (the 'Matés' of botanical gardens are more frequently plants other than this). *Ilex paraguariensis* contains oxidising ferments; the operation of singeing, called *sapécage*, to which the plant is submitted, neutralises the action of these ferments. The blackening of the plant and of the liquid obtained from it is thus avoided.—**L. Duparc** and **E. Rogovine**: A new indicator for the volumetric estimation of phosphoric acid. By the use of uranyl acetate with sodium salicylate as indicator, the authors were able to carry out an estimation of phosphoric acid which can be applied to the examination of urine.

ROME.

Royal National Academy of the Lincei, Jan. 15.—**F. Severi**: Simple and double algebraic integrals (3).—**N. Parravano** and **G. Malquori**: Investigations on the sulphides of molybdenum (2). Equilibrium of the reduction of molybdenum disulphide by means of hydrogen. This reduction, $MoS_2 + 2H_2 = 2H_2S + Mo$, is a reversible reaction, equilibrium being established the more readily if the disulphide and hydrogen are taken as starting materials. The values of P_{S_2} are calculated from the experimental values of P_{H_2S}/P_{H_2} at different temperatures by means of the equation $\log P_{S_2} = 2 \log P_{H_2S}/P_{H_2} + \log K$, and the isochor equation gives for the tonality at the reaction, Q = −20,000 cal. at 805°-910°, −28,000 cal. at 910°-1005°, and −24,000 cal. at 1005°-1100°.—**L. Sabbatini**: Pharmacological experiments with sodium permanganate injected endovenously. When injected directly into the veins

of the ordinary experimental animals, sodium permanganate acts simultaneously on the blood plasma, the histological elements of the blood, and the endothelium of the vessels, but the greater portion is fixed on the red corpuscles, causing intense hæmolysis, hæmoglobinæmia, hæmoglobinuria, and anæmia, which, within certain limits, are proportional to the doses injected. At the same time, the salt undergoes reduction to manganese dioxide, which remains colloidal. Thus, the action of the permanganate is at first limited to a local effect on the blood, which then reduces the salt and acts as an antidote, preventing it from diffusing as such to the tissues and organs and from giving the general action of permanganate. If the dose is small, the animal survives, since the hæmatic lesion is slight. In a washed red globule from the blood of the rabbit hæmolysis is produced by $7 \cdot 9 \times 10^{-16}$ and complete mineralisation by 3540×10^{-16} gm.-mol. of the permanganate.—**G. Palozzi**: Projective invariants of contact between plane curves at a point of flexion.—**P. Nalli**: Integral equation of the third species and applications to differential equations (i).—**G. Wataghin**: The general integrals of some differential equations of mathematical physics. An attempt was made previously to overcome some of the difficulties attending the explanation of luminous interference on the basis of the hypothesis of the corpuscular structure of light by considering the light quanta as resulting from the superposition of ordinary, plane, or spherical electromagnetic waves. This decomposition of the quantum into harmonic components makes it possible to show that the quantum hypothesis is not contradictory to the undulatory theory of interference and may serve as a foundation for the interpretation of the whole complex of optical phenomena. A demonstration is given of a theorem on the solutions of the equation

$$\Delta_2 f - \frac{1}{c^2}\frac{\partial^2 f}{\partial t^2} = 0,$$

which permits of the construction of models of the light quantum in conformity with the above views.—**E. Raimondi**: Complements relative to the calculation of the dynamic action of a current flowing between a strip and an indefinite plane wall.—**G. Vranceanu**: The geodesic displacement in anolonomous varieties.—**E. Persico**: Molecular velocities, conditions of excitation, and probability of transition in a degenerating gas.—**A. Quilico**: Action of aminosulphonic acid on unsaturated compounds. When heated at 140°-150° with excess of anethole, aminosulphonic acid gives a good yield of the ammonium salt of an acid, which is converted quantitatively into anisic, acetic, and sulphuric acids when boiled with alkaline permanganate solution and has the constitution, $CH_3 . O . C_6H_4 . CH : C(CH_3) . SO_3H$ or $CH_3 . O . C_6H_4 . C(SO_3H) : CH . CH_3$.—**G. Malquori**: The systems, $Cd(NO_3)_2 - HNO_3 - H_2O$; $Zn(NO_3)_2 - HNO_3 - H_2O$, and $Mg(NO_3)_2 - HNO_3 - H_2O$ at 20°. The salt $Cd(NO_3)_2, 4H_2O$ is in equilibrium with solutions containing up to 52·95 per cent. of HNO_3, the corresponding concentrations of the acid for $Cd(NO_3)_2, 2H_2O$, $Zn(NO_3)_2, 6H_2O$, $Zn(NO_3)_2, 4H_2O$, and $Mg(NO_3)_2, 6H_2O$ being respectively 60·01, 34·45, 59·21, and 49·12 per cent. Thus, whereas tetrahydrated cadmium nitrate may be completely dehydrated at ordinary temperature by nitric acid (*d.* 1·52), hexahydrated zinc nitrate loses only two molecules of water, and hexahydrated magnesium nitrate remains unchanged, under the same conditions.—**F. P. Mazza**: The rotatory dispersion of the alkyl aspartates.—**Giambattista Dal Piaz**: The gneissic digitation of Val Inferno (Gran Paradiso).—**B. Monterosso**: Observations on the sexual biology of the Scytodoids.

Official Publications Received.

British.

Report of the Department of Industries, Madras, for the Year ended 31st March 1927. Pp. vi+84. (Madras: Government Press.) 12 annas.

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 66, No. 276, April. Pp. 341-452+xxxii. (London: E. and F. N. Spon, Ltd.) 10*s.* 6*d.*

Department of Agriculture: New South Wales. Science Bulletin No. 29: Veterinary Research Report, No. 3. By Dr. H. R. Seddon. Pp. 53. (Sydney, N.S.W.: Alfred James Kent.)

Commonwealth of Australia. Journal of the Council for Scientific and Industrial Research. Vol. 1, No. 3, February. Pp. 133-192+6 plates. (Melbourne: H. J. Green.) 1*s.* 6*d.*

Union of South Africa: Department of Mines and Industries. Geological Survey Memoir No. 26: The Iron Deposits of the Union of South Africa. By Percy A. Wagner. Pp. 268 (45 plates). (Pretoria: *Government Printing and Stationery Office.*) 10*s.*

Nyasaland Protectorate. Annual Report of the Geological Survey Department for the Year 1927. Pp. 8. (Zomba: Government Printer.)

Board of Education. Vacation Courses in England and Wales, 1928. Pp. 28. (London: H.M. Stationery Office.) 6*d.* net.

Reports of the Progress of Applied Chemistry. Vol. 12, 1927. Pp. 743. (London: Society of Chemical Industry.)

Air Ministry. Aeronautical Research Committee: Reports and Memoranda. No. 1118 (Ae. 291): A Survey of Longitudinal Stability below the Stall, with an Abstract for Designers' Use. By S. B. Gates. (T. 2504.) Pp. 27+22 plates. 1*s.* 3*d.* net. No. 1128 (E. 27): Motoring Losses in Internal Combustion Engines. By Dr. H. Moss. (I.C.E. 616.) Pp. 7+2 plates. 6*d.* net. (London: H.M. Stationery Office.)

Proceedings of the Royal Society of Edinburgh, Session 1927-1928. Vol. 48, Part 1, No. 5: Reflex Postural Adjustments of Balance in the Duck. By D. Noel Paton. Pp. 9+2 plates. 1*s.* 6*d.* Vol. 48, Part 1, No. 6: The Theory of Jacobians, from 1885 to 1919. By Sir Thomas Muir. Pp. 37-54. 1*s.* 6*d.* (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Foreign.

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 35: Achievements in Home Economics Education. By Emeline S. Whitcomb. Pp. ii+26. (Washington, D.C.: Government Printing Office.) 5 cents.

Société des Nations: League of Nations. Institut international de Coopération intellectuelle: International Institute of Intellectual Co-operation. Bulletin des Relations scientifiques. 3e année, No. 1, Février. Pp. ii+49. (Paris: Les Presses universitaires de France.) 8 francs.

Zentralanstalt für Meteorologie und Geodynamik. Publikation Nr. 131: Jahrbücher der Zentralanstalt für Meteorologie und Geodynamik. Amtliche Veröffentlichung. Jahrgang 1924. Neue Folge, Band 61. Pp. xx+A42+B46+C40+D11+19+6 Karten. (Wien.)

Ministerio da Agricultura, Industria e Commercio: Directoria de Meteorologia. O café e os factores meteorologicos. Pelo Dr. J. de Sampaio Ferraz. Pp. 19. (Rio de Janeiro.)

Instituts scientifiques de Buitenzorg: "'s Lands Plantentuin." Treubia: Recueil de travaux zoologiques, hydrobiologiques et océanographiques. Vol. 7, Suppl., Livraison 1, Novembre 1927. Pp. 35+2 plates. 2.50 f. Vol. 10, Livraison 1, Février 1928. Pp. 144+6 plates. 2.50 f. (Buitenzorg.)

Sudan Government: Wellcome Tropical Research Laboratories, Khartoum. Report of the Government Chemist for the Year 1927. (Chemical Section, Publication No. 50.) Pp. iv+30. (Khartoum.)

University of California Publications in Zoology. Vol. 30, No. 8: The Muscular Anatomy of the American Badger (*Taxidea taxus*). By E. Raymond Hall. Pp. 205-219. 25 cents. Vol. 30, No. 9: Variation within a Brood of Pacific Garter Snakes. By Edna M. Fisher. Pp. 221-229. 25 cents. Vol. 30, Nos. 10 and 11: A New Race of Black Bear from Vancouver Island, British Columbia, with Remarks on other Northwest Coast Forms of *Euarctos*, by E. Raymond Hall; and Records of Supernumerary Teeth in Bears, by E. Raymond Hall. Pp. 231-242+plates 11-12+243-250+plates 14-15. 25 cents. (Berkeley, Cal.: University of California Press; London: Cambridge University Press.)

Proceedings of the Imperial Academy. Vol. 4, No. 1, January. Pp. vi+29. Vol. 4, No 2, February. Pp. vii-viii+31-83. (Tokyo.)

United States Department of Agriculture. Technical Bulletin No. 58: Paradichlorobenzene Experiments in the South for Peach-Borer Control. By Oliver I. Snapp and Charles H. Alden. Pp. 40. (Washington, D.C.: Government Printing Office.) 10 cents.

Smithsonian Miscellaneous Collections. Vol. 80, No. 9: Aboriginal Wooden Objects from Southern Florida. By J. Walter Fewkes. (Publication 2960.) Pp. 2+3 plates. (Washington, D.C.: Smithsonian Institution.)

Catalogues.

"Sunic" X-Ray Apparatus for use with Metalix Tubes. (Bulletin No. 93.) Pp. 28. (London: Watson and Sons (Electro-Medical), Ltd.)

A General Catalogue of the Manufactures of Adam Hilger, Ltd. Pp. 8+D22+E36+F36+H32+K2+L7+M28+N14+iv. (London: Adam Hilger, Ltd.)

Classified List of Second-hand Scientific Instruments. (No. 92.) Pp. vi+58. (London: C. Baker.)

Eastman Organic Chemicals. List No. 18, March. Pp. 79. (Rochester, N.Y.: Eastman Kodak Co.)

The Holway Dual Control Unit for Rapid Radiography. (Publication No. 283.) Pp. 8. (London: Newton and Wright, Ltd.)

Diary of Societies.

SATURDAY, April 28.

Royal Sanitary Institute (at Guildhall, Worcester), at 10 a.m.—T. Caink and others: Discussion on The Worcester Activated Sludge Plant.

Institution of Municipal and County Engineers (W. Midland District) (at Borough Hall, Stafford), at 11 a.m.—W. Plant: Recent Municipal Work in Stafford.

North of England Institute of Mining and Mechanical Engineers (Associates and Students' Section) (jointly with Graduate Sections of North-East Coast Institution of Engineers and Shipbuilders, and Institution of Electrical Engineers) (at Neville Hall, Newcastle-upon-Tyne), at 2.30.—L. H. Forster: Notes on the Conversion of Main Pumping from Steam to Electricity, with Special Reference to the Plant Installed at Messrs. The Stella Coal Company's Clara Vale Pit. —*Papers open for Discussion*:—Some Notes on Accidents from the Use of Explosives, by W. B. Brown; Roof Control on Longwall Faces, J. F. C. Friend.

MONDAY, April 30.

Institute of Actuaries, at 5.—P. C. Crump: War-time Finance—A Résumé of Financial Conditions during and after the War as they affected Life Insurance Companies.

Royal Society of Arts, at 8.—A. G. Huntley: Applied Architectural Acoustics (Dr. Mann Lectures) (III.).

TUESDAY, May 1.

Royal College of Physicians of London, at 5.—Dr. E. P. Poulton: An Experimental Study of certain Visceral Sensations (Oliver-Sharpey Lectures) (I.).

Royal Society of Medicine (Orthopædics Section), at 5.30.—Annual General Meeting.

Zoological Society of London, at 5.30.—Dr. G. M. Vevers and R. A. Smith: Exhibition of Flint Implements, Flakes, and Cores of Human Origin but of Uncertain Age collected at the Society's Estate at Whipsnade.—H. B. Cott: Report on the Zoological Society's Expedition to the Zambesi, 1927.—O. W. Richards: The Species of Notogonia (Hymenoptera, Larridæ) occurring in the Mediterranean Basin.—Dr. J. Waterston: The Mallophaga of Sand-Grouse.

London Natural History Society (at Winchester House, E.C.), at 6.30.—Dr. S. A. Neave: Mt. Mlange in Nyasaland and its Insect Fauna.

Royal Photographic Society of Great Britain (Pictorial Group), at 7.—The late Mr. Greenall: Southern Italy.

Institution of Automobile Engineers (Luton Graduates' Section) (at Royal Hotel, Luton), at 7.30.—G. D. Ricketts: Modern Methods of Engineering Inspection.

Diesel Engine Users' Association (at 19 Cadogan Gardens, S.W.3).—M. Gercke: Some Considerations regarding the Peak Load Problem and High-powered Peak Load Diesel Engines.

WEDNESDAY, May 2.

Royal Society of Medicine (History of Medicine Section) (Annual General Meeting), at 5.—Papers on the Sources of Harvey:—Prof. F. J. Cole: The History of Embryology.—Dr. J. F. Prendergast: Galen.

Institution of Electrical Engineers (Wireless Section), at 6.—M. G. Scroggie and others: Informal Discussion on Screened-grid Valves.

Society of Public Analysts and other Analytical Chemists (at Chemical Society), at 8.—A. L. Williams: Locust Kernel Gum and Oil.—Dr. W. R. Schoeller and E. F. Waterhouse: Investigations into the Analytical Chemistry of Tantalum, Niobium, and their Mineral Associates. XII. Observations on the Pyrosulphate Hydrolysis Method.—D. B. S. Evans and S. G. Clarke: A New Precipitation Method for the Determination of Vanadium, and its Application to Steel Analysis.—Dr. P. Houseman: Method for the Analysis of Liquorice Mass.

Royal Society of Arts, at 8.—W. Taylor: Standardisation in Apparatus for Science Teaching.

Royal Microscopical Society (Biological Section).

THURSDAY, May 3.

Iron and Steel Institute (Annual Meeting) (at Institution of Civil Engineers), at 10 a.m.—Presentation of Bessemer Gold Medal to C. M. Schwab.—Presidential Address: The History and Latest Development of the Basic Open-Hearth Process.—E. C. Evans and F. J. Bailey: Blast-Furnace Data and their Correlation.—J. H. Jones, J. G. King, and F. S. Sinnatt: Reactivity of Coke.—T. Thomson: The New Plant of the Appleby Iron Co., Ltd.—J. E. Holgate and R. R. F. Walton: Blast-Furnace Practice in Natal.

At 2.30.—H. J. Tapsell: The Fatigue Resisting Properties of 0·17 per cent. Carbon Steel at Different Temperatures and at Different Mean Tensile Stresses.—J. A. Jones: The Properties of Nickel Steels with Special Reference to the Influence of Manganese.—A. B. Everest and D. Hanson: The Influence of Nickel in Iron-Carbon-Silicon Alloys containing Phosphorus.—J. Swan: The Effect of Silicon on Tungsten Magnet Steel.—A. Westgren, G. Phragmén, and Tr. Negresco: On the Structure of the Iron-Chromium-Carbon System.

Ceramic Society (at Atlantic Hotel, Newquay), at 10.30 a.m.—Prof. D. A. Moulton: Refractory Material used as Mortar for Laying up Refractories.—W. J. Rees and W. Hugill: The Effect of Substituting High Silica Sand for some Grades in Lime-bonded Silica Bricks.—G. M. Gill: New Developments in Gas Works Carbonising Plant, with Special Reference to Refractory Materials.—A. T. Green: The Vitrification of Clay Products.—P. Cooper: Refractory Formers for Electric Heating Elements; Some Problems in the Manufacture and Use.—W. Emery: Notes on Refractories for Salt Glaze Kilns.

Royal College of Physicians of London, at 5.—Dr. E. P. Poulton: An Experimental Study of certain Visceral Sensations (Oliver-Sharpey Lectures) (II.).

Chemical Society, at 5.30.—P. D. Coppock, V. Subramaniam, and T. K. Walker: The Mechanism of the Degradation of Fatty Acids by Mould Fungi. Part II.—A. Robertson and R. Robinson: Experiments on the Synthesis of Anthocyanins. Part V. A Synthesis of 3-β-glucosidyl-pelargonidin Chloride which is believed to be identical with Callistephin Chloride.—Dr. H. J. Emeléus: The Phosphorescent Flame of Sulphur.—A. J. Berry and Prof. T. M. Lowry: Studies of Valency. Part IX. Molecular Structure of Thallium Salts. (*a*) Thallium Tri-iodide (with Mrs. R. R. Goldstein); (*b*) Alkyl-derivatives (with F. L. Gilbert).

Institution of Electrical Engineers, at 6.—F. H. Rosencrants: Practice and Progress in Combustion of Coal as applied to Steam Generation.

Royal Society of Medicine (Tropical Diseases Section), at 8.15.—Annual General Meeting.

FRIDAY, May 4.

Iron and Steel Institute (Annual Meeting) (at Institution of Civil Engineers), at 10 a.m.—Report of the Committee on Heterogeneity of Steel Ingots.—V. Harbord: A Comparison of the Most Important Methods Employed in the Cleaning of Blast-Furnace Gas.—Dr. W. H. Hatfield: Heat-Resisting Steels. Part II. Mechanical Properties.

At 2.30.—T. Swinden and P. H. Johnson: Chromium Steel Rails.—Dr. J. Newton Friend: A Study of the Resistance of Over-Stressed Wrought Irons and Carbon Steels to Salt-Water Corrosion.—W. E. Woodward: The Rapid Normalising of Overstrained Steel.—A. L. Norbury and T. Samuel: The Recovery and Sinking-in or Piling-up of the Material in the Brinell Test and the Effects of these Factors on the Correlation of the Brinell with certain other Hardness Tests.—H. O'Neill: Twin-Like Crystals in Annealed α-Iron.

Royal Astronomical Society, at 4.30.—Geophysical Discussion: Meteors—Mr. Whipple, Prof. Lindemann, and others.

Royal Society of Medicine (Laryngology Section), at 5.—Annual General Meeting.

British Psychological Society (Æsthetics Section) (at Bedford College), at 5.30.—J. A. Thorburn: Is there a Logic of the Imagination?

Royal Photographic Society of Great Britain (Informal Meeting of Pictorial Group), at 7.

Junior Institution of Engineers, at 7.30.—F. C. Dain: The Application of Electricity to Domestic Purposes.

Geologists' Association (at University College), at 7.30.—G. M. Lees: The Chert Beds of Palestine.—Dr. P. K. Ghosh: The Mineral-Assemblage of the Falmouth Granite.

Philological Society (at University College) (Anniversary Meeting), at 8.—Prof. D. Jones: Report on Progress of Phonetics.—N. B. Jopson: Report on Board of Comparative Philology.

Royal Institution of Great Britain, at 9.—Rt. Hon. R. McKenna: Credit and Currency.

SATURDAY, May 5.

Royal Sanitary Institute (at Guildhall, Preston), at 10 a.m.—Prof. F. E. Wynne and others: Discussion on The Present Position of the Milk Supply.

British Mycological Society (at Cheshunt).—Phytopathological Meeting.

PUBLIC LECTURES.

TUESDAY, May 1.

London School of Economics and Political Science, at 5.—Prof. F. Oppenheimer: Tendencies in Recent German Sociology. (Succeeding Lectures on May 2 and 3.)

University College, at 5.—Dr. J. H. Burn: The Pharmacological Evidence for Current Methods of Treatment. (Succeeding Lectures on May 2 and 3.)—At 5.30.—Dr. D. R. Fox: Civilisation in Transit.

Gresham College, at 6.—Sir Robert Armstrong-Jones: Physic. (Succeeding Lectures on May 2, 3, and 4.)

WEDNESDAY, May 2.

London School of Economics and Political Science, at 5.—Dr. H. Hall: Some Common Factors in the Economic and Social Development of England in Medieval and post-Medieval Times. (Succeeding Lectures on May 9, 16, 23, and 30.)

King's College, at 5.30.—Dr. W. B. Brierley: Present Tendencies in the Study of Plant Disease.

THURSDAY, May 3.

East London College, at 3.—Prof. W. C. McC. Lewis: Some Physico-chemical Aspects of Malignant Tissue (Cancer).

Institute of Pathology and Research, St. Mary's Hospital, at 5.—Prof. D. W. Carmalt-Jones: Iodine in Relation to Goitre.

FRIDAY, May 4.

Oxford University, at 5.—Prof. D. M. S. Watson: Palæontology and the Origin of Man (Romanes Lecture).

Royal College of Science, at 5.—Prof. G. Elliot Smith: Conversion in Science (Huxley Memorial Lecture).

King's College, at 5.30.—Dr. J. A. Bierens de Haan: Animal Psychology for Biologists. (Succeeding Lectures on May 9 and 11.)

SATURDAY, MAY 5, 1928.

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Forestry and Agriculture in Great Britain.

A RECENTLY published part of the *Scottish Forestry Journal* (vol. 41, pt. 2) contains several articles of interest for those who have some acquaintance with forestry practice in Great Britain. Perhaps the paper of chief importance at the present time is that by Dr. John D. Sutherland on the "Economic Balance between Forestry and Agriculture." Dr. Sutherland's main theme revolves round the contention of the Forestry Commissioners that in view of the good work already accomplished, a larger grant should be made to them for the next ten years' work, allusions to which have already appeared in our columns. Dr. Sutherland in his opening remarks states that "there is the certain prospect of a world shortage of coniferous timber within the period of one forest rotation." Opinions differ, as can be readily understood, as to the exact significance to be attributed to the phrase "the threatened timber famine."

Some time ago, reference was made in some short paragraphs under the heading "Log Rolling," in the *Timber News*, to Lord Clinton's remark in a recent address on "Imperial Forestry" read at the Royal Colonial Institute. Lord Clinton stated that it was estimated that the quantity of timber used and destroyed amounted to eight times the annual growth. On this the writer remarks, with particular reference to the subject of timber famine in Europe :

"This cannot go on for ever . . . we have no great faith—like the masters in the timber trade—in the belief of approaching timber famine . . . we are inclined to the impression that prices of timber will gradually rise after post-war stabilisation, and that in course of time there will be a shortage compared with the preponderating supplies of to-day, and it seems that in hardwoods, as with softwoods, those who warn us of a timber famine are nearer the truth than those who ignore the idea."

In his article Dr. Sutherland contrasts the Government expenditure in connexion with agriculture with that on forestry :

"It is a fact," he says, "that both food and timber are essential to our existence, that our consumption of the former represents a value of £722,000,000, and the value of the timber used is £63,000,000 (figures for 1925) . . . is it too much to expect that when the subsidies and assistance to agriculture are £16,000,000 the amount presently devoted to the making of timber through the creation of forests might not in the same proportion be £1,300,000 annually instead of about £350,000 ? If further support of this suggestion

be necessary, it may be represented that the expenditure by the nation on forestry, whatever the amount, is for creative purposes and might be described as a national endowment, and one which will be productive of material absolutely essential, and in this process of production yield a return to the State."

Dr. Sutherland produces many sound arguments in favour of afforestation in his paper, but the one above quoted appears open to question. Both as individuals and as a nation we are greatly impoverished. However desirous individuals might be to form an endowment for the future of their children, let alone grandchildren (as is the case with forestry), their present circumstances preclude the idea. Much of the State expenditure on agriculture is at least profitable to the existing generation, and therefore the taxation imposed for this cause results in some direct return. Few at present alive can hope to share in any future benefits which may accrue from the afforestation work undertaken at the present day. In the opinion of many who have studied this question, the decision which faces the Government, in view of the fact that no very apparent alleviation to the taxpayer is in sight, is on what scale the afforestation work, with due regard to the interests of the taxpayer, should be carried on during the next ten-year period and whether some of the heavy overhead charges could not be curtailed.

Science and Policy in India.

The Development of Indian Agriculture. By Albert Howard and Gabrielle L. C. Howard. (India of To-day, Vol. 8.) Pp. vi + 98 + 6 plates. (London: Oxford University Press, 1927.) 3*s*. 6*d*. net.

THE Oxford University Press is to be congratulated on the foresight it displayed in 1924 in inviting Mr. and Mrs. Albert Howard to prepare a short account of the present position of agriculture in India, and Mr. and Mrs. Howard deserve the warmest thanks of all those interested in agricultural development and research, the education of the farming community, and the social institutions and economic life of the coloured cultivators of Great Britain's tropical and subtropical possessions, not only for the skill with which they have dealt with their subject matter, but also for its timely publication. Their hundred-page volume on "The Development of Indian Agriculture" is a model of compression, not merely a masterly summary, of the salient facts and current opinions regarding the past, present, and future of the industry upon which nine-tenths of the population of India is directly or indirectly dependent. It should prove invaluable as a guide to the labours of the Royal Commission on Indian Agriculture which at present, under Lord Linlithgow, is pursuing its investigations in India; it can also be warmly commended to the members of the Simon Royal Commission for their careful study, not because it deals with the constitutional issues which are their immediate concern, but because constitutional reform without economic and educational reform will do nothing to ameliorate the condition of life of the mass of the population of India, and this is what matters most.

Mr. and Mrs. Howard are concerned mainly with the problem of raising the standard of living of the rural communities of India. They write with an authority based upon twenty years' successful work in the country. They possess the cardinal virtues of faith, hope, and charity: faith in the scientific method, hope for the dawning of the day when the peoples of India possess the knowledge and determination to apply the discoveries of science to the soil which sustains them, and that charity born of sympathy and a ripe understanding of the peasants for whom they labour. They combine a *flair* for research with unusual gifts for administration, the enthusiasm to discover, coupled with the will, capacity, and determination to have their results applied. They are of a type with those public servants of Canada recently described by Prof. McLennan as working for meagre rewards and little recognition to confer incalculable benefits upon mankind. The very nature of their work makes them the architects of a new order, missionaries of an enlightened imperialism, statesmen of the world, not the instruments of parties, factions, or nations. Their function is so to direct the energies of man that he will no longer spend all his days in ceaseless toil for mere existence.

Nothing could illustrate the struggle for existence better than the statistics given in this volume. Out of the 316,000,000 people in India, about 225,000,000 are directly dependent on agriculture. The total area under food and fodder crops, for supplying the cultivator and his cattle with food, is only 220,000,000 acres, that under money crops —out of the proceeds of which the cultivator pays his land revenue and purchases a few necessaries other than food—is less than 40,000,000 acres. The average holding is thus extremely small, in some districts less than five acres in area, and the position is made worse because they are frequently cultivated by methods which are suitable only for

large areas. Abject poverty is the result. The majority of the people of rural India live in houses built of mud, thatched with grass, and possess practically no furniture. Small wonder that people living under such conditions are unprogressive.

They are "for the most part uneducated, illiterate, and almost incapable of thinking for themselves. The majority are born in debt, live in debt, and die in debt. Money-lending has become one of India's greatest industries. . . . Even the best cultivators have little or no capital for developing their fields. Everywhere agricultural land is regarded as a convenient means of investing money so that the rents can provide a certain income. Only in rare cases is money devoted to land improvement. In many parts of the country the pressure of population, both human and bovine, is intense, and but for the high infant mortality and periodical waves of pestilence the position would become desperate."

Keatinge estimates there are nearly 1,000,000 useless cattle in the Bombay Deccan alone—and these have to be fed: as the cow is a sacred animal, and the people mostly vegetarian, they cannot be used for food.

One fact is omitted in this volume which is of the greatest importance. Due largely to the application of the discoveries in medical and sanitary science, and the improvement in means of communication which enable food to be distributed in the event of the failure of the monsoon, the population of India has risen in the last fifty years from about 200,000,000 to its present total of 320,000,000. Now it cannot be pretended that the agricultural and allied services, in spite of their recorded triumphs, touch the fringe of the problem presented by this increase, or that the growth of manufacturing industries in India has done much to improve the general condition of the peoples. There is obviously an urgent demand for the acceleration of the work having for its objects the improvement of methods of agriculture, so that each unit shall yield "either more produce, more valuable produce, or an increased yield of a better quality than the average," and the increase of the area under cultivation. That this can be done is exemplified by some of the results obtained in the past fifteen years. 'Pusa wheats' now spread over an area of more than two and a quarter million acres in the United Provinces, representing a yearly increase of profit to the growers of £2,500,000: heavy yielding varieties of rice now cover 0·8 per cent. of the total area under this crop; 1¾ per cent. of the area under cotton, and nearly 10 per cent. of that under jute, is now raising improved types; improved varieties of sugar-cane, fodder-crops, ground-nut, and tobacco have also been introduced with successful results. At a conservative estimate, made in 1925–26, improved varieties covered no less than 7½ million acres, representing an enhanced yearly value of more than £5,500,000. Compared with the cost of the services which produced them, the results are a magnificent achievement, but

"much greater progress could have been made," say our authors, "but for one great obstacle, namely, the fact that the Indian cultivator is uneducated and cannot be reached by the printed word. How greatly the illiteracy of the peasant has hampered the work of rural uplift [my only complaint against the authors is the frequent use of this word 'uplift'] in India will be realised if the spread of the new varieties of Pusa wheats is compared with that of Marquis varieties in Canada and the Northern States of the Union. . . . In 15 years the Pusa wheats have covered a little over 2 million acres. In about the same period the area under Marquis has exceeded 20 million acres."

Mass education of the Indian country-side is the obvious need. By no other means will a desire for progress be kindled among the inhabitants of the villages of India. Unless the educational level is raised it is impossible to achieve lasting results by mere demonstration, except at ruinous expense.

Two aspects of the problem of educating hundreds of millions of people have to be considered, the education of the adult and the education of the child. Grundtvig in Denmark, Plunkett in Ireland, and the General Education Board—the unofficial body which investigated conditions in the southern States of the United States of America—have dealt with the first aspect with such success that prosperity has been brought to peoples which were formerly distressingly poor and unprogressive. The experiments they tried were successful because official effort was deliberately limited to propaganda aimed at creating a demand on the part of the cultivators themselves for the education of their children and for better villages, rather than foisting upon them a programme of education and rural improvement from the outside, and as a first practical step to assist them by the inauguration of co-operative farm demonstration to make the soil yield a higher dividend. Above all, the problem of "rural development was surveyed as a whole, studied as a whole, and dealt with as a whole."

The efforts made in India for the past twenty years, which at first sight resemble closely those adopted elsewhere with success, have been ineffective because of the lamentable fragmentation

of effort. "Moreover, the horde of minor officials (mostly townsmen) who now deal piecemeal with the problems of the villager is more likely to exasperate than to awaken him from his present attitude of indifference to all forms of progress." Consequently, just as Mr. and Mrs. Howard advocate a reform of the agricultural research services whereby the plant, for example, cotton, will be regarded as the centre upon which a knowledge of several sciences, of practical agriculture, and of the requirements of the trade will be brought to bear, its activities controlled by an unofficial organisation representing all interested parties, in place of the present officially controlled system based on the separate science, so they recommend the removal of the various agencies which deal with the problems of rural India from official to unofficial control and their consolidation under a Development Board of Rural Reconstruction, upon which the legislature, the executive, the local notables, and the most able of the workers could be represented.

For dealing with the problem of the education of the child in rural areas Mr. and Mrs. Howard suggest that full use be made of American experience. In America the inefficiently staffed, inadequately equipped and poorly built schools were abolished and replaced by a lesser number of central schools, well-staffed and equipped and well-built, the children being conveyed to them at the public expense. This system, it is suggested, could be adopted with great advantage in India. What is wanted is not

"one poor little school in each of the 7,000,000 villages of India," but from "1,000,000 to 2,000,000 well-constructed central schools, each with suitable equipment, a number of well-trained teachers, and sufficient pupils to feed the classes. Each of these schools, under the guidance of a schoolmaster who should be drawn from a village—with adequate pay and a recognised position of honour in the community—could be the centre of progress of a group of villages. By its means such movements as Co-operative Credit, the Co-operative sale of produce, the establishment of better markets, the demonstration of simple improvements in cultivation, the distribution of improved seed, improved rural sanitation, better housing and better communications will be provided with a suitable meeting place. . . . The people generally will come in contact with the Government in other ways than through the policeman and the tax-gatherer."

In short, Mr. and Mrs. Howard believe that by the reorganisation of research, the concentration of the various departments at work for rural development into a single agency for each province, mass education for adults and children on lines similar to those followed in America,

"the people [of India] could be taught how to help themselves and how to appreciate and make proper use of funds contributed by the State for the support of local movements. The gradual growth of the rural electorate, capable of intelligent co-operation with Government in the future development of India, would follow."

This volume should not only be eagerly read by the members of the two Royal Commissions dealing with Indian problems; it should also be in the hands of every statesman and politician in India, every student of rural education the world over, and of all those who wish to understand the problems with which administrators and other public servants in the various parts of the British Empire are faced. The problems facing India have been intensively studied for some years. They do not differ essentially from those facing our local governments in Africa. It has been said: "It is one of the defects of our system of State departments that the invaluable lessons of our Indian administration and economic progress—the result of much costly experience and research—and the history of its successes and failures, are not more readily accessible to other tropical dependencies, which are emerging from the state in which India was many years ago." Mr. and Mrs. Howard have done much to remedy this defect.

A. G. CHURCH.

Stellar Thermodynamics.

Thermodynamik der Himmelskörper. Von R. Emden. (Sonderausgabe aus der Encyklopädie der mathematischen Wissenschaften.) Pp. iii + 373-532. (Leipzig und Berlin: B. G. Teubner, 1926.) 6·40 gold marks.

R. EMDEN is well known among students of theoretical astrophysics from his book "Gaskugeln," which summarised and extended the work done prior to 1906 on the problem of the internal constitution of the stars. The present book has many points in common with "Gaskugeln," but it covers a wider field, inasmuch as the recent development of the subject is also considered.

In its scope and arrangement of subjects the book appears essentially as a historic account of our ideas concerning the internal structure of celestial bodies since the foundation of modern astrophysics. The introduction is naturally concerned with the fundamental laws of thermo-

dynamics and their applicability to stellar problems. Next comes a short review of earlier ideas concerning the origin of the energy radiated from the stars: the meteoric hypothesis of Mayer, and the gravitational contraction theory of Helmholtz; and the insufficiency of both, in accounting for the apparently long life cycle of a star, is pointed out. An interesting excursion on meteors in the terrestrial atmosphere closes this first section of the book.

The second section is concerned with the structure of gaseous stars in which the effect of transmission of energy by radiation is ignored. This was the point of view commonly adopted by the pioneer workers in this field in the past century, which led to the conception of stars in convective equilibrium. Most of Emden's work fell within this category, and was ably covered in his "Gaskugeln." By a rare caprice of Nature, it happened that much of this work retained some interest also in the theory of radiative equilibrium of the stars, such that an inclusion of this section in a modern work is justifiable. Besides, this section is concerned with a variety of allied problems in which it is essential to adopt the microscopic point of view of kinetic gas theory. An important problem of this type is, for example, the calculation of the loss of mass from the surface of a star due to random motion of the molecules.

In the third section a step further is taken, so as to include the effect of transmission of energy by radiation inside a star. We are here led through the different stages of development in this phase of the theory, as they are marked down by the names of Schwartzschild, Eddington, Milne, and Jeans. This section is written with sober judgment and becoming reticence with regard to doubtful points, which is much to be commended, considering the delicate nature of the questions involved. The fourth section is concerned with the application of atomic physics to stellar problems. Here is given, for example, a short exposition of the theory of thermal ionisation, which was initiated by Eggert and Saha, and has proved to be of great value in the interpretation of astrophysical facts.

The book thus covers a wide field and bears witness of being written by a broad-minded and intelligent observer. However, in view of the difficult aspects of most questions concerned with stellar constitution, we cannot help thinking that this book would have gained considerably in value if it had been written from an entirely different point of view. In fact, so much space has been spent on the historical side of the questions, that modern aspects of the stellar problems have received too scanty consideration. The author himself admits that the vital questions of stellar theory are really problems in atomic physics. If he had drawn the logical consequence of this recognition he would have devoted the bulk of the book to a thorough discussion of just these basic atomic problems, leaving earlier ideas, which we admit to be inadequate or unessential, to the care of the historian.

S. ROSSELAND.

The Streptococci.

Annals of the Pickett-Thomson Research Laboratory. Vol. 3 (containing a Historical Survey of Researches on the Streptococci). Published for the Pickett-Thomson Research Laboratory, St. Paul's Hospital, 24 Endell Street, London, W.C.2. Pp. vi + 316 + 57 plates. (London: Baillière, Tindall and Cox; Baltimore, Md.: Williams and Wilkins Co., 1927.) 42*s.* net.

ALL pathologists will agree that our present knowledge of the streptococci, the round-celled bacteria which form chains by successive division, is in great confusion, and that the reason for this is the lack of proper means of identification of the numerous streptococcal species. Yet the importance of the streptococci in both human and veterinary pathology is known to be very great and suspected to be still greater than has been actually established. Scarlet fever, puerperal fever, erysipelas, and the gravest forms of wound infection are accepted examples of streptococcal invasion, while acute and chronic rheumatism, in its many manifestations, heart disease, the enlarged tonsils and adenoids of youth, and the premature decay of teeth, are all diseases of possible streptococcal origin which, for elucidation of their cause, wait upon the identification of the infecting streptococcus by the bacteriologist.

Our authors, Drs. David and Robert Thomson, have attempted to bring some order out of the present chaos. They have assembled the widely scattered literature on the appearance, behaviour, and classification of streptococci, the more important papers being reviewed in great detail and illuminated by comments based on the authors' own observations. This review, which occupies 250 of the 300 pages of letterpress, would alone justify the very great labour and expense involved in the production of the book. Nothing comparable in extent has ever been published on the streptococci, and it may be taken as certain that bacteriologists who have been deterred from research on the streptococci by the thought of the arduous

preliminary reading involved will now take up the problems thus prepared and set before them.

The review is followed by an article of 19 pages by Dr. Warren Crowe, giving an account of his methods of differentiation (with 5 full-page colour plates of colonies) and by the authors' list of the streptococci which they think can be identified and classified as separate varieties. They divide the streptococci into five main groups, distinguished from each other by the colour changes produced by the constituent varieties on agar containing boiled blood. Group A produces no colour, group B produces a faint green tinge, group C shows a narrow green or yellow zone, group D bleaches powerfully, producing a wide yellow zone, while group E blackens the medium. Each main group has 4 to 6 sub-groups, based on hæmolysin production, the appearance of the colony and the character of the streptococcal chains; the sub-groups comprise each from 2 to 16 individual varieties differing from each other in their power to produce acid from a set of 10 different sugars. Each of the varieties—there are above 100—is given, finally, 7 photographs (made up in 52 full-page half-tone plates) illustrating the appearance of its colonies under different conditions of culture and illumination and the microscopical characters of the constituent cocci.

Photographs have not hitherto proved of much value as an aid to the working bacteriologist, and it is doubtful whether those in the volume, despite the care and skill which have obviously been devoted to them, will be more successful.

It is perhaps regrettable, since, at least, it is an honest attempt at orderly arrangement, that the general body of bacteriologists are not at all likely to accept the classification proposed, and this for the reason that the characters on which it depends have not the validity required for the creation of bacterial types. The authors discuss this question and appear to conclude that, since cultivation and examination were in each instance performed by them under uniform and optimal conditions, the distinguishing features are stable and will reproduce themselves with all strains of the same type. They admit that strains which have been long in artificial culture may be found greatly altered, but that has not deterred them from classifying and figuring such altered strains on the basis of the latter findings. The consequence is that the hæmolytic streptococci which most probably do belong, for the most part, to one species, find themselves in all three of the main groups A, B, and C.

Bacteriologists are tending rather to admit a wider and wider range of possible variations in the cultural characters of even well-established bacterial species and to choose, as the nucleus of specific definition, the chemical reactions of the bacterial protein displayed in serological tests. It is true that variation is possible even in these, and it may turn out that there is a limbo of less differentiated bacteria from which emerge, and to which return, the definable species as met with in disease and other forms of special bacterial activity. But the serological basis of species differentiation has, at least, the virtue of depending on a single reaction instead of on a complex of characters which so easily leads to the simulation of innumerable varieties.

The volume includes a bibliography referring to more than a thousand original papers, a testimony, if further such were needed, to the industry and devotion of the authors.

In the preface the promise is made that volume 4 of these *Annals* will deal with the pathogenic streptococci, and bacteriologists in general may hope that it will furnish them with an equally useful tool for research on this highly important group.

W. M. Scott.

Descartes' Geometry.

La géométrie de René Descartes. Pp. iii + 91. (Paris: J. Hermann, 1927.) 21 francs.

THIS is a reprint—"nouvelle édition" it calls itself—of the great work of Descartes, giving the first exposition (such as it is) of the system of co-ordinate geometry since known as "Cartesian." The reprint comes only two years after another, edited by David Eugene Smith and Marcia L. Latham for the Open Court Publishing Company, and naturally provokes comparison with it. The Open Court edition has the text in the form of a facsimile of the first edition of 1637. The present reprint is not a facsimile, but a reprint in modern type, and it is made more modern by the substitution, *e.g.*, of a^2 for aa, and of = for Descartes' sign for equality (a symbol like that used in modern algebras for 'varies as,' but turned the opposite way); it has no historical or explanatory notes, no preface and no index; and it does not give even the date of the edition from which it is reproduced. The Smith-Latham edition, on the other hand, has an English translation facing the facsimile text, and a large number of useful notes, historical and other.

No doubt the present reprint is meant for the French reader, but the question arises, who

nowadays is likely to read the "Géométrie" in the original, unless he is studying or writing on the history of mathematics, and wants to understand the exact stage of development represented by that work?—for no one would think of going to it for the technique of modern analytical geometry. As Prof. Loria has remarked, there is a greater gulf between Descartes' work and a modern treatise on analytical geometry than there is between an ancient (*i.e.* Greek) and a modern treatise on any other mathematical subject.

If the book is read from the historical point of view, the reader will certainly want much help in the way of notes showing the relation between Descartes' methods and those of other writers, ancient and modern. Such aids are all the more necessary with a book which is in any case difficult to read, because the author himself purposely left many things obscure or only half explained. There was a reason for this in the general attitude of the mathematicians of the time to one another. Every one wanted to get personal credit for discoveries, and to avoid giving anything away which another could use and then claim as a discovery of his own. So far does Descartes betray this anxiety that he even hints at things which he has not set down but could 'an if he would.' "I hope," he says, "that posterity will give me credit, not only for those things which I have explained, but also for those which I have voluntarily omitted in order to leave them the pleasure of discovering them," as if he wished 'to have it both ways'!

On the whole, the reprint before us seems rather to fall between two stools, unless indeed it is merely intended as a handy book of reference for those who, studying an account of Descartes' work in an ordinary history, wish to look up some particular point in the original. T. L. H.

Our Bookshelf.

Rasa-Jala-Nidhi: or Ocean of Indian Chemistry and Alchemy. Compiled in Sanskrit by Rasacharya Kaviraj Bhudeb Mookerji. With English translation by the Author. Vol. 1. Pp. v + xv + viii + 350 + v. Vol. 2. Pp. ii + 5 + 8 + 10 + 296 + 23. (Calcutta: The Author, 41A Grey Street, n.d.) 10 rupees.

THE author says that he has been a devout student of early Indian chemistry from his boyhood. By accident, he came into contact with a Yogi from whom he learnt much more than could be found in the existing books on Indian chemistry, which he considers to be incomplete, incoherent, incorrect, and in many cases misleading. The Yogi's teaching, however, enabled him to arrange methodically the materials found in the existing books on early chemistry, which were mostly in a chaotic state, and had been neglected for several centuries past. Unfortunately, the author gives no list of authorities for his facts and recipes, though he promises one for the concluding volume (the tenth); it is therefore impossible to assess the work properly from a historical viewpoint. Since, however, he maintains that Rasavidya, or chemistry, was cultivated by the early Aryas some 1950 million years ago, and states that fragments of two or three books written about 898,000 B.C. are still in existence, his claims to be treated as a serious historian are perhaps not very weighty. Mr. Mookerji dismisses Sir P. C. Ray's work on Hindu chemistry as that of an amateur critic, and says that it contains many misinterpretations of important principles, due to a hasty and superficial study of the subject.

It appears that the author is the principal of a college of medical chemistry, as testimonials of cures are given at the end of the first volume. Whether the remedies described in the book are those employed in practice by Mr. Mookerji does not seem clear, but if so, the Indian constitution must be remarkably resilient. Among other bizarre recipes we read that "essence of earth-worms is cool, and cures all sorts of carbuncles and leprosy," besides imparting to mercury the property of withstanding the heat of fire.

The 'chemistry' is equally startling—"mercury is in a state of swoon, when it succeeds in curing diseases without producing any after-effect. The processes of causing swoon of mercury, as known to the expert chemists, are many; of all these, heating with six times its weight of sulphur is the best of all."

It is not improbable that much of the material which the book contains may be of some antiquity, and it is to be hoped that the author will fulfil his promise of adducing his authorities. Until he does so, his book must serve merely to throw into relief the unscientific nature of a queer folk-pharmacology. E. J. H.

Mushrooms and Toadstools: an Account of the more common Edible and Poisonous Fungi of Canada. By H. T. Güssow and W. S. Odell. Pp. 274 (128 plates). (Ottawa: Division of Botany, Dominion Experimental Farms, 1927.) 1 dollar.

THE outstanding feature of this book is its price—one dollar! For a large, well-bound volume of 274 thick loaded pages, with 128 plates containing hundreds of unusually good photographs of fungi, two of these plates being in most delicate colouring, a price of one dollar is literally startling. The book is published by direction of the Minister of Agriculture, Ottawa, and if this is a sample of his direction, one can only fervently wish 'more power to his elbow.' The volume is really an extended bulletin of the Division of Botany of the Dominion Experimental Farms, the senior author being the Dominion botanist. It contains simple but adequate descriptions of the common edible and poisonous fungi of Canada, and although it is far from complete, few if any of what may be

regarded as the commonest fungi have been omitted. It is in no sense a 'learned treatise,' and the arrangement adopted might cause a strict systematist to wilt. For its avowed purpose, however, which is "to appeal to students as well as nature lovers, who wish to know the many odd or beautiful forms of fungous growth they may happen upon in their country rambles," it is quite admirable. Four introductory chapters deal with the general structure of the fungi and useful practical hints to collectors. Following these are the illustrated descriptions of 160 species, and then brief but adequate accounts of the preparation and value of fungi as food, of poisoning by fungi, and of mushroom culture. A useful glossary and a good index complete the volume.

To criticise such a work is in very truth to look a gift horse in the mouth, and one can only admire and envy the skill of Mr. Clarke, chief of the Photographic Division of the Geological Survey of Canada, who took nearly all the photographs, and the energy and opportunities of Mr. Odell, who, "in his frequent jaunts through woods and meadows," collected the specimens.

Altogether, a book for every botanist to become possessed of with all possible speed, so that the Minister of Agriculture may be encouraged to direct the publication of others. W. B. B.

Die Tierwelt der Nord- und Ostsee. Herausgegeben von G. Grimpe und E. Wagler. Lieferung 9. Teil 6 c_1: *Oligochæta*, von W. Michaelsen; Teil 12 a_2: *Thaliacea*, von J. E. W. Ihle; Teil 12 f_1: *Chondrostei*, von E. Ehrenbaum; Teil 12 f_2: *Teleostei Physostomi*, von H. M. Kyle und E. Ehrenbaum. Pp. 44+28+86. 13·60 gold marks. Lieferung 10. Teil 7 d_1: *Gastrotricha*, von A. Remane; Teil 11 c: *Halacaridæ*, von K. Viets; Teil 12 h_2: *Teleostei Physoclisti*, 11-15, von E. W. Mohr und G. Duncker. Pp. 56+72+61-140. 16·80 gold marks. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1927.)

THAT section of the present work dealing with the oligochætes contains a unique account of the marine and brackish worms belonging to that order and occurring in the North and Baltic Seas. All oligochætes living in, or at intervals submerged by, water, the salinity of which is greater than five parts per thousand, are regarded as coming within the scope of the present paper. Habitat receives especial attention. The section dealing with the Gastrotricha is very well illustrated and deserves no less praise than the last section.

The portions dealing with the systematics of fishes are, in our opinion, not up to the standard of the remainder of the work. Most of the figures are from familiar books. Nevertheless, the advanced students and amateurs to whom the work is mainly addressed could not be blamed if they failed to recognise some of their fish captures from the figures given. In accordance with the original plan of the book, those fishes of economic importance receive fuller treatment than the others, yet there is a good deal of recent and important work upon the herring which receives no recognition, and although there are references in the text to names apparently to be given in the bibliography, they are not to be found there. In a review of an earlier part of the publication, mention was made of the great usefulness of the table given for the identification of pelagic fish eggs. If this could be included, it seems a pity that there is not more information given upon the larval and post-larval stages of fishes.

Christ the Word. By P. E. More. (*The Greek Tradition: from the Death of Socrates to the Council of Chalcedon, 399 B.C. to A.D. 451*, vol. 4.) Pp. viii+343. (Princeton: Princeton University Press; London: Oxford University Press, 1927.) 18s. net.

MODERN theologians who attempt the most necessary task of devising a scheme of Christian thought at once retaining all the traditional content and yet not incongruous in the light of scientific knowledge, tend more and more to utilise the Greek conception of the *Logos*. It seems evident that the Greek tradition in theology is the right one to follow. Hence the value of Dr. More's book for those students of natural science who take an interest in the problems of theology. It is a short history of the development of Christian theology from the Fourth Gospel to the Council of Chalcedon.

In reading these pages, students of science will find themselves in a world where much seems unfamiliar, but they will recognise the fundamental idea that the reason of man finds its counterpart in the essential rationality of existence. We cannot avoid the conviction that if men of science occupied some of their leisure moments in the study of the origin and development of Christian ideas, they would discover an unexpected source of intellectual interest, and perhaps find an atmosphere less alien than they had imagined, since both science and theology have their origins in Greek thought.

J. C. H.

Lectures on the Religion of the Semites: the Fundamental Institutions. By the late Prof. William Robertson Smith. Third edition, with an Introduction and Additional Notes by Dr. Stanley A. Cook. Pp. lxiv+718. (London: A. and C. Black, Ltd., 1927.) 12s. 6d. net.

A NEW edition of Prof. Robertson Smith's lectures was badly needed, for although they were first published in 1889, and the second edition edited by Sutherland Black appeared in 1894, they still hold first place as a classic study of the subject. But a vast amount of material dealing with the Semitic and other religions of the world has accumulated during the last thirty years, and cognisance of this must now be taken. In the new edition, Dr. Stanley Cook has provided a carefully considered introduction, in which he examines Robertson Smith's main conceptions in the light of later developments in the comparative study of religion, and in some two hundred pages of notes has added facts and bibliographical references to further information, which will serve to illustrate and define the position of the beliefs of the Semites in their relation to other systems, especially in the ancient world.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Coals as Colloid Systems.

IN a memoir on the geology and coal resources of Korea State, Central Provinces, published in 1914 (*Memoirs, Geological Survey of India*, **41**, p. 180), I suggested that the bright coal of the Barakar series "judging from its brilliant conchoidal fracture is of the nature of a colloidal substance." I find that H. Potonié had noted the colloidal nature of humus in 1911, whilst Drs. Stopes and Wheeler, in their paper on the "Constitution of Coal," mention H. Winter as believing in the colloidal nature of coal in 1913, the reference quoted (*Glückauf*) not being, however, accessible to me. Later authors have referred to the same point, but I have not noticed accounts of any research specifically directed towards the study of coals as colloid systems. It may be useful, therefore, to refer briefly to data derived from a study of certain Indian coals that appear to provide definite evidence on this question.

For some years I have been interested in the relationship between the specific gravity and ash contents of Indian coals, and I have in particular collected data for the Bokaro (Bihar and Orissa) and Kurasia (Korea) coalfields. These data are discussed in a paper now in the press for the *Records of the Geological Survey of India* (vol. 60, pt. 4).

The most important fact that has been elicited by this research is that the coals from the Bokaro coalfield can be divided into two series according to their macroscopic aspect in hand specimens, and that the series so made are found to yield different types of density-ash curves.

The economically more important series is the *vitrain–durain series* ranging from *bright coal* with about 1 per cent. of ash through various types of *banded silky coals* to *dull coal* with ash contents up to about 40 per cent. For these coals the density-ash relationship is linear. If g be the specific gravity of any piece of coal in this series, k the specific gravity of ash-free vitrain, and a the ash contents, then it is found empirically that the following relationship holds:

$$a = 100(g - k).$$

For Bokaro $k = 1{\cdot}26$. Hence, if in the jungle a piece of coal is found to have a specific gravity of 1·50 (by means, for example, of Walker's balance), one can predict that the ash contents will be found to be $100 \times (1{\cdot}50 - 1{\cdot}26) = 24$ per cent. Actual analysis yields results often within 1 per cent. of, and rarely so much as 3 per cent. different from, the predicted value. Larger deviations than this can be attributed to special causes; for example, ash of unusually high specific gravity due to a high proportion of ferric oxide.

The second series contains types ranging from *shaly coals* through *coaly shales* to *carbonaceous shales*, in which layers of vitrain and carbonaceous shale are interlaminated in various proportions. The relationship between specific gravity and ash contents for this series is not linear, but is expressed by a curve of the same shape as would be obtained by mixing mechanically two substances of different specific gravities.

Searching for an explanation for the different types of relationship between specific gravity and ash contents in these two series, I find that an appeal to colloid chemistry appears to provide the answer, and that my empirical data are explicable if we regard the vitrain-durain series as a series of suspensoid colloid solutions, and the shaly coals, coaly shales, and carbonaceous shale as a series of coarse suspensions, often with layers of vitrain.

Reverting now to the vitrain–durain series, I may mention another curious fact. On comparing the proximate analyses and specific gravity of vitrain from various coalfields, I find that the specific gravity *increases* with the moisture contents, but not according to a linear rule as for the ash contents, the few data so far collected yielding a curve convex towards the density ordinate. These data find a simple interpretation if we regard the moisture as present in a colloidal state, as in a gel or in an emulsoid, in moisture-free vitrain.

Durain has been shown by various observers to contain both vegetable detritus and vitrain, as well as a variable quantity of 'ash.' Recalling this, it appears that on the basis of the data referred to above we can describe (1) *vitrain* as a colloid system (either gel or emulsoid) containing moisture; (2) *durain* as a disperse system in which vitrain is the dispersion medium, whilst the ash contents (suspensoid) and the vegetable detritus (coarse suspension) are present as disperse phases.

If these suggestions are well founded, then light may be thrown on certain practical aspects of coal (1) prospecting, (2) beneficiation, (3) coking, and (4) conversion to liquid fuel. The points are noticed in the paper mentioned and need not be discussed further here, except that, with reference to the coking coal, I may mention that my data indicate that high moisture contents are much more harmful to the coking properties than high ash contents. (These conclusions concerning coking coals are in harmony with results obtained by Mr. Balaram Sen, of the Tata Iron and Steel Company, as described by him at the recent meeting of the Indian Science Congress in Calcutta.)

The suggestions contained in this paper are really based on the consideration of coals as specimens representing points on density–concentration diagrams of various types of disperse systems. It appears that much valuable information would result from an exact study of the specific gravity of selected specimens of coal in conjunction with various properties both physical or chemical. In this letter, for example, vitrain has been treated as a homogeneous substance acting as the dispersion medium for the ash contents and vegetable detritus. That it is really extremely complex is of course well known; and various methods of attack have been devised in the attempt to solve its constitution. Little success, however, seems hitherto to have been attained. Perhaps a study of vitrain, and of coal in general, from the physico-chemical point of view might help. Thus, since the paper referred to above was sent to the press, I have been comparing analyses of similar coals from different fields. This comparison reveals curious relationships between 'volatile matter,' 'fixed carbon,' and specific gravity. Taking matched pieces of coals with almost identical ash contents, and not very dissimilar moisture, these comparisons indicate that for each pair higher specific gravity almost invariably means higher 'volatile matter' and lower 'fixed carbon.' We do not know the condition in which the 'volatile matter' and 'fixed carbon' is present in coals, but the facts exposed by these comparisons suggest several questions. Is the moisture-free vitrain itself a colloid system? Has the component of this

system that yields 'fixed carbon' a lower density than that which yields the 'volatile matter'? Is there actually free carbon in colloid solution in the hydrocarbon complex, or are we dealing with a colloidal association of two series of compounds, one of which series yields the major portion of the 'fixed carbon' on the application of heat, whilst the other series yields the major portion of the 'volatile matter'?

In conclusion, one may say that the data to which reference is made in this letter seem to indicate that much valuable information might be obtained from a systematic study of coals as colloid systems; not being myself a student of colloid chemistry, but a geologist with no opportunity for physico-chemical research, I have, therefore, ventured to direct attention to these data and to make some apparently rash suggestions in the hope that they may attract attention to the subject and cause others more competent to undertake the careful research that the preliminary data seem to warrant. L. L. FERMOR.

Geological Survey of India, Feb. 16.

Light and Sight.

ALL the facts point to the conclusion that vision takes place by stimulation of the cones of the retina through photo-chemical decomposition of the liquid surrounding them which is sensitised by the visual purple. The rods are not percipient elements, but control the visual purple. Helmholtz stated that there was no evidence that the rods were percipient elements. This theory explains numerous facts which are otherwise inexplicable, such, for example, as the change in position in the field of vision of after-images on movement of the eye. Two after-images may combine into one, or a red after-image may go right through a green one. This proves conclusively that the stimulus is liquid.

Apart from the numerous facts against the duplicity theory, which supposes that the rods are percipient elements for perception in a dim light, it will be found that it is supported almost entirely by misstatements, namely, (1) that certain animals have only cones, and others have only rods; (2) that the periphery of the retina is colour-blind; (3) that the eye is totally colour-blind in dark adaptation; (4) that the Purkinje phenomenon and the recurrent image are not found with the fovea. With regard to these I offer the following criticisms:

(1) Though I have examined numerous collections I have never been able to find any animal with only rods or only cones, neither have I found anyone who has seen such a retina. The tortoise is the most quoted; it is stated to have only cones. The rods and cones in the retina of the tortoise are as clearly defined and distinct as in the human retina.

(2) The periphery of the retina is not colour-blind when colours of sufficient intensity are used. The reader can test this for himself with a doctor's red lamp. He will find he can see it as red to the extreme periphery.

(3) In dark adaptation the eye is not totally colour-blind. Further, there is no scotoma or blind area corresponding to the rod-free portion of the macula which is equal to a visual angle of about three degrees.

(4) The Purkinje phenomenon and recurrent image are found with the fovea.

Hess showed not only that the recurrent image was found with the fovea, but also that it was bent outwards at this region as it would be if the visual purple had to flow into the fovea.

F. W. EDRIDGE-GREEN.

London, April 21.

PROF. HARTRIDGE's letter in NATURE of April 21 is of interest if only for the reason that it exposes our ignorance of the history of human vision. Apparently those who have studied this problem have not yet established any conclusion which limits the field of speculation. It would scarcely be possible to find suggestions more diverse in character than the three already made in this discussion, and it is doubtless much easier to add to the variety than to demonstrate the impossibility of those already put forward. I do not claim to have shown that Sir John Parsons' suggestion is impossible; having pointed out that an additional link is needed to complete the chain of his argument, I merely venture the opinion that this link is very unlikely to be found.

In his third and fourth paragraphs, Prof. Hartridge attempts to provide this missing link, but since he prefers another theory he is perhaps conscious that something is still wanting. Unfortunately, I find his third paragraph unintelligible, and part of the fourth is so ambiguously worded that it would not be profitable to discuss it. It may, however, be as well to say at once that similarity of the two curves Sir John mentioned is not a factor in the problem; the only point under consideration is the occurrence in the same neighbourhood of the peaks of both curves. Since the distribution of solar energy is known, nothing can be gained by introducing into the discussion such foreign considerations as experimental apparatus.

Many readers of NATURE may like to see reproductions of Prof. Wood's photographs, and read his own explanation of these effects, before deciding whether Prof. Hartridge's assumption that they are faulty and misleading photographs is well founded. They will be found in the *British Journal of Photography* for Aug. 12 and Oct. 28, 1910. If, after reading and inspecting them, Prof. Hartridge has any lingering doubts about the reality of these effects, I suggest that he should himself take corresponding photographs through filters of the types used by Prof. Wood, utilising, of course, the much more convenient plates that are now available.

The explanation of our limited visual sensibility proposed by Prof. Hartridge scarcely seems to me compatible with an evolutionary outlook. The words 'difficulty' and 'absence,' suggesting as they do such questions as 'who found it difficult?' almost carry the discussion into the domain of theology. In any event, it is not a view of which my opinion is likely to interest others.

An inappropriate choice has been made in selecting the visibility of a thin dark line as an illustration of the finer powers of the eye; there is no mystery about the explanation. The phenomenon is independent of resolution, and, despite his penultimate paragraph, I can scarcely think that Prof. Hartridge commits such an error as making the line width a function of the resolving power. What is yet uncertain is how it comes about that the eye can detect want of alinement of two parallel lines when the displacement corresponds to an angle of about one second at the eye, and can discriminate between an outline formed by two perpendicular straight lines meeting in a point and another formed by two perpendicular straight lines joined by a circular arc of a radius so small that the separation of the pointed and rounded contours, if the straight lines were superposed, would be much less than the projection, on the plane containing the lines, of the diameter of a single retinal cone. Does Prof. Hartridge's theory give an adequate explanation of these facts?

Is the eye capable of making these refined judgments without moving in its socket, and can the

unattached ends of the cones move? Is there any evidence which supports some of the theories offered to reconcile the appreciation of these small differences of position with the comparative coarseness of the unit retinal receiver, and tends to discredit the others? When we have obtained answers to such questions we may begin to feel more secure in our theories.

The distinction between the "Optical Paradox" and the problem of measurement has been discussed in my reply to Dr. Campbell. The word optical is of some significance, for the special conditions of this experiment enable us to disregard factors such as memory and fatigue, which introduce uncertainty into many other experiments on sensations.

T. SMITH.

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Teddington, Middlesex.

The Polarisation and Fading of Short Wireless Waves.

THE effect of the earth's magnetic field in altering the plane of polarisation and producing circular polarisation in a transmitted wireless ray has been fairly fully discussed recently by Nicholls and Shelling [1] and by Appleton.

Examples of this effect have been observed at night time when the ray from a vertically symmetrical aerial gives a received ray either partially or wholly horizontally polarised, and consequently an erroneous bearing. Further, rather more definite indications of these polarisation effects have been observed on very short waves in two sets of experiments originally started early last year. In these a receiver consisting of a vertical aerial coupled to a closed loop rotating about a vertical axis was used. Such a receiver has unidirectional receiving characteristics. The E.M.F. in the vertical aerial can be made to balance that induced in the loop when the plane of this is in the plane of the incoming ray, but maximum signals will be obtained if the loop is rotated 180°. The position of the loop when zero signals are obtained is an indication of the direction of the station. This arrangement can also be used to indicate the existence of a circularly or elliptically polarised ray to show the direction of rotation of this ray. In using this receiver in April of last year, on the short wave band between 14 and 50 metres, it was found that on certain occasions the received ray was circularly or elliptically polarised.

The results were not numerous, but quite definite, the conditions under which circular polarisation occurs being relatively rare. The effect has not been observed on long-distance stations, and it appears to be most marked on stations just outside the skip distance. The stations observed giving the effect were:

		Wave.	Direction.
(1) PCMM	Kootwick, Holland	27 m.	East.
(2) PCJJ	Eindhoven, Holland	30 m.	Slight S. of E.
(3) Unknown	Station probably Belgian		S.E.
(4) GBK	Bodmin [2]	26 m.	W.S.W.
(5) GLQ	Ongar	24 m.	W. nearly.

The first three stations to the east and south of us always showed circular polarisation in a clockwise or right-handed direction; the latter two in a counter-clockwise or left-handed direction. The observations were all made in the daytime; unfortunately, there were no stations to the north on which to test, so that the information is rather incomplete. The explanation is obviously connected with the double refraction suffered by two circularly polarised components of the plane polarised wave emitted; one of the components being more bent than the other, the two will be separated near the edge of the skip distance where the effect is observed.

It has not been possible yet to trace the two rays which must pass through a medium of variable electronic density, partly along and partly across the earth's magnetic field, in sufficient detail to account for the difference in direction of rotation of the rays according as they travel eastward or westward. But it might be surmised that at greater distances, that is, well outside the skip distance, both the rays into which the original plane polarised wave is split will reach the receiver, where they will combine to produce a plane polarised ray, the direction of which will depend on the distance traversed by the ray through the medium and the strength of the magnetic field. This resultant direction will vary momentarily with slight changes in the path and the earth's magnetic field,[3] with the result that the vertical field will vary

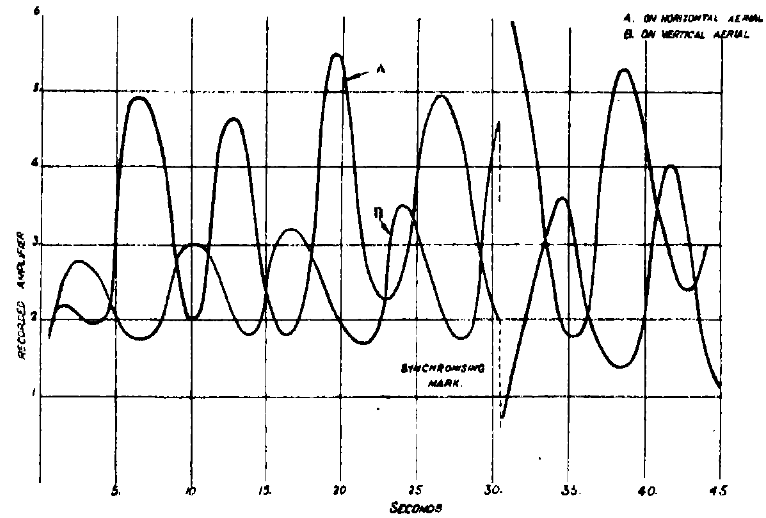

FIG. 1.—Strength of signals from PQW beam station, Lisbon, λ = 15·6 metres, sending high-speed dots.

from time to time and produce fading. But fading from this cause, which is due to a bodily rotation of the electric vector, will produce opposite effects on a vertical and horizontal aerial perpendicular to the ray. In fact, the fading on one will be the inverse of the fading on the other, for when the vertical electric force is a maximum the horizontal force is zero and vice versa. Experiments made recently confirm this view, at least in certain cases. In Fig. 1, simultaneous fading records taken on a horizontal and vertical aerial are shown, and it is clear at a glance that these are opposite in phase.

The observations were made on PQW, a beam station at Lisbon, and many more records showing the same characteristics have been taken. Apart from the theoretical interest, these results have great practical value in devising systems which will eliminate, or at least reduce, fading.

Whether all short wave fading is of this type remains to be seen, but further experiments seem to show that this is not the only type of fading.

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[1] *Bell System Technical Journal*, April 1925.
[2] On the rare occasions when it was outside the skip distance.
[3] As suggested by Breit. *Proc. Inst. Radio Eng.*, August 1927.

Thames Floods.

THE Thames flood of Jan. 6–7 last has served to direct attention to the conditions under which these visitations are developed. From the concluding paragraph of the review of Messrs. Loughton and Heddon's volume on "Great Storms" (NATURE, Mar. 31), the natural inference is that northerly gales are necessary to drive the North Sea tide into the Thames. The authors, however, do not limit themselves to northerly gales. At page 70 they again mention northerly gale floods, but they also bring in the Thames flood under the great storm of November 1703, in which the wind "did not veer to the north-west in time to produce the effect to its full extent."

Of meteorological information contained in the log books of more than a hundred ships of the navy of that period I made a special collection for an article on this great storm, which appeared in the *Cornhill Magazine* for November 1897. The records enable me to state definitely that throughout the night of November 26–27 the storm maintained its south-westerly direction, at no time veering beyond W.S.W., between Rye, the Downs, the Thames Estuary as far north as the Long Sand, 51° 50′ N., and on the Dutch coast. Farther north, off Harwich, the wind veered to W. and W.N.W. about 11 A.M. on Nov. 27; off Yarmouth, after 10 A.M.; off Haisbro', very violent from S.S.W. at 6 A.M., shifted to N.W., and continued very violent until 11 A.M., then it abated (time of the shift not stated); off Claypole (the Wash), extremely hard S.W. gale, apparently veered to N.W. at 6.30 A.M., when "our small bower cable parted"; off Grimsby, after a stormy night at S.S.W. the wind shifted to N.W. at 5 A.M. and blew a violent storm; off Scarborough, while at anchor, from noon until midnight, moderate and fair weather, wind S.S.W.–N.W.; sailed at midnight, and soon ran into hard gales with storms of rain, by 4 A.M. blowing very hard, wind W.N.W.–W. by S.

From these facts it is obvious that during both the rising and the subsequent falling of the North Sea tide, between the Wash and Harwich, the hurricane continued to blow hard from S.W., that is, dead against the rising tide. In these circumstances the Thames flood was an extension of the great floods raised by the violent storm along our south-western and southern coasts. This is practically on all fours with our experience in January last, when the country was swept by a violent south-westerly storm, with wind velocities ranging upwards to 85 miles an hour, and the veering to W. or N.W. on the North Sea being too late and not far enough north to affect materially the east-coast tide. As was stated in the *Times* of January 9, the heavy south-westerly wind "is thought to have been the determining factor, for it piled up the southward flow of the tide in the Straits, and so diverted an unusual quantity of water into the Thames Estuary."

As the coast from about Lowestoft into the Thames runs due south-west, gales from between N. and E. or S.E. are necessary to raise the river above the normal level. So long as our gales maintain a direction between S. and W., they keep in check the North Sea tide, and according to circumstances, as recently, flood the river from the Channel.

In the *Meteorological Magazine* for March 1927, p. 35, discussing the great storm of 1703, occurs the following: "Over England the storm was succeeded by an intense anticyclone, for on the 28th [of November] there was a north wind of unusual violence in the North Sea, which caused a very high tide in the Thames." The particulars in the ships' logs show that the south-westerly type of disturbed weather was maintained until the close of the month; the *Deal Castle*, which left Scarborough at midnight of Nov. 26, took 80 hours to beat down against the head wind, casting her anchor off Yarmouth at 9 A.M. on Nov. 30. Daniel Defoe, in his collection of information, prints in full communications he had received from three ships cast adrift early in the morning of Nov. 27 in the southern part of the North Sea, all helpless and carried away northward, one as far as Scarborough; another driven "at a great rate" before the storm to the Norwegian coast by Tuesday, Nov. 30; and H.M.S. *Association* drifting so far as Gothenburg by Dec. 11, the only northing in the wind during the fortnight being a brief interval of N.W. wind on Dec. 4, off the Elbe. These northward driftings would have been impossible against "a north wind of unusual violence," which itself would have been a very striking occurrence in an intense anticyclone, where naturally we should expect to find a dead calm and very light variable breezes.

HY. HARRIES.

April 12.

The Disappearance of Gases into Glass under the Action of the Electric Discharge.

THE passage of sodium through glass under the influence of the electric discharge is well known (Burt, *Phil. Mag.*, **49**, 1168; 1925. Taylor, *Jour. Scient. Instrs.*, **3**, 12, 400; 1926). The present writer showed (*loc. cit.*) that with neon lamps or discharge tubes the action was reversible. If the molten sodium nitrate, which is used as electrolyte, was maintained at negative potential with respect to the internal electrodes (about 300 volts negative), then the inside glass wall became covered with negative glow. A current of many milliamperes flowed initially, but fell off with time in an almost exponential manner to a constant smaller value. Similar results were obtained with other electrolytes and with conductors such as mercury.

The potential required to strike a discharge was independent of the temperature (60° C. to 400° C. examined), but the current fell off rapidly with decrease of temperature.

With such a discharge the hydrogen contained in the neon lamps—indicated spectrographically—disappeared rapidly and only a trace remained after a run of five minutes. On continuing the discharge the carbon monoxide bands appeared. The carbon monoxide arose largely from an electrical action, not from thermal decomposition.

Experiments were carried out in a specially constructed apparatus (soda glass) in which positive ions obtained in various gases at low pressures by means of a seven-metre wave electrodeless discharge were pulled out by an electric field to the walls of a thin-walled glass bulb immersed in molten sodium nitrate. The glass apparatus was thoroughly 'baked out' at high temperature and subjected to the action of the electrodeless discharge before results were taken.

The currents flowing through the glass walls of the bulb and the gas disappearance were measured concurrently. Experiments were made on hydrogen, oxygen, nitrogen, helium (mercury vapour frozen out in all cases by liquid air trap), and the results showed:

1. For hydrogen, oxygen, nitrogen, the quantity of gas disappearing is directly proportional, within the limits of experimental error, to the quantity of electricity transferred through the glass walls.

2. For hydrogen, every electron charge passed involves the disappearance of one hydrogen molecule.

3. For oxygen and nitrogen, every two electron

charges passed involves the disappearance of one atom of oxygen or nitrogen respectively.

4. For helium (continually purified by carbon in liquid air), a current flowed but no disappearance of gas took place.

Thus with hydrogen at an initial pressure of 2·5 mm., in 21 min. the pressure fell to 0·03 mm. The current through the glass (at 480 volts) was variable (6 to 16 m.a.) Assuming H^+ as carrier, then, from the electrical quantity, 1·16 c.c. at N.T.P. should have disappeared. Actually 2·05 c.c. disappeared. With initial pressure 0·057 mm. the current was 0·5 to 0·1 m.a. (500 volts), and the estimated disappearance was $22 \cdot 7 \times 10^{-8}$ c.c. at N.T.P. The actual disappearance was 41×10^{-8} c.c.

Experiments carried out on the conduction of glass and quartz at temperatures such as those used in the above experiments showed that the conductivity was considerable and the mechanism largely electrolytic. Only a relatively small quantity of the gas that had disappeared was recovered on heating, and the electrical action was not reversible (sodium was introduced on reversing). Experiments carried out to test whether the gas passed through the glass walls and could be collected have, up to the present, given negative or inconclusive results.

The non-disappearance of helium shows that the action is not an accelerated diffusion through the glass pores, for, in that case, helium should pass through about twenty times as quickly as hydrogen.

The action appears to arise from an electrolytic decomposition of the glass which probably results, in the case of hydrogen, in the formation of water which penetrates deep into the glass structure.

With mercury discharges gas is usually brought out of the walls.

The above actions are probably of fundamental significance in most phenomena of 'clean up' or gas disappearance into glass walls.

JAMES TAYLOR.

Trinity College,
Cambridge, April 11.

Rare Fishes in the North Sea.

THERE are a good many North Sea fishes which never pass their whole lives in that sea, but only enter it for limited periods, in quest of spawning-grounds or of food. Amongst these are several important species, such as the hake and the halibut, the mackerel and the tunny; and others also of less importance, such as the gurnards, the anchovy, the horse-mackerel, and the monk or angler (Lophius). While all of these arrive in sufficient quantity to be more or less important to the fisherman, there are others which come in small shoals or as individual stragglers, and so come to be considered as rare and unusual occurrences. It happens that within the last couple of years or so some of these casual visitors have been unusually plentiful, and have attracted the attention of the fishermen.[1]

Among these recent visitors has been a number of sharks, of more or less uncommon species. The Thresher shark (Alopias) is one of these; another, and a greater stranger, is the great Basking Shark of Atlantic waters (*Selache maxima*). Another stranger to the North Sea is the Six-gilled Shark (*Hexanchus* or *Notidanus griseus*, L.), which has its home in the Mediterranean and neighbouring parts of the Atlantic, but has of late occurred in our home waters in quite unusual abundance. It has been caught especially on the Viking Bank, to the westward of the deep Norwegian Channel, and in such numbers as to become of almost regular occurrence in the fish-markets of Germany, where these and other sharks are in demand for food and fetch very good prices.

Even more remarkable perhaps than these is a long succession of captures of Ray's Bream, a fish of remarkable and striking appearance, which up to very lately had been but seldom recorded from the North Sea. Of late it has been taken in the English Channel and on the Viking Bank; and specimens have been caught or cast ashore in a large number of places all along the east coast of Great Britain from Cromer to the Dornoch Firth. One was lately caught in a flounder net on the Swedish coast of the Öro Sound; and there is an earlier record so far east as the Pomeranian coast of the Baltic.

In the past few months there have also been caught on the Viking Bank by German steam-trawlers certain other very rare species:

1. The so-called 'Devil-fish' (*Epigonus telescopus*, Risso; formerly wrongly named Pomatomus). This is a perch-like fish never before recorded from the North Sea; its true home is in the southern Atlantic, for example, near St. Helena. It is a dark-coloured fish, with enormous shining or luminous eyes. Our North Sea specimen was 57 cm. long, and was trawled at the very considerable depth of 230 metres.

2. The Blackfish (*Centrolophus pompilus*, Risso) belongs to the family Stromateidæ, and has a certain outward resemblance to some of the flatfishes. A specimen (53 cm. long) was caught recently in 59° 20′ N., 3° E.; and another a couple of years ago, on the Danish side of the Cattegat. It has been recorded before from the North Sea, but by no means often; it is an Atlantic fish, going as far south as Madeira. An allied species (*C. britannicus*) has occasionally been captured in the western part of the Channel.

3. The Snipefish, or Trumpet-fish (*Centriscus* or *Macrorhamphus scolopax*, L.), is a fish of curious appearance, with a small toothless mouth on a long tubular snout, well known in the Mediterranean. It has been observed a few times on the Cornish and on the Irish coasts, and on one previous occasion in the North Sea, near Arendal on the south coast of Norway.

All these rare Atlantic fishes come from the deep water of the Viking Bank; and it would seem necessary to suppose, in order to account for their presence there, that they had been transported by a submarine current from the Atlantic rounding the plateau of the northern North Sea and making its way into the Norwegian Channel. But while Ray's Bream, the Devil-fish, and the Blackfish may all be considered deep-water forms, and might well have come by such a deep-water under-current, it is somewhat remarkable that the Snipefish is known to prefer soft ground near to the coast in waters of only moderate depth —at least in its home in the Mediterranean.

E. EHRENBAUM.

Hamburg.

[1] Cf. *Der Fischerbote* (Hamburg), p. 487, 1927; p. 126, 1928.

Stark Effect and Series Limits.

THE treatments of the Stark effect found in the literature concern themselves chiefly with the behaviour of atoms in the lower quantum states, a problem to which the theory of perturbations can be applied. Consideration of the effect of the external electric field on highly excited atoms necessitates the discussion of the complete equations, in particular with regard to the existence of conditionally periodic orbits. The investigation which we have carried out gives a negative upper limit for the energy of quantised

orbits in a hydrogen-like atom, and shows that there exist various types of unquantised orbits which have negative energies.

The energy of a periodic orbit must be less than

$$-\frac{3}{2}\left(\frac{eFp_\phi}{\sqrt{m_2}}\right)^{2/3} \quad . \quad . \quad . \quad . \quad (1)$$

where F is the magnitude of the applied field. This necessary condition is sufficient only for small values of F and of the angular momentum p_ϕ. There can, however, exist aperiodic orbits of less, as well as of greater, energy than this value, and in one class of these orbits the electron may approach the nucleus within distances comparable with the dimensions of the periodic orbits. The lower limit of the energy of these latter orbits is approximately

$$-2e\sqrt{eF} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

As a result, the line spectrum will not be continued to the normal spectral limit, but will end to the long wave-length side at a point which depends on the field in the gas; the continuous spectrum associated with ionisation or recombination will also extend to the red of the limit.

Since any atom becomes hydrogen-like as one of its electrons is removed to higher quantum states, expression (2) can be used to calculate the apparent limit of any continuous atomic spectrum. The following table gives the observed maximum and calculated limit of the continuous spectrum for the available data for which an estimate of the mean field strength can be made.

Element.	Limit.	Field. (e.s.u.)	Maximum (cm⁻¹ from Limit).	
			Observed.	Calculated.
H	Balmer	6	330	270
He	$2s$	3	175	190
Cs	$2P$	8	250	310
Cs	$2D$	8	300	310

The data for hydrogen are taken from the measurements of Yü (*Lick Obs. Bull.*, **12**, p. 104; 1926) on stars of class A and B. Russell's estimate (*Astrophys. Jour.*, **59**, p. 197; 1924) of the field in the sun is used for these stars, since the ion concentrations may be considered the same in the two cases. The data for helium are from the work of Paschen (*Berl. Sitzungsberichte*, p. 135; 1926), and those for cæsium from the recent measurements of Mohler (*Phys. Rev.*, **31**, p. 187; 1928). The field in this last case was estimated from Mohler's measurements of ion concentration in a tube similar to the one in which the spectrum was observed (as reported at the meeting of the American Physical Society, New York, Feb. 25, 1928), using the formula of Holtsmark (*Ann. d. Phys.*, **58**, p. 577; 1919). Considering the rough methods of estimating the field and the fact that we have applied a theory of homogeneous fields to the stray fields arising in an ionised gas, the agreement is satisfactory.

A paper discussing this subject in more detail is being submitted to the *Physical Review*.

JANE M. DEWEY.
H. P. ROBERTSON.
(National Research Fellows.)
Palmer Physical Laboratory,
Princeton University,
Feb. 29.

The Buoyancy of Whales.

THE hydrostatic equipment of the whale would be incomplete without some means of enabling it to alter its buoyancy at will: these means are doubtless the lungs and chest.

The lungs and chest of whales are known to be very elastic and capable of great expansion and contraction. When the whale wishes to sink, it compresses its lungs, and allows them to expand when it wishes to rise or float. In whales that die at the surface and float, these organs are doubtless in a state of expansion, and in those that die at a depth in a contracted and airless one. In the latter, that is, in those that die at a depth, the chest and lungs are compressed; the blow-hole valves yield to the pressure from within (but not to that from without); the imprisoned air escapes; the chest contracts; and the body sinks. In the former, however, that is, in those that die at the surface, the chest and lungs remain expanded and the body floats.

In whales, in the intervals between the respirations, the air in the chest, for hydrostatic reasons, may be in a more or less compressed state. Consequently, when the whale dies at the surface, its chest may expand somewhat, but it is difficult to see why, and bearing in mind the mechanical nature of the valves, even to see how more air can enter it, as Mr. Taylor suggests.

Except in death from asphyxia, in which the animal's body doubtless sinks, no matter at what depth death takes place, the answer to the question at issue, namely, why do whales recently dead in some instances float, in others sink, appears to depend on the depth at which death takes place; for a certain degree of compression of the chest is necessary to overcome the blow-hole valves and cause the air imprisoned in the chest to escape. Given the necessary pressure, that is, if death takes place at a sufficient depth, the body sinks, but failing this, that is, if death takes place at or near the surface, the body floats.

Granted that the tendency of the whale's body to float or sink depends entirely on the state of its chest and lungs, and given the weight of a dead one that sinks, the lungs and chest of which are presumably in the fully contracted state, or the weight of the parts that in the living one appear above the surface when the animal is motionless and its chest and lungs are presumably in the opposite condition, it follows that the whale's 'vital capacity,' or the volume of the air it inhales and exhales when breathing deeply, is ascertainable. Making use of certain imperfect data, a large Greenland whale, estimated to weigh 70 tons, had a vital capacity amounting to about 250 cubic feet.

Whales struck with the hand harpoon probably never die at once, and when the simple gun harpoon was substituted against them, did so very rarely; but when they died under water, presumably from asphyxia, they did so irrespective of which weapon was used.

Of 203 Bottlenose whales captured in 1882, only one was shot dead and only one died under water; the former floated, the latter had to be hauled up (see Log of *Eclipse*, *Land and Water*, Dec. 1882). Of about the same number of Greenland whales captured by Scoresby senior in a number of years, a larger number died under water and had to be hauled up; but his catches largely consisted of young whales, and, as his son states, "it is not unusual for small whales to run downward until they exhaust themselves so completely that they are not able to return to the surface, but are suffocated in the water."

In conclusion, whales killed with the hand harpoon

or with the simple gun harpoon usually die at the surface and float, while those killed with the bomb harpoon, as is well known, usually do so under water and sink. The latter appear to do so because death is seldom instantaneous enough to prevent them leaving the surface, yet the injury done them is usually so serious that they are unable to regain it and consequently die under water from asphyxia.

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The Optical Analogue of the Compton Effect.

THE presence in the light scattered by fluids, of wave-lengths different from those present in the incident light, is shown very clearly by the accompanying photographs (Fig. 1). In the illustration (1)

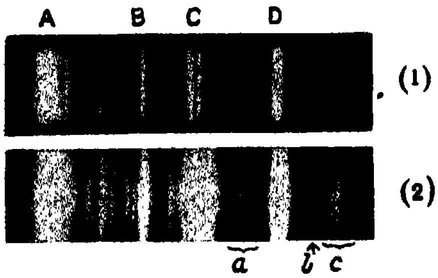

FIG. 1.—(1) Spectrum of incident light; (2) spectrum of scattered light.

represents the spectrum of the light from a quartz mercury vapour lamp, from which all wave-lengths greater than that of the indigo line have been filtered out. This line (4358 A.) is marked D in the spectrogram, and C is the group of lines 4047, 4078, and 4109 A. Spectrogram (2) shows the spectrum of the scattered light, the fluid used being toluene in this case. It will be seen that besides the lines present in the incident spectrum, there are several other lines present in the scattered spectrum. These are marked *a*, *b*, *c* in the figure, and in addition there is seen visually another group of lines which is of still greater wave-length and lies in a region outside that photographed. When a suitable filter was put in the incident light to cut off the 4358 line, this latter group also disappeared, showing that it derived its origin from the 4358 line in the incident radiation. Similarly, the group marked *c* in spectrogram (2) disappeared when the group of lines 4047, 4078 and 4109 was filtered out from the incident radiation by quinine solution, while the group due to 4358 A. continued to be seen. Thus the analogy with the Compton effect becomes clear, except that we are dealing with shifts of wave-length far larger than those met with in the X-ray region.

As a tentative explanation of the new spectral lines thus produced by light-scattering, it may be assumed that an incident quantum of radiation may be scattered by the molecules of a fluid either as a whole or in part, in the former case giving the original wave-length, and in the latter case an increased wave-length. This explanation is supported by the fact that the diminution in frequency is of the same order of magnitude as the frequency of the molecular infra-red absorption line. Further, it is found that the shift of wave-length is not quite the same for different molecules, and this supports the explanation suggested.

Careful measurements of wave-length now being made should settle this point definitely at an early date.

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Calcutta, Mar. 22.

Excitation of the Auroral Green Line in Active Nitrogen.

THE auroral green line, which is now thought to be an arc line of oxygen, has been excited with considerable intensity in active nitrogen that was produced by a condensed discharge in a mixture of nitrogen and about 4 per cent. oxygen. Under the most favourable conditions for its excitation, the line was as intense as the afterglow band at 5442 A. Eastman astronomical plates were used because of their great sensitivity in the green. The spectrum was photographed on a small Hilger visible spectrograph. Because of the small dispersion of the instrument, the wave-length of the line could be measured only to within 0·1 A. Using helium standards the wave-length was found to be 5577·5 A. The measurements of Babcock and of others give this wave-length as 5577·35 A. It was shown definitely that with decreasing amounts of oxygen the line gradually disappeared. This and the fact that the wave-lengths agree fairly well, give sufficient proof that the line in question is the auroral green line.

Besides the green line, a red line having a wave-length of 6654·8 A. was observed in the afterglow under the same conditions as the green line. There is an unclassified line of oxygen at 6654·8 A. and it is thought that these two lines are identical. Amounts of oxygen too small to bring out the green line were found to be sufficient to bring out the red line. This observation is based on the fact that the red line was as intense as one of the afterglow bands in the red (6185 A.), the intensity of which was given by Lord Rayleigh as the same as the band 5442 A. mentioned in connexion with the green line.

Too little is known about the energy levels of the oxygen atom and about the spectroscopic origin of the green line for any hypothesis as to the process of excitation in this experiment to be of any value. The excitation of the line with an intensity comparable with that of one of the afterglow bands does, however, seem to indicate that the dissociation of the oxygen molecule and the excitation of the atom occur in a single act. Since no green line afterglow has ever been observed in oxygen discharge tubes, it is certain that the excitation in this experiment is due to the active nitrogen. It is interesting that the green line has been excited without the simultaneous excitation of the other strong arc lines of oxygen, a phenomenon that occurs in the night sky, where the green line alone has been observed.

JOSEPH KAPLAN.
(National Research Fellow in Physics.)
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Princeton University, U.S.A.
April 13.

Stellar Radiation and the Nature of the Universe.

REFERRING very briefly to NATURE of April 28, p. 674, the reason Dr. Jeans and I agree to differ in our estimate of the possibilities of the universe is because he is dependent on matter for all energy, the rest being empty space; whereas I postulate a vast store of energy in a rotational ether, which only or mainly manifests itself in localised portions apprehended by us as particles or waves.

Similarly, a cyclically permanent universe would seem to him dull or dead; whereas to me it furnishes the mechanism apparently needed for the continued evolution of an entity known to us as life or mind, which, unlike its inorganic counterpart, is progressive.

OLIVER LODGE.

Correlation Coefficients in Meteorology.

IN NATURE for Mar. 17, Mr. E. V. Newnham, in an interesting letter on "Correlation Coefficients in Meteorology," points out that if we wish to test if an observed value could reasonably have occurred in a sample from uncorrelated material, ρ should be put equal to zero in the formula

$$\frac{1-\rho^2}{\sqrt{n}},$$

and not equated to the observed value, r. So far as it goes, this advice is correct, but without other warning, and especially in conjunction with the example chosen, it is not a little misleading. The correction may be considerably greater, or less, than that required to give a reliable value.

Using $(1-r^2)/\sqrt{n}$, the probability that a correlation derived from 16 pairs of observations should exceed 0·70, would appear to be 0·000,000,02, or only one in 50 million trials; this, as Mr. Newnham indicates, would make the odds in favour of a genuine connexion "overwhelmingly great"; using the corrected formula, $1/\sqrt{n}$, it would appear to be 0·00256. However, if the odds are calculated by an exact method, it is found that the probability is actually a little more than 0·00127; the real odds happen in this case to be nearly double those which Mr. Newnham advocates.

The fact is that the distribution of the correlation coefficient from small samples is so far from normal that the use of any formula for the standard error is misleading. This is not to be regretted, since the exact test of significance is no more difficult to apply than the use of the standard error; indeed, special tables have been available for some time from which the level of significance of an observed correlation can be read off at a glance, and similar tables for the multiple correlation have already been prepared for publication by Dr. Wishart in this laboratory.

Since in nine cases out of ten only the small sample formula is exact enough for practical purposes, the formula for the standard error of the correlation coefficient may soon be classed among the things "which students have to know, but only a fool would use." R. A. FISHER.

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Harpenden, Herts.

The Golgi Bodies of Plants.

I RECENTLY directed attention to the discovery of Golgi bodies in plants, which was made by Bowen, and is of interest to all botanists.

In this laboratory two of my senior students, Miss Patten and Miss Scott, have gone over a part of Bowen's work, and I have therefore had the opportunity of studying slides of plant tissues prepared according to the methods which Bowen has used. In hyacinth root, and pea root and stem, we have been able to conform Bowen's results, especially in material prepared by the Kolatchev method. Bowen's bodies are discoidal structures, or osmiophilic platelets as he calls them, and very like the hæmatids of mammals. There is a stainable cortex and a thinner, or at least less chromophile, central area. They are very small, but stain very sharply by the Kolatchev method, and there can be no doubt as to their presence. They are not osmium granulations.

For the benefit of those students of botany who may care to investigate these bodies, I give full details of the Kolatchev method; if it is carried out properly it never fails: Slit up root tips, etc., and fix in Champy's fluid, or the following modified Champy. Equal parts of 6 per cent. bichromate of potassium, 1 per cent. chromic acid, and 2 per cent. osmic acid. After 24 hours the material is washed overnight in a gauze-covered vessel, under a running tap. Transfer to 2 per cent. osmic acid, and keep at 30° to 35° C. for from 3 to 7 days, 4 days usually being enough. Wash in running water for several hours, transfer to 30 per cent. alcohol, upgrade and embed in wax. Cut sections thinly and mount unstained. The Golgi bodies are black discs, while the cell and nucleus are a more or less uniform yellow colour. As a control one may add to the pieces of plant tissue, fragments of mollusc ovotestis (in which Golgi bodies can be seen *intra vitam*), the intestinal tracts of centipedes, and pieces of dorsal root ganglion, or guinea-pig testis (in which Golgi bodies have been stained *intra vitam* by Subba Rau and Brambell (*Jour. R. Micr. Soc.*, 1925, p. 438)).

Thus in one operation it is possible to show Golgi bodies in a protozoon (Coccidium or Adelea, in the gut wall of the centipede), in an insect (gut cells), in a mammal, and in plant cells. The fragments, which must be small (⅛ inch in diameter), can all be carried through together, and cut in the same wax block.

Careful details of techniques suitable for plant tissues will be found in the last-mentioned of Bowen's papers: *Science*, vol. 64; *Anat. Record*, vol. 34, 1926; *Biol. Bull.*, vol. 53, 1927; *Zeit. f. Zellf. u. mikr. Anat.*, vi. Band 6, Heft 5, 1928.

J. BRONTË GATENBY.

Trinity College, Dublin,
April 16.

Milk Pasteurisation and the Tubercle Bacillus.

MY attention has been directed to a paragraph in NATURE of Mar. 31, p. 513, referring to my recent research into the effect of pasteurisation on the bovine tubercle bacillus in naturally infected tuberculous milk. The note concludes with the words "we still seem to lack experimental information of the efficiency of a *commercial* pasteurising plant for destroying the tubercle bacillus in naturally infected milk."

While this statement is correct, I feel that it needs some amplification. In the laboratory experiments it was possible to maintain a constant temperature of 145° F., which in the commercial process is almost an impossibility—the temperature usually fluctuating from 1° to 5° F., which fluctuation usually tends towards the lower temperatures in an effort to use the minimum temperature in order to conserve the cream line of the milk. In addition to this tendency to subject the milk to the minimum temperature, there is the further possibility of mechanical defects in commercial plants—defects that were shown to be present in certain machines that were tested in connexion with an American investigation in 1924, the results of which are published in the *United States Public Health Bulletin, No. 147.*

In view of these facts, I think it is fair to assume that laboratory experiments may be taken as applicable only to perfect commercial pasteurisation, and that given perfect commercial pasteurisation at 145° F. for 30 minutes, we are still forced to the conclusion that this combination of time and temperature does not invariably kill the tubercle bacillus.

LEONARD J. MEANWELL.

The National Institute for Research
in Dairying,
Shinfield, Nr. Reading,
April 2.

World Weather.[1]

By Sir GILBERT WALKER, C.S.I., F.R.S.

THE data recognised as necessary for the forecasting of weather come from a region that is ever widening. Before telegraphic charts were prepared the local observatory had to suffice; but the daily maps now used in predicting the weather of a single country of Europe may cover several thousand miles from west to east. Further, the desirability of warnings of the famines that have devastated semi-tropical and tropical countries has led to thinking in terms of seasons rather than days, and it soon became clear that seasonal variations over much of the earth are related to a surprising extent.

The first fact emerged in 1878 when Hoffmeyer pointed out the association between pressure in the North Atlantic and weather in Europe; and he was shortly followed by Blanford in India and by a group of continental meteorologists, including Teisserenc de Bort, Hann, Meinardus, and Pettersson. The far-reaching character of the subject was first visualised by Hildebrandsson, who in 1897 published the pressure data for ten years of 68 stations scattered over the world, and directed attention to certain relations between them as indicated by plotted curves. But in this and in his later papers the graphic methods used, and the shortness of the series of data available, generally prevented him from reaching final conclusions. In 1902 the Lockyers confirmed his discovery of the 'see-saw' of pressure in the Argentine and in India or Australia, and, still using purely graphical methods, they made it the basis of a classification of pressures over the world according as they oscillated with India or with Cordoba.

Since then, work on the Continent has been chiefly occupied with conditions in northern latitudes, and the more general problem has been mainly studied in connexion with Indian monsoon forecasting. For this purpose it was necessary to have quantitative information as to relationships, not merely visual impressions from plotted curves, and to work with seasonal, not annual, values. Also there was no hope of unravelling the tangled threads of causes and effects unless help was got by finding cases in which the conditions in one place were related with those in another in a subsequent season. Statistical methods were therefore indicated, and these efforts have culminated in the production of tables of relationships between conditions of pressure, temperature, rain, or river-flood at 32 centres scattered over the world. For each of these the correlation coefficient has been worked out for each quarter with those of contemporary quarters of the other stations, and also with those of one quarter before and after, and with those of two quarters before and after.

The total number of coefficients worked out is considerable, but simplification of the process has reduced the time spent on each to one or two minutes; also, by confining attention to those figures which are larger than the biggest that chance can be expected to produce, the number of significant figures is reduced to 396, and these fall very consistently into the scheme of oscillations indicated below.

The main conclusion reached is that there are three big swayings or surgings:

(a) The North Atlantic oscillation of pressure between the Azores or Vienna on one hand and Iceland or Greenland on the other;

(b) The North Pacific oscillation between the high-pressure belt and the winter depression near the Aleutian Islands: and

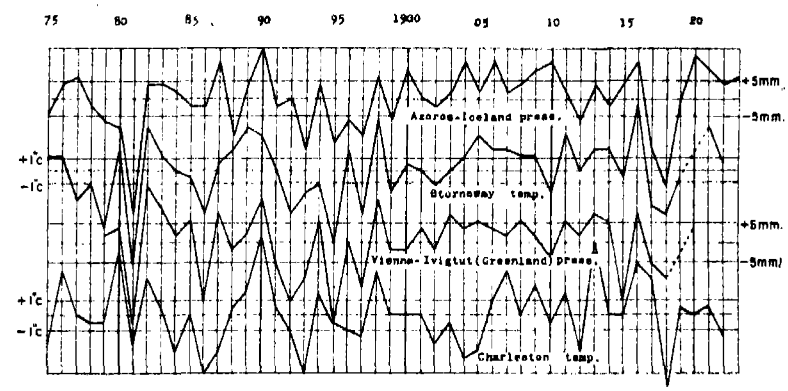

FIG. 1.—The North Atlantic oscillation.

(c) The southern oscillation mainly between the South Pacific and the land areas round the Indian Ocean.

Regarding (a), it is well established that a strengthening of the pressure gradients and of the ocean winds (indicated in Fig. 1 by the pressure differences Azores—Iceland and Vienna—Greenland) is associated with a strengthening of the Gulf Stream and higher temperatures in northern Europe (e.g. Stornoway in Fig. 1) and along the east coast of the United States (e.g. Charleston). The diagram shows the variations of these quantities in successive Januaries from 1875 for nearly fifty years, and the relationships are closer than is generally realised, the correlation coefficient (or degree of association) between the second and third curves being 0·88. Increased circulation goes also with higher temperature in Siberia and Java and less monsoon rainfall in India.

The North Pacific oscillation is rather like that of the North Atlantic, strengthening of the winter pressure differences and winds being associated with higher winter temperatures in central and

[1] This article contains the substance of a recent presidential address to the Royal Meteorological Society.

western Canada, and increased rain in the North Pacific coast states.

The southern oscillation is more far-reaching than the two oscillations just described, and as the effect of an abnormal season is propagated slowly, it may not appear at the other side of the earth until after an interval of six months or more. In illustration we may see in Fig. 2 in the topmost curve the variations of the Nile floods of July to October in successive years from 1889 to 1925; they are, however, reversed, so that a dip below the normal line like that of 1916 means a high Nile. The next curve shows the variations of temperature at Samoa in the following summer, December to February, and the correspondence is obvious, the coefficient between the departures being 0·72. The third curve is that of Samoa temperature during the succeeding autumn, March to May, which brings out the great persistence of the ocean temperatures. Following this we have the pressure at Port Darwin in North Australia for September to November, six months before the third curve, yet with so close a correspondence that the coefficient between them is 0·80. Lastly, we have the pressure at Zanzibar of December to February three months later, and so three months after the third curve, with which its coefficient is 0·72.

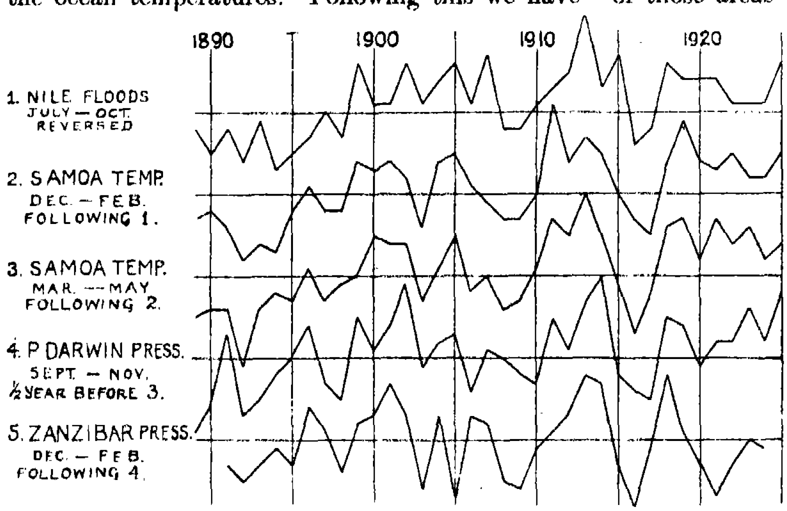

FIG. 2.—The southern oscillation.

The general character of the southern oscillation may be inferred from the statement that in the season June to August the first group of stations, *i.e.* that oscillating with pressure in the Pacific, is most clearly represented by pressure at Honolulu, Samoa, the Argentine, and Chile, by India monsoon rainfall and by the Nile floods; and the second group, tending to have departures of the sign opposite to those of the first, is represented by Port Darwin pressure, and by temperature at Batavia and Samoa. During the season December to February the most representative stations are materially different. In the first group there are only Samoa pressure and rainfall at Java; and in the second, pressure at Honolulu, Zanzibar, North-West India, Port Darwin, and the Cape, with the temperatures of central North America, Batavia, and Samoa.

The first question that arises is that of the mechanism that binds together the southern oscillation; we have seen that the North Atlantic and North Pacific oscillations implied variations in the strength of the air circulation in those areas, and there is a presumption that a similar interpretation is applicable here. Now where there are areas of low pressure and areas of high pressure in the same latitude, the former are in general relatively warm and the latter relatively cool; so that in winter, seas have low pressure and in summer high; and for land the opposite obtains. Thus the low pressures of Iceland and the Aleutian Islands are much more developed in winter than in summer, and the high-pressure belts in the Atlantic and Pacific in summer than in winter. Accordingly, in the southern oscillation the first group consists of those areas the pressure of which will increase with increased temperature contrasts or increased circulation; thus, in the Pacific, Honolulu is in the first group in summer when the high-pressure area is more marked, and in the second group in winter when the reverse obtains; similarly, the Argentine and Chile as land areas are only in the high-pressure group in winter. Also Samoa as a high-pressure centre at times of increased circulation is much more marked in summer than in winter; and the Cape is only in the second group in its summer when pressure is relatively low.

This explanation is not complete, however, for Northern Australia is almost as strong in the second group in its winter as in its summer. Further, at times of increased circulation, when we should expect solar radiations to be stronger, temperatures are markedly lower except in higher latitudes. But here we are reminded of the old paradox, that at times of sunspot maxima, when there is a definite though small general increase of rainfall owing presumably to increased circulation, temperature is decidedly lower in the tropics and generally lower in the middle latitudes; and, going further, if we compare the relationships of sunspots with pressure, temperature, and rainfall, we find a remarkably close resemblance with those of the southern oscillation, extending in many cases into the detail. Thus if we consider our description of the southern oscillation in terms of representative centres, there were, in the season June to August, 5 centres in the first group and 3 in the second, while from December to February the numbers were 2 and 8; and without an exception we find the variations of centres of the first group associated positively with those of sunspots and those of the second group negatively, even when the members of the group change between summer and winter.

This correspondence would be explained if the southern oscillation were an effect of sunspots; but this hypothesis is untenable as the relationships between factors in the southern oscillation are much closer than those between the factors and sunspots. It seems too speculative to postulate some solar influence which should closely control terrestrial conditions and yet have but a small influence on the sunspot numbers. So we are led to the view that the southern oscillation merely expresses a natural oscillation or system of surges in the general circulation, and that, for example, the fall of temperature in the tropics is, on physical grounds, associated with an accentuation of low pressure in the Indian Ocean. If this is granted, we suppose that an increase in the number of sunspots or of solar radiation will increase slightly the general circulation and so bring about the observed relationships with sunspot numbers.

The belief held by Hildebrandsson in 1910 was that, in the tropical and temperate regions, circumstances were too regular to afford an explanation, and it must lie in the ice conditions of the polar seas; he believed also that in the southern hemisphere types of season were propagated eastwards like waves, the character of the pressure at the Cape during its summer appearing at Mauritius in the next winter, in Java and Australia the succeeding summer, and finally in South America six months later, or eighteen months after its original appearance at the Cape. This generalisation was founded on inadequate materials, and the feature which stood out most prominently in the first set of relations worked out in India was that while winter pressures in the Argentine and Chile were not controlled by any centre in the southern oscillation six months before, they controlled conditions six months later round the Indian Ocean, appearing as a reversed pressure wave which took six months to reach the Cape. It seemed therefore as if South America was the origin of the variations.

At first it appeared that a modification of Hildebrandsson's hypothesis would solve the problem. For, owing to the shape of the Antarctic continent, it would seem inevitable that the ice which flows in a westerly direction along the coast would be thrown off northwards into the Drake Strait by the projection of Graham Land, so that it would then flow north-eastward and eastward in the currents of the 'roaring forties.' The few data forthcoming from that neighbourhood indicated that a winter of low pressure in Chile was a winter of much ice at the South Orkneys, and as this would take some months to produce an area of chilled ocean and therefore of high pressure at the Cape, it seemed as if we might hope to understand how a period of low winter pressure in South America could produce a period of high summer pressure at the Cape. But subsequent examination showed that although low winter temperature at the South Orkneys produced low temperature at the Cape a year later, the coefficient between the two temperatures being +0·56, the effect six months later was small; and, apart from this, the explanation would break down because the effect of Cape temperature on Cape pressure proves on calculation to be negligible.

Unfortunately, it is easier to reject this hypothesis than to replace it. If we count in the tables the number of significant relationships, we find that pressure at Port Darwin has no less than 76 with other places, of which 32 are with subsequent seasons; next in importance come temperatures at Batavia and Samoa, each with about 60 relationships, of which only 13 are with subsequent seasons; and then come the pressures of North-West India and Samoa with smaller numbers. So pressure in the neighbourhood of Port Darwin seems to exercise more control over other regions than any other world factor, and its influence seems to be increased by Batavia temperature, which varies in close sympathy. Temperature at Samoa, the oscillations of which closely resemble those of Batavia temperature, is an equally important world centre, but belongs to the second group, while Samoa pressure belongs to the first group and has not more than half its influence. On the whole, then, although certain pressures appear to come earlier than any temperatures in the sequence of cause and effect, it is clear that ocean temperatures play a most important part in world weather. Their effectiveness may be due in part to their extreme persistence, so that successive seasons produce cumulative instead of antagonistic results.

Although it may be some time before we learn the processes by which Nature effects these enormous oscillations, and the relationships found must in general be regarded as empirical, there is no reason why they should not be utilised when possible for administrative or commercial purposes such as seasonal forecasting. Thus methods of predicting the general character of the winter and spring temperatures of a large part of northern Europe have been known for twenty years, and much additional knowledge has been won in recent researches by Brooks, Exner, Wiese, and others. The facts of the southern oscillation have been systematically utilised in predicting the rice crops of Japan, and the Java rainfall; and the recent tables have been shown by Bliss to have an immediate application to the Nile, the final relationship for forecasting being 0·72. The latest purpose to which they have been directed is in connexion with Ceara, a state in north-east Brazil liable to terrible droughts, and, as rainfall there belongs to the second group in the southern oscillation, a formula with a coefficient of 0·82 follows at once, the effect being shown in Fig. 3.

It must be admitted that a certain amount of scepticism over these matters is of great value as an antidote to rashness; for it is obvious that if we examine short series of data of pressure, temperature, and rainfall of hundreds of stations chosen at random, and look for similarities of conditions separated by all intervals of time up to five years, the laws of chance will provide one or two promising results. But, on the other hand, it is impossible to deny the validity of conclusions

based on close relations over an adequate number of years, such as forty or fifty, and this view is confirmed by actual experience. For in 1908, in my early years in India, I published an admittedly imperfect formula for predicting the monsoon based on about 34 years of data; and its reliability can

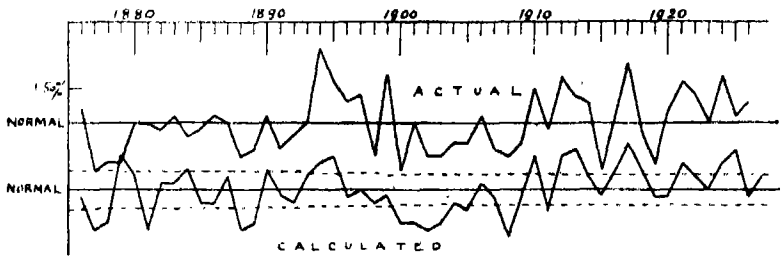

FIG. 3.—Forecast on Dec. 1 of Ceara rainfall, January–June.

be definitely estimated by comparing the indications that would have been given by it if employed during the past 19 years with the actual rainfall. Now the coefficient expressing the closeness of fit between the results of the formula and past data in 1908 was 0·58, and I should have been satisfied under the conditions if the indications of the past 19 years had a closeness of fit of 0·48 instead of 0·58; actually, however, as will be seen from Fig. 4, the foundations of the relationship have proved sound and the coefficient has worked out as 0·56; so it may be claimed that our present improved formulæ based on 50 or 55 years instead of 35 years are worthy of confidence if used with due caution. It is in my view essential that forecasts should only be issued when the indications are well marked, and if during the past 19 years a prediction had only been made in the 11 years when an excess or deficit of one inch or more had been indicated, the character of the season's rainfall, expressed merely as 'in excess' or 'in defect,' would have been correctly given 9 times (Fig. 4).

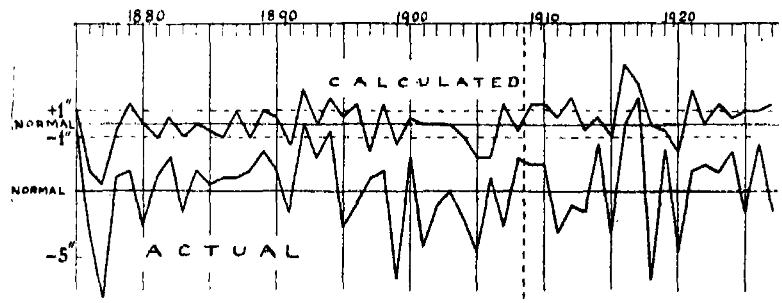

FIG. 4.—Forecast on June 1 of Indian monsoon, June–September. (1908 Formula, R = 0·58.)

Since 1908 many new relationships have been ascertained, and the present formulæ for North-West India and for the Peninsula have coefficients of 0·76 instead of 0·58. Also, there is no reason whatever for thinking that finality has been reached; for with the seasonal changes in India are associated very big changes in the strength of the upper currents; and it is an obvious hypothesis that when the change in the upper currents takes place with unusual vigour the seasonal rainfall will be abundant. The pilot-balloon observations hitherto made strongly support this hypothesis, and what appears to hold in India very probably holds over a far wider region. Moreover, the idea that upper-air conditions are vital to the study of world weather derives support from the table of relationships with the Nile. The significant relationships with other stations for its single season number 31, while the greatest number for a single season at any other centre is 24; and as the corresponding number for pressure at Cairo is only 8, it seems likely that this effect of the Abyssinian rainfall is brought about by the agency of the upper air, not by surface conditions. Similarly, the monsoon rainfall of India has eight significant relationships elsewhere, but June to August pressure in North-West India only one.

It is to be hoped, therefore, that the tables of the *Réseau Mondial*, to which statistical workers have been enormously indebted in the past, will in future contain monthly means of air motion at fixed heights above such observatories as can provide the data.

Recent Earthquakes in Bulgaria and Greece.

By Dr. CHARLES DAVISON.

WITHIN the last year, destructive earthquakes have occurred in Palestine, the Crimea, Smyrna, and Asia Minor, and, so lately as Mar. 27, in north-eastern Italy. They have been followed, during the latter half of April, by a series of equally violent shocks in the south-east of Europe. Indeed, the close succession of earthquakes—and, since April 15, scarcely a day has passed without news of fresh shocks—has given rise to the impression that earthquakes have of late been more frequent than usual. There is nothing to support the impression beyond the clustering of shocks within a limited area. Assigning roughly the intensity according to Milne's scale for destructive shocks, it would seem that, in the first four months of this year, there have been one earthquake of intensity III (strong enough to destroy towns and devastate wide regions), perhaps two of intensity II (capable of shattering many buildings and overthrowing some), and two of intermediate strength. In each of ten years during the latter half of the nineteenth century there

have, during the first four months, been from three to five earthquakes of intensity III, and in each of thirteen years from three to nine earthquakes of intensity II.

The earthquakes of April 14 and 18 are described as the most violent ever felt in Bulgaria, and this is not improbable. There is a centre of some importance near Plovdiv (Philippopolis), and there are a few minor centres to the south of the Balkans, but, in the area first struck, earthquakes are exceedingly rare, if not unknown. The earthquake of April 14 occurred at about 11 A.M., and it is to this no doubt that we owe the small death-roll. The area of damage is about 70 miles long from east to west (Harmanli to Plovdiv) and 25 miles wide. The epicentre lies near Chirpan, probably a few miles to the south and close to Borisovgrade, which is almost entirely destroyed. The second great earthquake came on April 18 at 9.24 P.M., again at a time when most of the inhabitants were able to escape from the falling houses. The shock was distinctly stronger than the first and the area of damage was somewhat larger. Near Papazli, the distortion of the ground is evident; ground-levels have been changed in some places by so much as six feet, whether by crushing of the surface soil or by distortion of the underlying crust is as yet unknown. In both earthquakes the wide extent of the area of damage seems to point to a considerable depth of focus.

By far the most interesting feature of the Bulgarian earthquakes is the great and rapid oscillation of the focus. The epicentre of the earthquake of April 18 was close to Papazli, about half-way between Chirpan and Plovdiv and 10 miles to the west of the first epicentre. On the evening of April 19 it was displaced to Haskovo, 30 miles to the east of Papazli; two days later, on April 21, it had retraced its steps about 60 miles to the west, to near Golemokonare; on April 23, back 36 miles to the east, to Stara Zagora, a few miles north of Chirpan; and, lastly, on April 26, it continued its easterly march, by 24 miles farther, to the neighbourhood of Harmanli.

According to the official reports, only 103 persons were killed and 700 wounded by these earthquakes, while the total loss of property is estimated at 3¾ million pounds. In Plovdiv alone, more than five thousand houses have been damaged and two-thirds of the town rendered uninhabitable.

Very different from the Bulgarian earthquakes were those felt at and near Corinth on April 22 and following days. In the first place, they visited one of the most seismically active countries in the world. Area for area, there are more than three times as many earthquakes, weak and strong, in Greece as in Japan, and more than thirty times as many as in Italy. Or, counting only shocks of the very highest intensity, there are more than four times as many as in Italy, and nearly seven times as many as in Japan. Again, in this active country, the isthmus of Corinth is one of the most active regions, being exceeded, according to Montessus, only by the Ionian Islands to the west of Greece and, though very slightly, by the island of Eubœa to the east. In the third place, the area of destruction is small. It includes Corinth itself, in which many of the houses are damaged, the small adjoining towns of Kalamaki and Loutraki, and some of the coast villages to the west of Corinth. At the most, it may be about 10 miles in diameter, for it appears that Isthmia, four miles to the east, escaped injury during the first shock. The small area of damage, and the high intensity near its centre, combine in pointing to a shallow-seated focus. Lastly, though the foci of the after-shocks were not stationary, the limits of migration were small. On April 25 there seems to have been a slight shift to the east, most of the houses in Isthmia being destroyed.

So far as our present information goes, the Corinthian earthquakes were less important than those in Bulgaria, and owed their destructive power chiefly to the proximity of the origin to the surface.

The Voronoff Operation in Stock-breeding.

THE claims made by Dr. Voronoff and others concerning the economic value of his method of reactivation in the field of practical livestock breeding have attracted so much public interest that it was considered desirable that an authoritative report should be prepared for the information of the Ministry of Agriculture and for the Board of Agriculture for Scotland. Delegates from Great Britain, with representatives of several other countries, recently visited Algeria to witness the operation of testis-grafting in animals of agricultural importance, to examine certain animals which already had been subjected to this technique, and to examine and to report upon the claims that have been made concerning the economic value of its application. Their report has now been issued.[1]

The Voronoff operation has been employed in the case of the senile male whose own testes have become insufficient in their physiological activity, and of the sexually immature male whose testes have not yet profoundly affected the developing characterisation of the individual. It is claimed that in the first case the old, decrepit and infecund male becomes reactivated, his reproductive powers becoming restored; and that in the second, growth and general vigour are stimulated to a fuller expression as evidenced by the attainment of a larger body size and a greater sexual potency. It is also claimed that these characters are, in part at least, transmitted to the offspring. The delegates were shown a bull which had been rejuvenated, and a number of sheep in which the operation had been performed upon the sexually immature male.

The conclusions at which the delegates arrived were as follows: The claim of Dr. Voronoff to effect rejuvenation of the aged and decrepit animal

[1] Ministry of Agriculture and Fisheries: Board of Agriculture for Scotland. Report on Dr. Serge Voronoff's Experiments on the Improvement of Livestock. By Dr. F. H. A. Marshall, Dr. F. A. E. Crew, Dr. A. Walton, and Wm. C. Miller. Pp. 24. (London: H.M. Stationery Office, 1928.) 9d. net.

by the operation of testis-grafting is possibly justified, but the evidence presented has not been based upon critical experimentation. The delegates were not satisfied that this method, even if and when its merits have been fully demonstrated, can become of any great importance in a country such as Great Britain. The claim of Dr. Voronoff to increase the body weight and the wool-clip of the ram by the operation of testis-grafting applied to immature male, was supported by the data submitted and by the appearance of the sheep that were seen, but the conditions under which the experiments had been conducted, the inadequacy of the data submitted, and the method of the presentation of these data, made the forming of a critical opinion quite impossible. For the same reason, it was impossible to accept the evidence, which seemed to show that the improvements thus invoked were transmitted by the ordinary processes of reproduction. There is great need for repetition of these experiments with standardised material under controlled conditions of husbandry.

Obituary.

Sir David Ferrier, F.R.S.

THE death of Sir David Ferrier in London on Mar. 19 removes from the roll of living neurologists a veteran pioneer, eminent in example and in service. He had reached his eighty-sixth year, and his life meant for those at work to-day a personal tie with a historic past which he conspicuously had helped to make significant.

Ferrier, as student in Aberdeen, his native city, had been a pupil of mark under the psychologist and philosopher Alexander Bain, and had graduated at the University with high honours. He had then entered upon medicine at the University of Edinburgh. The study of the nervous system attracted him early; and a gold medal was awarded to his M.D. thesis, "On the Corpora Quadrigemina." Later, in the reports of the West Riding Lunatic Asylum, where a centre of neurological research had arisen under Dr. (now Sir James) Crichton-Browne, Ferrier issued his first paper of experiments on the brain of some of the higher mammals. Hughlings-Jackson's observations upon localised discharging fits were being discussed in 1868; the famous "Study of Convulsions" followed from him in 1869. The experiments of Ferrier had for an object the "testing of the theory of Hughlings-Jackson that localised and unilateral epilepsies are caused by irritative or 'discharging' lesions of the grey matter of the hemispheres."

Ferrier's extension of these experiments to types of brain nearer the human was encouraged by the Royal Society with a grant in aid supplying the material for the work. Ferrier was able to establish that in the ape's brain, a considerable area of the surface sheet is excitable by faradism. Localised movements in the face and limbs, of the crossed side, were evoked with such definition and precision that "the experimenter can predict with certainty the result of stimulation of a given region." Ferrier described a 'motor region' stretching across the lateral aspect and thence over and upon the median aspect of the hemisphere. He pointed out that its extent was greater and its character more detailed in the ape than in any of the types less near to man. He then turned to determine the effects of localised destruction of portions of the cerebral surface. These experiments formed the main theme of a second Croonian Lecture following his earlier of 1874. He directed attention to the hemiplegic symptoms ensuent on injury of the motor region in the ape, symptoms in several respects indistinguishable from human symptoms familiar in the clinic. It is related by Sir Charles Ballance that at the International Congress of Medicine in London in 1881, on the appearance of one of the monkeys shown by Ferrier, Charcot of Paris, the physician, exclaimed, "It is a patient!"

Outside and beyond the region of cerebral surface which he termed 'motor,' Ferrier described further certain other regions which conversely he termed 'sensory.' He distinguished separate sensory fields severally related to the several special senses. Individual destruction of these entailed, he concluded, specific sensory defects and disturbances. His lectures upon all this work were followed in 1876 by a memorable volume, "The Functions of the Brain." The book reached beyond medical circles to a wide scientific public. It was translated into various languages. It and the work it embodied exerted decisive influence toward placing cerebral localisation in the forefront of movement in the physiology and medicine, and indeed in some respects in the psychology, of its time.

If we would seek to trace the origins of Ferrier's inquiry and the great and lasting effect it produced, we must pay regard to some contemporary circumstances. Current scientific opinion, both physiological and medical, had held that the cerebrum—'organ of mind' and mind a unity—revealed in its functioning no spatial differences. Further, current teaching had been that the cerebrum, unlike the spinal cord, remained in all appearance irresponsive to such stimuli, electrical and what not, as physiological experiment had resort to. There had, however, arisen recently the views of Hughlings-Jackson, based on clinical observation of epileptoid convulsions. Contrary to orthodoxy of the time, he taught the existence of motor centres situated in the grey matter of certain of the cerebral convolutions, namely, "the convolutions surrounding the corpus striatum." This teaching Ferrier's paper mentions as an impetus to, and its testing as an immediate object of, his first experiments. Ferrier's inquiry was also made in the light of observations obtained by Fritsch and Hitzig three years before, on the brain of the dog, with closing and opening of a galvanic current as stimulus. On that mode of stimulation the method adopted by Ferrier constituted an important advance. It enabled deliberate and sustained movement to be evoked and without

damage to the cerebral tissue; it allowed elicitation and study of the 'march' (that is, the spreading) of movement which Jackson had noted to be of diagnostic value in the epileptoid convulsion; it brought the clonus characteristic of epilepsy under observation as a feature of cerebral 'after-discharge.' Ferrier's method of stimulation has been followed by all observers since.

A conception which Ferrier formed regarding the localisation of function in the cortex held it to be primarily 'sensori-motor.' He conceived this region which yielded, in such systematic order, purpose-like actions of limb, etc., to represent so to say a motor executive; and he distinguished outside it, in contradistinction to it, fields which he regarded as sensory inasmuch as he read them to be dominantly connected each with a special sense. In short, 'motor' and 'sensory' were the fundamental categories underlying the scheme of localisation in the cerebral cortex in his pioneer interpretation of it. Not 'motor' and 'sensory' of course with the crudity of the efferent and afferent sides of a simple reflex arc; but yet distinguishably 'motor' and 'sensory.' The problem thus entered upon has exhibited during the succeeding fifty years continual increase of complexity at every renewal of attack. None the less, in intrinsic conformity with Ferrier's original point of view regarding the 'motor region,' we have to-day the experience of so versed and highly qualified an observer as Dr. Gordon Holmes, to the effect that "the precentral gyrus [the motor region proper] has no sensory functions." In addition, Ferrier's scheme, which assigned the major part of the cerebral surface to specific sensory fields, can stand as a prototype of that which comparative anatomy and cytoarchitecture have step by step since then substantiated. Also, the modern finding of Pavloff and his school arrives no less at a functional scheme which, even more than did Ferrier's original, allocates the cerebral surface to territories representing the several specific receptor-systems, with exclusion and negation altogether of 'pure association' fields.

The interpretation of observations regarding cortical functions forms an arena which has seemed to invite conflict. Ferrier arrived at a conception with the fundamental simplicity of which there corresponds, very probably, a fundamental truth. As regards animal mind, analytic psychology has not yet reached the elements needed in application to the problem. Be that as it may, a tribute which was quickly paid to Ferrier's work was that subsequent investigation of the nervous system, whether by adherents or by opponents of his views, for many years did little else than search for 'localisation' of something. A tide of localisation flowed with subversion of other interests. A 'localisation' era followed on Ferrier's work. The vogue became, as time went by, tedious, and in many respects infertile; but the importance of the work which ushered it in can never be forgotten.

It is difficult now to think back to a functional neurology which resigned itself to picturing the cerebral cortex as an uncharted sea, an unknown uniformity. With Ferrier's experiments that state of things came to its term. There followed consequences theoretical and practical. One beneficent practical result was that the symptoms of certain brain tumours, etc., viewed in the light of his 'localisations' in the ape, allowed the physician to locate the seat of mischief within the skull and so sometimes enabled relief of the patient by surgery. An element of irony attaches to the fact that as a consequence of his experiments Ferrier was prosecuted by anti-vivisectionists. The charge against him fell unfounded.

If this brief notice has occupied itself chiefly with one outstanding achievement in the earlier career of a long and active life, that must not convey the impression that the subsequent years had not also their rich yield of labour given and worthy contributions made. It was as a lover of knowledge that Ferrier pursued knowledge. He had a share in many undertakings to foster and advance it. He was of those who at a meeting in London in the spring of 1876 founded the Physiological Society; the Society elected him to its honorary membership in January of last year. On the title-page of the *Journal of Physiology* his name has stood as a collaborator for thirty-four years continuously. He was one of the small band who in 1878 launched *Brain*. He was a founder of the Neurological Society in 1886; its president in 1894. His zeal and interest in neurology, and indeed other science, never staled. When he no longer himself carried on experimental research it afforded him pleasure to watch others experimenting. His talk possessed a certain penetrative piquancy partly veiled in simplicity; it had a knack of getting to bottom. In literature he enjoyed dipping within the ancient classics. He was of artistic taste, in pictures as in other matters. The sea and the sea-coast were his favourite setting for a holiday. Numerous honours came to him. He was elected F.R.S. in 1876, and he received from the Royal Society a Royal medal in 1890. He was a laureate in Paris in 1878. His knighthood was conferred in 1911. C. S. S.

MISS J. E. HARRISON.

WE regret to record the death of Miss Jane Ellen Harrison, which took place in London on April 16, at the age of seventy-seven years. She was born in East Yorkshire on Sept. 9, 1850. At an early age she showed a special aptitude for languages, which she maintained until the end of her life. Before she entered Cheltenham Ladies' College at the age of fifteen, she had already acquired a knowledge of Latin, Greek, German, and Hebrew; while after she had attained the age of seventy, she made herself acquainted with the elements of Persian.

Miss Harrison entered Newnham in 1874 and, it was stated privately, was at the head of the Second Class in the Classical Tripos in 1879. She returned to Newnham as a fellow in 1900. On the termination of her college course she took up

the study of Greek art and literature, publishing her first book on the story of the Odyssey in 1882, her object being to elucidate the Homeric myths in the light of Greek art, especially as exemplified in the art of vase and gem. Other books on art and on the topography of Attica and primitive Athens followed; but as might have been expected from the bent of a mind which, tradition has it, would have preferred the Moral Sciences to the Classical Tripos, she found herself more and more absorbed in the study of Greek religion as time went on.

In her "Prolegomena to the Study of Greek Religion" (1903), and her admirable "Ancient Art and Ritual," Miss Harrison showed that she had given herself over to the study of Greek religion on comparative lines under the influence of Frazer and of Ridgeway's methods of utilising the customs and culture of primitive peoples in dealing with the problems of Greek archæology. Not, indeed, that she was attracted to the study of primitive custom as such, for she expressed herself as repelled by much of the material through which she had to wade. She always succeeded in keeping herself fully abreast of the literature and of the latest developments in theory in anthropology and psychology, and it is interesting to follow the development of her thought in her later books, "Themis" (1912) and "Epilegomena to the Study of Greek Religion" (1921), as she came successively under the influence of the French sociological school—Durkheim and Levy-Bruhl in particular—of Bergson, and later of Jung and Freud. Her last book, "Reminiscences of a Student's Life," appeared in 1925.

Even though Miss Harrison may have been apt to generalise too hastily and prone to allow herself to be dominated by a theory as if it were always of universal application, she was a pioneer in her field, and in the study of Greek religion her work will hold a permanent place.

WE regret to announce the following deaths:

Sir William Church, Bart., president of the Royal College of Physicians from 1899 until 1905, and a trusted leader of the medical profession in Great Britain, on April 27, aged ninety years.

Mr. A. J. Jenkinson, O.B.E., tutor, librarian, and senior dean of Brasenose College, Oxford, known for his work on philosophy and economics, on April 19, as the result of an accident, aged fifty years.

Prof. Theodore W. Richards, For. Mem. R.S., professor of chemistry at Harvard University since 1901 and director of the Gibbs' Memorial Laboratory since 1912, a distinguished authority on atomic weights, on April 2, aged sixty years.

Mr. F. W. Shurlock, formerly Principal of the Derby Technical College, on April 19.

Mrs. Sollas, wife of Prof. W. J. Sollas, and widow of Prof. H. N. Moseley, Linacre professor of human and comparative anatomy, Oxford, whose son, H. G. J. Moseley, the brilliant young physicist, was killed at Gallipoli in 1915, on April 28.

News and Views.

THE fifteenth International Geological Congress meets at Pretoria on July 29, 1929. As the British Association for the Advancement of Science is visiting South Africa at the same time, and has secured a large contribution from Government, professional people and the mining houses have raised a substantial sum privately as a guarantee for the Congress; the local committee is therefore able to offer subsidies towards the expenses of visiting members, as well as a reduction of from 35-50 per cent. in the railway fares. Negotiations are in progress with the shipping companies for similar concessions, the results of which will be announced later. So heavy have been the calls on the community in South Africa that an urgent appeal is issued to everyone who can, to apply for membership of the Congress, addressed to the General Secretary, Post Office Box 391, Pretoria, South Africa. The membership fee is one pound. The main discussions at the meeting will be on magmatic differentiation, pre-Pleistocene glaciation, and the genesis of petroleum, but the most attractive feature will be the excursions, which have been arranged so as to cover all the classic areas. At Cape Town will be seen the intrusions of granite into slate, described by Basil Hall in 1813, which were used by Dr. Hutton in illustration of his theory. North of this are the folded mountains, bringing down the Devonian beds, with fossils of an American type. On the margin of the Karroo occurs the Permian glacial deposit, the Dwyka Conglomerate, which will be seen in its full development. Later excursions will enable the members to see the Lower Cretaceous at Uitenhage, and the enormously fossiliferous Cretaceous rocks of Zululand. In the Transvaal, the Bushveld Laccolite dominates the stratigraphy, with its margin of basic rocks containing platinum. Three subsidiary structures are of special interest, the Pretoria soda caldera, the Pilandsberg, and the Vredefort granite mass.

ECONOMIC geologists attending the International Geological Congress will have an opportunity, very rarely given nowadays, of seeing the full working of the Kimberley mines, and of comparing them with the Premier Diamond Mine. In Johannesburg the surface and underground workings of a mine in the central area and on the Far East Rand will be shown, while a comparison of the Rand section with that of Pretoria with the iron deposits will be demonstrated. In Rhodesia the Great Norite Dyke is of interest, but the Victoria Falls, with the vast chasm of the Batoka Gorge, will be the greatest attraction. All the mineral deposits, chrome, asbestos, and the various gold ores will be seen in specially favourable circumstances. Applications for these excursions must be received before April 1, 1929. The meetings will be held in Pretoria on July 29–Aug. 7, but the excursions will extend from July 16 until Aug. 24, beginning and ending at Cape Town. The secretary of the Geological Society of South Africa appeals at the same time for additional members. He points out that the publications of the Society are indispensable to anyone interested in the geology of Southern Africa and the

mineral resources of that territory. The Society is dependent for its annual revenue upon subscriptions to defray the heavy cost of printing, and many who make use of, and derive benefit from the transactions, do not belong to the Society. The address is Post Office Box 1071, Johannesburg, South Africa.

IN our issue of Jan. 21 (p. 110) reference was made to the offer by the Premier of Queensland to the Commonwealth Council for Scientific and Industrial Research of an area of about 25,000 acres of land at Saltern Creek, in the middle of the State, to be used as a central scientific station for investigations into problems of the sheep industry. It was mentioned also that the Land Settlement Advisory Board had expressed a hope that the offer would be accepted in whole or in part. As a matter of fact, the offer had been declined at the time the Board reported. The Council was convinced that it could not justify the stocking and equipping of a big research station on the proffered area. Nor was it impressed by the suggestion that it might run the station in part as a commercial undertaking and recoup itself in that way for a part of the expense.

To laymen, the refusal of the Saltern Creek area seemed rather puzzling. The land is excellent sheep country for Northern Australia, carrying one sheep to 2½ acres. Its rental value is about 8d. per acre per annum, and the period of leasehold, offered free of charge, was thirty years. At first sight the offer appeared tempting, but further investigation convinced the Council that its acceptance would be very unwise. Just because the land is so good it is unsuitable for certain major lines of work. Thus, there are no parasitological diseases there at present, and it would be sheer folly to introduce them. The blowfly pest is prevalent, but so it is over vast areas in the Commonwealth, and work aiming at control can be carried out far more satisfactorily in more readily accessible places in New South Wales nearer to the Council's central entomological laboratories. For work on artificial feeding of sheep (which is generally quite unnecessary in this region) an area of poorer country would be more useful. Investigation of natural grasses best suited for wool production could be carried on there, but such investigations are needed all over Australia, and the Council hopes that pastoralists themselves will provide the necessary facilities in a great number of much smaller areas. Work on mineral deficiencies in pastures is already in hand in several places where it is urgently required. Saltern Creek has no special claim for immediate attention. The Queensland Government was disappointed at the refusal, but the scientific grounds upon which the Council based its decision have not been seriously challenged.

THE Reports of the Zoological Society of London for the year 1927 tell of progress and prosperity which must be very gratifying to those responsible for the conduct of this great concern, and are a reward of fresh adventures in methods of exhibition, as well as an indication of the increasing interest taken by the populace in living animals. The number of fellows has mounted to 7687, and it is suggested that some mode of limitation and an increased annual subscription may have to be considered in the near future. The number of visitors to the Gardens in Regent's Park reached a record of 2,158,208, and to the Aquarium, 458,936; the surplus of income over expenditure was £16,859, in spite of the fact that more than £57,000 spent on new exhibition houses, which might well have been reckoned a capital charge, was paid from revenue. A hint of the part the Garden plays in encouraging the holiday spirit is contained in the item of more than £3000 drawn from elephant rides and the like. The difficulty of acclimatising animals is still apparent in the high death-rate within six months of arrival, but the steady reduction during the past three years in the percentage of deaths is very satisfactory, and the management is to be congratulated on the astounding improvement in pulmonary conditions, the mortality having been reduced by more than 50 per cent. since 1925. It would be interesting, and of value to other zoological gardens in Great Britain and abroad, to know whether this improvement can be ascribed to the new installations which have been described in former reports, to special feeding and a rise in tone and resistance, or to generally more healthy conditions of ventilation and isolation.

THE Zoological Society does not neglect the scientific opportunities which its unique collections afford: a new anatomist has been appointed, a panel of parasitologists, formed by the staffs of the Institute of Agricultural Parasitology and the London School of Hygiene and Tropical Medicine, has undertaken this important branch of research, and the biological investigations of the newly elected Aquarium Research Fellow should prove of scientific interest and practical value. During the year the scientific *Proceedings* absorbed £2760, and the preparation and printing of volume 63 of the *Zoological Record*, a sum of £1928. It is regrettable that, in spite of the donations received towards the publication of this invaluable guide to zoological literature, volume 63 alone should involve a loss of £1042, and societies, institutions, and individuals who wish the *Zoological Record* to be maintained, are requested to give their support in the form of annual donations to the "Record Fund."

THE frequency and sites of cancer in persons of different habits and following different occupations has from the first thrown important light on the conditions which lead up to the disease, and careful analysis of occupational statistics will be a fruitful line of further advance. One of the earliest associations to be recognised was cancer of the scrotum and chimney sweeping: with the change in the methods and personal cleanliness of chimney sweeps, their special liability of this form of cancer has disappeared. Most curiously, however, it has been replaced by the appearance of the same cancer in cotton operatives, which is variously attributed by those who have studied the matter in Lancashire either to the lubricating

oil used on the machines or to ill-fitting overalls which the decencies of industrial life have introduced. That there was some connexion with the products of the distillation of coal and shale had been proved or suspected on clinical grounds before Yamagiwa and Ichikawa showed that by patience and persistence the carcinogenic activity of any substance could be satisfactorily explored experimentally by applying it to the skin of mice repeatedly over long periods of time.

BY experimental work of this sort it has been shown that tar and soot have a unique efficacy in producing cancer, which is no doubt why the industrial labourer is so much more liable to the disease than his agricultural brother. By this method, too, it is possible to analyse the injurious action of the various lubricating oils which are used on factory machines. Dr. Leitch has done this already, and has found that shale oil is far the most harmful, illustrating the thorough clinical demonstration of its association with cancer in the Scottish oil field which was given by Dr. Scott. The particular field of mule-spinners' cancer has again been explored by Dr. Ç. C. Twort and Mr. H. R. Ing, working for the Manchester committee on cancer (*Lancet*, vol. i. 1928, p. 752). Applying each of 12 oils twice a week to 100 mice for periods up to 18 months, they find that sperm oil is harmless, natural petroleum oils are slightly carcinogenic (especially their higher boiling-point fractions), and shale oils are highly efficacious and act like a weak tar. Harmless oils do not become injurious by passage through the machines, and the carcinogenic action of shale oil may be removed by extraction with sulphuric acid and possibly other methods. If, then, mule-spinner's cancer is due to the lubricating oil, it seems likely that it should be possible to get rid of it.

AT the centenary of the Cockerill Works at Seraing in October last, the King of Belgium pointed out the necessity for honouring science throughout the country, since pure science is the indispensable condition for applied science, and neglect of it leads to decadence. As a result of this speech, a meeting of authorities interested in university education was held in Brussels in November to consider how best to encourage scientific work. Since then two pamphlets dealing with the subject have appeared, "La détresse de l'enseignement supérieur en Belgique," by L. C., and "Notre misére scientifique," by Q. M. Quaeris and others. The second of these traces the present paucity of intellectual effort in the country to the smallness of the Government vote for higher education, which is 5 francs per annum per head of the population, that is, less than in South American or in the Balkan States. The pay of university professors is in consequence small, and it is not possible to attract the best men to university posts. The method of selection is such as to attach less weight to a candidate's intellectual powers than to his political friendships. A particular case is cited at great length. The success of the recently established "Fonds national de la Recherche scientifique" is regarded as a sign that the country appreciates the position and is determined to improve it.

THE problem of the safe use of coal-mining explosives was dealt with by Dr. W. Payman in a paper read before the Midland Institute of Mining Engineers on April 17. He regards the production of a flameless and therefore completely safe explosive as an improbability. In practice, the explosive must be safe in spite of its flame. Safety resulting from a reduction of flame temperature is gained only at the expense of the efficiency of the explosive. Care in shot-firing would probably lead to safety more than any other obvious means, for no explosion would occur if contact of flame and explosive mixture did not occur. It is, however, desirable to improve, if possible, the composition of explosives. Considering the stringency of the official test of explosives, it is often puzzling to account for actual ignition of gas in the mine. If, however, the test were made so rigorous as to cover every possible combination of circumstances, its operation would probably exclude the use of explosives underground altogether. After contemplating the large hot flame resulting from firing a 'permitted' explosive, it is perhaps more astonishing that ignition of the fire-damp–air mixture does not always occur in the official test. Dr. Payman outlined the programme of the Safety in Mines Research Station at Buxton, which necessarily involves the analysis of explosion phenomena and the ignition of gas mixtures. His lecture was illustrated with photographs of flames produced under various conditions.

SOME further details of Capt. G. H. Wilkins' polar flight were published in the *Times* at the end of last week. From Point Barrow to about lat. 75° N., the pack-ice was heavy and rough, with a few east and west leads of open water, decreasing in number towards the north. In lat. 73° N. there was some evidence of obstruction preventing a drift to the eastward, but no land was sighted. From lat. 75° to 77° N. there was much young ice, making good landing places, but farther north the pack again became ragged. Between 78° and 80° N. the flight was over clouds. Then it was clear again to 84° N., and there was no sign of Crocker Land. The pack-ice again was rough. North of Grant Land there were clouds, but north of Greenland the visibility was good and the ice was young and relatively smooth. From Greenland to Spitsbergen the flight was across much open water. Capt. Wilkins was tempted to descend north of Greenland, but held on in spite of bad weather. If he had descended he could have fallen back on foot on Etah or the Royal Canadian Police post in Ellesmere Island. He explains that a descent to take a sounding on the earlier stretches of his flight, where soundings would have been valuable, was impossible on account of the heavy load of his machine and consequent difficulty of ascending again.

HIS MAJESTY THE KING has approved the award by the Royal Geographical Society of the Royal Medals as follows: *Founder's Medal* to Dr. T. G. Longstaff, for his discovery of the Siachen Glacier and long-continued geographical work in the Himalaya; *Patron's Medal* to Captain G. H. Wilkins, for his many years' systematic work in Polar regions, culminating

in his remarkable flight from Point Barrow to Spitsbergen. The Council has made the following rewards: *Murchison Grant* to Captain C. J. Morris, for his recent journey in Hunza; *Back Grant* to Mr. George Binney, for his journey across North-east Land and his successful conduct of the Oxford Expeditions to Spitsbergen; *Cuthbert Peek Grant* to Mr. H. G. Watkins, in recognition of his leadership of the Cambridge Expedition to Edge Island and to assist him in his proposed expedition to Labrador; *Gill Memorial* to Mr. C. P. Skrine, for his exploration of the Qungur area and his work on Chinese Central Asia.

A CORRESPONDENT has written pointing out an apparent discrepancy between a note entitled "The Cosmic Rays" in our issue of Mar. 24, p. 477, on Prof. Millikan and Dr. Cameron's work on cosmic rays, and a remark made by Dr. J. H. Jeans in the supplement to the same issue of NATURE. The note refers to the "progressive hardening of the [cosmic] rays in their passage through the air," while Dr. Jeans (p. 468) says: "There are many ways known to physics of softening radiation, but none of hardening it." It should be remembered, however, that Prof. Millikan and Dr. Jeans were discussing two different effects. The radiation with which Prof. Millikan is concerned is heterogeneous. During its passage through the air—or other absorbing media—the components of greater wave-length (the 'softer') are removed by absorption at a proportionately greater rate than those of shorter wave-length (the 'harder'). The result is that the fraction of the latter in the radiation increases as the rays pass through the air, which can be expressed in Prof. Millikan's own words, as ". . . a definite hardening of the cosmic rays . . . between 13 and 23 meters (of water) beneath the surface of the atmosphere" (*Physical Review*, February 1928, p. 170). Dr. Jeans, on the contrary, is referring implicitly to homogeneous radiation or individual quanta, for which any such effect as that considered by Prof. Millikan is out of the question. Homogeneous radiation can only be 'softened,' as, for example, by the type of scattering studied by Prof. A. H. Compton and Prof. Debye.

MAJOR P. H. G. POWELL-COTTON has recently presented to the Department of Zoology of the British Museum (Natural History) a selection from the collection of mammals shot by him in the Cameroons and Lake Chad district. The specimens are of great scientific importance, as they include the co-types of several new forms, including a new kudu. This animal is smaller than the eastern kudu and has smaller horns; its discovery extends the range of the species many hundreds of miles in a westerly direction. There are also some fine specimens of the western giraffe (*Giraffa camelopardalis peralta*) and of the Congo race of Lord Derby's eland (*Taurotragus derbianus congolanus*). The collection is one of the most important additions to the study series of Ungulates and Primates that has been received by the Museum in recent years. Another important gift to the Department comprises the greater part of the scientific collections of the late Mr J. J. Lister, presented by Mrs Lister, including 700 microscopic preparations of Foraminifera, together with a series of notebooks relating to them. The Department of Entomology of the Museum has received the Eustace Ralph Bankes collection of British Lepidoptera, presented by Mrs Grace Bankes, which includes many of the tiny moths of the families Tortricidæ and Tineidæ, among which are several type specimens. From Mr Arthur Lea, entomologist to the South Australian Museum, there have been received some remarkable cocoons, many of them larger than a fowl's egg; they are the abandoned cocoons of beetles, which have become filled with sand and afterwards solidified by the infiltration of lime in solution. A very fine example of the fossil fish *Lepidotus elvensis* (Blainville), from the Upper Lias of Holzmaden, Würtemberg, measuring 2½ ft. in total length, has been purchased for the Department of Geology.

ACCORDING to a *Daily Science News Bulletin*, issued by Science Service of Washington, some concern is being expressed on the present condition of the giant sequoia trees in the Yosemite National Park, California. Dr. E. P. Meinecke, of the U.S. Forest Service, states that they are suffering from the trampling of the thousands of tourists, which has in part destroyed the fine root endings. Some five and twenty years ago, 'Grizzly Giant,' one of the finest of the big trees, was similarly threatened, but by loosening the soil, and placing additional soil to a depth of 3-4 ft. around the tree, the veteran has regained its vigour.

THE issue for March of *The World's Health* (vol. 9, No. 3) contains an article by Dr. Roeschmann on the new German law against venereal disease, which was approved by the Reichsrat last year. Coercive measures are dispensed with as much as possible. A sufferer is required to submit to treatment by a qualified doctor, whose duty it is to make his patient fully conversant with the nature and dangers of the disease. So long as the patient follows his doctor's orders, he is not notified to the health authorities or molested in any way. If he fails to do so, the national insurance agencies first summon him to report for treatment. If this summons is neglected, a report is made to the health authorities, who then direct the patient to submit to treatment. If this should fail, coercive measures may be taken, involving compulsory treatment. The law contains special provisions for the protection of new-born infants and wet nurses, and a complete reform of the regulation of prostitution.

THE Department of Terrestrial Magnetism of the Carnegie Institution of Washington has a total staff of nearly sixty, of whom more than twenty are trained scientific workers. The *Annual Report* of the Director for the year 1926–27 indicates that the chief recent activities of this important body of investigators have been varied, but largely consisted of the reduction and preparation for publication of former observations made by the Department, and of numerous special researches of a non-routine character; no great

programme of surveying on land or at sea was in progress, though the non-magnetic ship *Carnegie* was being prepared for a new three-year cruise. The principal observing work of the Department consisted in the maintenance of two magnetic and electric observatories at Watheroo, Australia, and Huancayo, Peru. Among the special researches were included investigations into atomic physics, correlations between magnetic variations and the transmissibility of radio signals, and soil-resistivity surveys in Australia and at Ebro in Spain.

From the Bulletin of Information with regard to Professional Courses in Optometry at Columbia University, New York, in 1928–29, it appears that in the United States and in Canada opticians are required to pass through an extensive course of training before they receive a licence to practise. Before entering on the prescribed course of professional training, candidates are required to have attended an accredited high school for four years and to have been awarded a qualifying certificate. After attending courses on optometry for several years, and gaining the Certificate of Graduation, a candidate is eligible to take the licence examination. After 1930 a candidate must have spent four years in professional study, and must have graduated either B.A. or B.Sc. before he is eligible. At Columbia University the work is done in the physics building under the direction of Prof. P. C. Southall. University fees amount to £60 per annum, and board and lodging to £150 per annum as an average. The courses are open to men and women on the same terms.

The eighty-first annual meeting of the Palæontographical Society was held in the rooms of the Geological Society, Burlington House, on April 20, Dr. F. A. Bather, vice-president, in the chair. The annual report recorded the publication of further instalments of the Monographs of Gault Ammonites, Macrurous Crustacea, and Palæozoic Asterozoa, and the beginning of a new Monograph of Dendroid Graptolites by Dr. O. M. B. Bulman. It also announced the preparation of a Monograph of the Irish Deer by Prof. S. H. Reynolds, and of the Corallian Lamellibranchia by Mr. W. J. Arkell. The Council especially regretted the resignation of Mr. E. T. Newton from the office of president, and expressed its deep appreciation of his valuable services since his election in 1921. Dr. W. D. Lang, Mr. W. E. F. Macmillan, Mr. R. W. Pocock, and Mr. W. P. D. Stebbing were elected new members of Council. Dr. F. A. Bather was elected president, and Dr. F. L. Kitchin new vice-president. Mr. Robert S. Herries and Sir A. Smith Woodward were re-elected treasurer and secretary respectively.

At the meeting of the Illuminating Engineering Society on April 24, a discussion on "Daylight, Artificial Light, and Artificial Daylight" was opened by Mr. J. S. Dow. In the first section of his paper Mr. Dow directed attention to the chief respects in which daylight differed from artificial light, pointing out that natural lighting in most buildings is far from ideal. It was suggested that in general, owing to the eye being adapted to the bright sky overhead, somewhat higher illuminations are required by natural than by artificial light. The difficulty of working in a mixture of natural and artificial light was also analysed, the author suggesting that one of the chief causes of the feeling of discomfort is the progressive diminution in daylight intensity during the twilight period. It was pointed out that in many buildings, especially offices in congested areas, artificial light has to be frequently used to supplement daylight. There is therefore some reason to advocate the adoption of a form of 'modified artificial daylight,' that is, lamps so screened that the light is visually a match for daylight, provided the absorption of light occasioned is not too high. The Council Room of the Chartered Institute of Secretaries was mentioned as an interior in which this method has been followed with happy results. Mr. Dow also touched on the debatable question whether light resembling average daylight in colour is more favourable to acuteness of vision than uncorrected artificial light. Detail illuminated by red light is most distinct when viewed at a distance, whereas for very close vision the reverse is often the case. The effect is apparently associated with the chromatic aberration of the eye, and it is probable that this explains to a great extent why some people find reading by daylight easier than by artificial light of similar intensity.

The first conversazione this year of the Royal Society will be held on Thursday, May 17, at 8.30 P.M.

Sir James Walker will deliver the Arrhenius Memorial Lecture of the Chemical Society on Thursday, May 10, at 5.30 P.M., in the theatre of the Royal Institution. With regard to ordinary scientific meetings, it has been decided to hold the May and June meetings of the Society at 5.30 P.M. instead of 8 P.M.

The British Aquarists' Association will hold its third annual exhibition at Trinity Hall, Great Portland Street, W.C.1, on July 24–28. The exhibition will be of an international character, intending participants including exhibitors from Germany, Holland, America, Italy, and Japan.

Major Walter Elliot will give a Chadwick Public Lecture on "Sunlight—Natural and Manufactured—and its Use in Modern Medicine," at the house of the British Medical Association on May 15 at 8.15 P.M. He will review some recent research work and discuss the experience of certain local authorities.

A correspondent points out, with reference to the lately announced death of Lord Eversley, that before elevation to the peerage, and when known as Mr. G. J. Shaw Lefevre, he was elected (in 1899) a fellow of the Royal Society under the old statutory provision relating to the occasional inclusion of privy councillors. This was during the presidency of Lord Lister. Later, Lord Eversley withdrew from the Society.

The proceedings at the annual conference of the Institute of Quarrying at Blackpool, June 4-9, include

papers by Prof. P. G. H. Boswell, University of Liverpool, on "Silica—its Commercial Properties and Markets," and by Mr. W. J. Rees, University of Sheffield, on "Commercial Sands." Among other papers to be read are "Electric Traction as Applied to Quarries and Slate Mines," by Mr. M. I. Williams-Ellis; "Cutting Costs in Slate Quarries," by Mr. T. R. Druitt; and "Research," by Mr. Hadleigh S. Seaborne.

SIR THOMAS ARNOLD, professor of Arabic, University of London; Mr. W. R. Halliday, Principal of King's College, London; and Prof. A. G. Tansley, F.R.S., Sherardian professor of botany in the University of Oxford, have been elected members of the Athenæum Club under the provisions of Rule II. of the club, which empowers the annual election by the committee of a certain number of persons of distinguished eminence in science, literature, the arts, or for public services.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A fully experienced and capable designer at the Admiralty, intimately conversant with design and detail of small turbines and internal-combustion engines—The Secretary of the Admiralty (C.E.), Whitehall, S.W.1 (May 7). A warden of the Hostel for Men Students of Stranmillis Training College, Belfast—The Principal, Stranmillis Training College, Queen's University, Belfast (May 15). Lecturers in physics and botany respectively in the Durham Division of the University of Durham—The Head of the Department of Science, University of Durham, South Road, Durham (May 19). A professor of physiology in the University of Hong-Kong—The Chief Medical Officer, Ministry of Health, London, S.W.1 (May 21). A half-time assistant in the department of mathematics of the University College of Swansea—The Registrar, University College, Swansea (May 23). An Academic Secretary of the University of Wales—The Registrar, University of Wales, Cathays Park, Cardiff (June 8). A wheat chemist at the Wheat Research Institute, New Zealand—The High Commissioner for New Zealand, 415 Strand, W.C.2 (June 30). A lecturer in experimental psychology in the Queen's University of Belfast—The Secretary, Queen's University, Belfast (July 1). A professor of pathology in the Queen's University of Belfast—The Secretary, Queen's University, Belfast (July 16). A master to take entire charge of teaching and supervising chemistry and physics, with some mathematics, at the King Henry VIII. School, Coventry—The Headmaster, King Henry VIII. School, Coventry. A metallurgist (or engineer with metallurgical training) having a thorough knowledge of the theory, treatment, and application of alloy steels, and a technical assistant, each for the Mond Nickel Company, Ltd.—The Secretary, Research and Development Department, Mond Nickel Co., Ltd., Victoria Station House, S.W.1. A teacher for building subjects at the Derby Technical College—F. C. Smithard, Education Office, Derby. An assistant physiologist in the Clinical Laboratory of the Sheffield Royal Hospital—The Supt. and Secretary, Royal Hospital, Sheffield. An assistant, and junior assistants under the Directorate of Ballistics Research of the Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18.

Our Astronomical Column.

METEOR SHOWERS OF APRIL AND EARLY MAY.—Mr. W. F. Denning writes: "The April shower of Lyrids appears to have formed a display of minor importance this year. Mr. A. King watched from near Scunthorpe, Lincolnshire, on April 21, and recorded 12 Lyrids from a point $272° + 33\frac{1}{2}°$, and on April 22 he noted 5 meteors from $273° + 33°$. Bright meteors were observed on April 16 about $12^h\ 44^m$ P.M., on April 19, 12.21 P.M., and on April 21, 12.21 P.M. At Bristol, on April 19, an assistant of Mr. Denning's observed for 4 hours, but saw only 14 meteors, and on April 21 in $2\frac{1}{2}$ hours about 10 meteors were noted, the radiant being at $270° + 35°$ on April 19 and $273° + 34°$ on April 21. A brilliant Lyrid equal to Venus was seen at both places on April 21, and its real path will be computed.

"The Aquarid meteors of Halley's Comet are due on the mornings of May 2–7, but the moon will be near the full at the time. This need not, however, interfere materially with the display, for the meteors are often very bright and traverse considerable arcs. The shower apparently returns annually, but can only be witnessed in the couple of hours preceding sunrise, as the radiant is below the horizon in the earlier hours."

THE STRUCTURE OF THE GALACTIC SYSTEM.—An important paper by Dr. Seares on this subject appears in the current number of the *Astrophysical Journal* (vol. 67, p. 123). The problem is treated by statistical methods, based on assumptions concerning surface densities (expressed as logarithms of the number of stars of different apparent magnitude per square degree), and space densities, of stellar distribution.

The conclusions, which seem to satisfy all known peculiarities of stellar distribution, imply that our galactic system closely resembles the highly resolved spiral nebulæ such as M. 33; consisting of a central condensation and 'knots,' as well as scattered stars and diffuse nebulosity. The diameter of the system is 80,000 to 90,000 parsecs, and the central condensation is situated in longitude 325° at a distance of about 20,000 parsecs from the sun, though the effect of this condensation on the apparent surface density is masked by the dark nebulosity comprising the rift in the Milky Way. The sun is situated exactly in the galactic plane, except as defined by Cepheids, faint B-type stars, and other special objects.

There is also a smaller local cluster, forming an outlying aggregation or 'knot' of exceptional size and density, with a central condensation 100 parsecs from the sun. This is spheroidal in shape, 6000 to 8000 parsecs in diameter, with its centre in longitude 230° and 40 to 50 parsecs south of the galactic plane. The bright helium stars form a nucleus of this local cluster, which includes stars so faint as mag. 16 and has a dominating effect on the apparent stellar distribution, being responsible for three-quarters of the total space density near the sun, and one-half the mean density at distances of 700 parsecs in the galactic plane.

Research Items.

CANDLES AND LAMPS.—Mr. Walter Hough, in *Bulletin 141* of the United States National Museum, has described the collection of heating and lighting utensils in the Museum—a collection which was begun about forty years ago by bringing together specimens from the ethnological series and other material acquired by the Museum. It numbers at present about 1000 specimens. Mr. Hough's description of the collection is in reality a study of a very interesting and suggestive by-path of human invention, in which the significant element is that not only did it give scope to considerable inventive ingenuity, but also that ingenuity is still constantly being exercised. From observation of peoples of low culture to-day it is conjectured that the use of fire was primarily for light giving. The series epitomising the use of the candle begins with the firefly, and the burning of fat bodies of fishes or birds, and of faggots of resinous woods. Then follow torches consisting of rudely aggregated slivers of wood or sheets of bark, passing to torches made of wax or resin enclosed in palm leaf forming an exterior wick, torches of rope or cord soaked in wax or resin—the crude candle; and then formed candles, dipped candles, and moulded candles to the art candles of to-day. In the line of development the lamp comes at the stage when oils and fats come into use. Interesting examples of the natural torch are the bark of the Mexican candle tree (*Jacquinia pungens*), naturally so waxy that a small piece will give a good light, and, in another category, the stormy petrel of the Shetland islanders, who used to thrust a wick down the throat of the dead bird and applied a light. A wide-spread form of illuminating device is made from the candlenut (*Aleurites triloba*). Meats are strung on a strip of bamboo and the topmost lighted, when they burn to the bottom of the strip. This is generally in use among the Polynesians, and the Tule Indians of San Blas, Panama, use the palm nut in identical fashion.

STUDIES IN TROPICAL WASPS.—Bulletin 19, Entomological Series of the Experiment Station of the Hawaiian Sugar Planters' Association, contains a series of very interesting articles by Dr. F. X. Williams on the habits of tropical wasps. The importance of this group of insects to the sugar industry of the Hawaiian Islands is well illustrated in the species *Scolia manilæ*, which is now so valuable an agent in controlling the introduced Asiatic beetle (*Anomala orientalis*). The publication affords a striking example of the wise policy of the Planters' Association to encourage and foster the prosecution of fundamental research bearing upon all insects affecting, or likely to affect, the sugar and other industries of the Islands. Dr. Williams provides an admirable account of the part played by fig-wasps in the fertilisation of wild figs in the Philippines, which is of special interest in connexion with the recent introduction of such insects into Hawaii to ensure the maintenance of fig-trees in that territory. The greater part of the publication, however, is devoted to an account of the family Larridæ, and more especially of the Philippine species. At least ten species of the genus Larra are known to prey upon mole crickets, which in many parts of the world are agricultural pests of some importance: in the Hawaiian Islands the species *Gryllotalpa africana* frequently attracts notice by destroying newly planted sugar cane. A small experiment, attempting the introduction of *Larra guiana* Cam. from Brazil into the island of Oahu, is mentioned. Among other articles Dr. Williams has some interesting field observations on wasps which prey upon cockroaches, and others which attack the giant South American aviculariid spiders.

STAINING AND STRUCTURE IN MICROSCOPIC ANATOMY.—For his presidential address to the Royal Microscopical Society (*Jour. R. Micr. Soc.*, March 1928) Dr. J. A. Murray chose the subject of staining and structure, for discovery in microscopic anatomy has been closely bound up with advances in the technical manipulation of the material which formed the subject of investigation. Tissues were at first examined in their own watery fluids, and this method is still practised, in fact probably to a greater extent than ever before because of the enormous improvements in present-day optical methods. Then came the development of methods of fixation, hardening, staining, and mounting, which was briefly traced. The methods devised for producing thin sections not only accelerated discovery in all branches of microscopic anatomy, but also exercised a profound effect on every branch of microscopical manipulation, more especially on methods of staining and mounting. The most important advance in staining methods was the iron-alum hæmatoxylin of M. Heidenhain, the special advantages of which were considered. Dr. Murray instanced an application of this technique to the age-old microscopic problem of the nature and form of the markings on diatoms. Cleaned diatoms were immersed in a solution of gelatine for several days, and samples were then spread on slides, fixed in formol, stained with iron-alum hæmatoxylin and mounted in euparal. The markings on the diatoms were then seen as very dark lines and dots, and the appearances suggested that the characteristic markings are indentations on the inner surface of the frustule which are filled during life with protoplasmic processes. In conclusion, Dr. Murray said that it might appear inappropriate to many in the Society, so largely representative of the amateur element, that he should have devoted his address to a subject which mainly concerns the professional biologist. But the so-called professional microscopist must be in a very real sense an amateur if he would go far in the science. "If he has not the humble enthusiasm which is sustained by the pleasure in viewing microscopic images pushed to the limit of technical perfection in every way, the path of discovery in microscopic anatomy is not for him."

THE PENETRATION OF METHYLENE BLUE INTO LIVING CELLS.—Much use has recently been made by American physiologists of the alga Valonia, on account of the suitability of its large cells, for studies on the permeability of protoplasm. A single cell contains enough sap for the colorimetric and spectrophotometric examination of the contents. M. M. Brooks (*Proc. U.S. Nat. Acad. Sci.*, **13**, 821–23; 1927) has found that though the rate of penetration of the dye depends both upon temperature and the hydrogen ion concentration of the external medium, yet the concentration found in the sap when equilibrium has been attained is independent of the external hydrogen ion concentration. The methylene blue, moreover, penetrates as such, and it is not the lower homologue, trimethylthionine, that penetrates as Irwin thought. The latter is found in sap which has stood for some time after being expressed and arises from oxidation of methylene blue.

SEX CHROMOSOMES IN EMPETRUM.—*Empetrum nigrum* is a well-known Ericaceous plant found in Europe and circum-polar in its distribution, extend-

ing into the mountains of South America. A variety *hermaphroditum* has long been known, and is now recognised by Mr. O. Hagerup (*Dansk Botanisk Arkiv*, vol. 5, No. 2) as a separate species. He found it common in Greenland. It is also circum-polar, but in higher latitudes, being found in Newfoundland, Iceland, the Faroes, Scandinavia, Finland, Spitsbergen, and Siberia. It occurs also at high altitudes in the Alps, Vosges, and Auvergne. The species is stouter than *E. nigrum*, with shorter internodes, and the flowers are nearly always hermaphrodite, whereas in *E. nigrum*, which is the only form occurring in Denmark, the sexes are separate. Hagerup finds that the haploid number of chromosomes in *E. nigrum* is 13, and that there is an unequal *XY* pair of sex chromosomes. *E. hermaphroditum* is a tetraploid cell giant having 26 pairs of chromosomes. According to his account, there are two *XY* pairs; but they are arranged inversely on the heterotypic spindle, so that each pollen grain gets an *XY* pair. If the eggs also have an *XY* pair, the resulting plants might be expected to be hermaphrodite. This new sex chromosome situation is of much interest. It would appear that a tetraploid mutation has produced a form which is adapted to colder conditions and has acquired a balance of its double set of sex chromosomes, giving a stable bisexual species. It is possible that similar conditions may explain the peculiar behaviour of some of the polyploid willows.

SILURIAN CORALS.—Although much attention has been paid in recent years to the Rugose Corals of the Carboniferous and Devonian, but little work has been done on those of earlier formations. Revived interest is shown by the publication by R. Wedekind of a monograph on the Rugose Corals of Gotland (*Sveriges Geol. Undersök*, Ca, No. 19, 1927). He divides these corals into two sub-orders, the Streptelasmacea and the Cystiphyllacea, and describes several new genera. The stratigraphical significance of the coral faunas is discussed. The Lower Gotlandian is characterised by the occurrence together of the last of the Streptelasmacea and the first of the Cystiphyllacea, and the genera Dinophyllum and Chonophyllum are dominant at this stage. The Middle Gotlandian is dominated by the Cystiphyllacea, and there is no Streptelasmid except the long-lived Calostylis; this division of the Silurian is divided into three stages, each with its characteristic coral fauna. The Upper Gotlandian is distinguished by the Omphymatids, especially by the genus Omphyma. Other recently published papers on Silurian Rugose corals are: (1) Revision of the Rugose Corals described in Murchison's Silurian System, by W. D. Lang and S. Smith, *Quart. Jour. Geol. Soc.*, **83**, p. 448; 1927. (2) *Tryplasma rugosum*, by S. Smith and W. D. Lang, *Ann. Mag. Nat. Hist.*, **20**, p. 305; 1927. (3) Ptilophyllum and Rhysodes, by S. Smith and R. Tremberth, *ibid.*, p. 309. (4) Structure and Development of Stauria, by S. Smith and T. A. Ryder, *ibid.*, p. 337.

THE ST. LAWRENCE EARTHQUAKE OF FEB. 28, 1925.—This remarkable earthquake has already been noticed in these columns (vol. 116, pp. 56 and 948), and a detailed report on it by Mr. Ernest A. Hodgson, seismologist in the Dominion Observatory of Ottawa, has recently appeared in the *Transactions of the Royal Society of Canada* (vol. 21, pp. 145–52; 1927). The earthquake was felt strongly in eastern Canada and the New England States, and slightly as far as Virginia and the Mississippi, and even at Duluth, about 1200 miles from the origin. The disturbed area may thus have contained more than a million square miles. The damage caused by the shock was confined to a narrow belt, about 20 miles long, crossing the St. Lawrence near Rivière Ouelle (about 90 miles below Quebec), the epicentre (as determined by instrumental observations) being near the centre of this band, in lat. 47°·6 N., long. 70°·1 W. The earthquake was probably due to a sharp upward thrust on the north-east side of a fault traversing the band, coupled with a horizontal movement of the south-west side towards the north-east. The only line of levels in the district was one made in 1915 from Levis to Rivière du Loup. A series made in 1925 after the earthquake showed no displacements exceeding the order of the errors of observation, but, assuming that the Levis end of the line was undisturbed, it is worthy of notice that the differences to the east of St. Pacome and Rivière Ouelle were all in the same sense and upwards, while those to the west were in the opposite direction.

INCIPIENT IONISATION.—A process described by Prof. J. Franck in the *Zeitschrift für Physik* of Mar. 6 shows how it is possible for an electron to part with more energy than is needed to produce ionisation when it collides with an atom, without the actual formation of new charged particles. The electron which would be liberated normally is supposed to pass into one of the exterior quantum orbits which is usually vacant, and to emit in the form of radiation the excess energy that it could have carried away from this position to a point outside of the sphere of influence of the positive residue. Such radiation would be mainly in the infra-red, but arc lines would be emitted in the subsequent return to the normal state, and it is suggested by Prof. Franck that this explains why the intensity of the latter varies with the energy of the impacting particles in much the same way as the number of ions produced.

LARGE MERCURY ARC CONVERTERS.—For several purposes, notably in connexion with storage, railway, and tramway traction, direct current supply is better than alternating current supply. Hitherto machines for converting alternating current into direct current, called rotary converters, have been generally used. Now, however, judging from an article which appears in the March number of the *Brown Boveri Review*, the mercury arc rectifier, which twelve years ago was a modest piece of laboratory apparatus, has developed into a formidable rival of the rotary converter. Continuous research on the phenomena which accompany the working of the electric arc has enabled the difficulties in the way of designing large current rectifiers to be overcome. Now rectifiers having outputs so great as 16,000 amperes are made. It is claimed that all risks of 'back-fires' have been eliminated, and that this static converter, the depreciation of which is very small, surpasses all types of rotary converter. It is possible to convert alternating currents at the very highest pressures into direct current by its means. Continuous tests have been made on a rectifier having an output of 200 amperes at 16,000 volts. At present, however, there is no great demand for conversion at very high pressures. When speaking of the rating of a rectifier, the current for which it has been designed is understood, as by merely altering slightly the current input it can be used over a wide range of pressures. In the 16,000 ampere mercury arc rectifier with steel cylinder there are 24 anodes.

RAILWAY ELECTRIFICATION.—As it is highly probable that in the immediate future extensive developments of main line railway electrification will be made, it is necessary for traction engineers to study very carefully the working of the electric railways of all countries. Unfortunately, very different systems are in use, and the solutions which are successful in one

country may be quite unsuited for another. A paper by F. Lydall on the electrification of the Pietermaritzburg—Glencoe section of the South African railways was read to the Institution of Electrical Engineers on Mar. 29. It describes the electrification of 170 miles of narrow-gauge railway which runs through difficult country. Glencoe is approximately the centre of the Natal coalfields, and most of the traffic consists of coal consigned to Durban. As most of the line is single track and very powerful locomotives (3600 horse-power) had to be used, it was necessary to use a pressure of 3000 volts owing to the limited carrying capacity of the rails. The power station is close to Colenso and is about 60 miles from Glencoe. The river Tugela supplies the necessary cooling water. The station generates 3-phase 50-frequency current at 6600 volts. The power is then stepped up to 88,000 volts, at which pressure it is transmitted to 12 substations spaced about 15 miles apart. This distance is very short compared with the Chicago and St. Paul Railway, where the average spacing is about 35 miles, but it was chosen in view of the density of the traffic and the necessity of working to schedule speeds. All the substations are fully automatic, so that attendants are not required. As thunderstorms in Natal are frequent and severe, their effects on the overhead equipment caused some dislocation of the service during the first two summers. The lightning flash sometimes caused a spark over an insulator, and this started a 3000-volt arc. By the adoption of high-speed automatic circuit breakers, it was found that this arc was prevented from doing damage, and so it was unnecessary to use special lightning arresters.

Electric Furnaces in Metallurgy.—A pamphlet recently issued by the Birmingham Electric Furnaces, Ltd., is an indication of the rapid strides which are being taken in connexion with the application of electric heating in the metallurgical industries. Photographs of quite large, internally heated electric furnaces with automatic charging gear are shown which have recently been installed in Birmingham and, in simplicity of design and convenience of operation, would appear to be of high promise. A feature of particular interest is the type of door fitted in these units. This is, in general, both a source of loss and at the same time one of inconvenience to the workers. The patented design adopted in these furnaces swings outward with a parallel motion, so that the hot face is never presented to the operator. It is counterbalanced to facilitate movement and well lagged to minimise heat losses. By means of a door switch, the furnace is rendered electrically dead immediately the door is opened and any danger to workmen thus removed. The material used for its framework is nickel-chromium.

The Effect of Quenching and Tempering Non-ferrous Alloys.—Two papers read at the spring meeting of the Institute of Metals, by T. Matsuda and A. L. Norbury respectively, both deal with the effect of quenching and tempering on non-ferrous alloys, and in both papers it is shown that in certain cases it is possible to bring about a very considerable increase in the hardness and strength by tempering the quenched alloy at an appropriate temperature. For example, a brass containing 60·44 per cent. of copper, which when quenched at 800° C. has a Brinell hardness of just above 90, attains a hardness of about 125 when it is afterwards tempered at 300° C. There is corresponding increase in the tensile strength, very little change in the elongation or the Izod-value, but a very profound increase in the Stanton impact-number. In the quenched state this was about 3800; tempered at 300° C., it had risen to nearly 6000. Norbury, dealing with standard silver (92·5 per cent. silver, 7·5 per cent. copper), has shown that when quenched from 770° C., the alloy is about 30 per cent. softer and 20-30 per cent. more ductile than it is in the ordinary annealed condition. On tempering the quenched alloy for about half an hour at 300° C., its Brinell hardness is about trebled, the tensile strength being increased by about 50 per cent. At the same time, however, the ductility falls by about 50 per cent. The hardening obtainable by tempering is uniform throughout the sample, and is superior, therefore, to the similar hardening effected by cold-working operations, which set up internal stresses. It is possible to harden the quenched alloy by cold-working and then further harden it by suitable tempering. When in the quenched and tempered condition, the alloy is more resistant to oxidation and tarnishing than when it is in the annealed state.

The Purification and Atomic Weight of Erbium.—In the *Journal of the American Chemical Society* for February, A. E. Boss and B. S. Hopkins describe the preparation of pure erbium compounds from yttrium-erbium mixtures by fractional decomposition of the nitrates by fusion and by treatment with sodium nitrite. The ratio of erbium chloride to silver was determined, and the average of six analyses gave the value 167·64 for the atomic weight of erbium. This is in close agreement with the previously accepted value of Hofmann, namely, 167·68.

The Position of the Rare Earth Elements in the Periodic System.—The difficult problem of the position of the rare earth elements in Mendeléeff's system is discussed in an interesting paper by Prof. J. F. Spencer in the *Journal of the American Chemical Society* for February. Apart from scandium and yttrium, which can be easily accommodated in the periodic system, there is a series of fifteen elements, from atomic number 57 (lanthanum) to atomic number 71 (lutecium), between barium (56) and hafnium (72). Since these elements are basic and tervalent, they must be placed in the six places of the periodic system in Groups III and IV, Series 8, 9, and 10. They can be divided into two groups according to the ionic magnetic moments and the solubilities of their compounds, and Prof. Spencer discusses the distribution of the rare earths among the possible places, taking into consideration these characteristics, together with such chemical evidence as is available.

The Action of Active Nitrogen on Iodine Vapour.—In the *Proceedings of the Royal Society of Edinburgh*, vol. 48, Part 1, L. H. Easson and R. W. Armour describe a spectroscopic investigation of the effect of active nitrogen on iodine vapour. The authors support Willey's view that the glow of active nitrogen is due to the recombination of nitrogen atoms, while the complex band spectrum is due to nitrogen molecules in many different states of activation. A line at $185\mu\mu$, corresponding to an energy content of 6·7 volts (equivalent to 154,000 gm. cal.), was observed in the spectrum of iodine excited by active nitrogen. The shortest line previously known to be excited by active nitrogen was the iodine line at $206\mu\mu$ observed by Lord Rayleigh. In view of the very low pressures used during this work, it is considered that no chemical action took place, the iodine merely receiving and radiating energy. When the iodine pressure was about the same as that of the active nitrogen, the blue glow produced on mixing with iodine vapour was only visible as an instantaneous flash, the duration of which was found by the use of a kinematograph camera to be less than 1/100 sec.

The Steam Wells of California.

THE utilisation of the steam of the *soffioni* of Tuscany as a source of mechanical power has steadily developed since 1904 when the first pioneer experiments were carried out at Larderello by Prince Ginori Conti. The remarkable results which have since been achieved were described in NATURE of Jan. 14 last. Similar sources of geothermal energy were first tapped in California in 1921, and since then several deep wells have been successfully sunk, some of them being superior both in pressure and steam output to any yet reported from Italy. The active region is known as 'The Geysers,' and lies on the western side of the St. Helena Range, one of the coast ranges of California. Along a line some twenty-five miles in length, which appears to mark a fault or shatter belt, hot springs, some of which are associated with quicksilver deposits, occur at intervals. There are no actual geysers at 'The Geysers,' but over an area of thirty-five acres the ground is dotted with hot springs and fumaroles and salt patches, and steam and gases are constantly seeping through the surface. A thorough investigation of the locality has been made by Dr. E. T. Allen and Dr. A. L. Day, and the results, beautifully published by the Carnegie Institution of Washington,[1] add very materially to our knowledge of subterranean supplies of magmatic steam.

The hot springs mainly occur where the ground-water drainage would naturally be expected to emerge: they are clearly related to a thin zone of groundwater and show seasonal variation with the rainfall. Some of the waters are acid, and contain acid sulphates produced by the oxidation of sulphuretted hydrogen. Others have become alkaline through their prolonged action upon the superficial rocks, this leading to the production of neutral sulphates, and allowing the alkaline character of the bicarbonates in the water to make itself felt. The fumaroles, known as the Smokestack, the Safety Valve, and the Steamboat, and the steam vents, are unrelated to the topography; and neither these nor the artificial wells are affected by the weather. The exceptionally dry winter and spring of 1923–24 had no measurable influence on the steam flow, and all the evidence bearing on the origin of the steam points conclusively to a deep-seated magmatic source.

In all, eight wells had been sunk by June 1926, at depths gradually increasing from 200 to 650 feet. There is a marked temperature gradient, measurements revealing a rise of 130° to 165° C. within a depth of 500 feet from the surface. As at Larderello, and also at Katmai and Lassen National Park, the steam is supersaturated as it rises from the depths, but becomes saturated eventually after it has stood in a closed well for some time. "The opening of a well after the tools are removed presents an imposing spectacle. As the valve is opened steam and hot water rush violently out with a great roar, rising in successive leaps like a geyser and carrying a shower of sand and loose rocks which bombard the steel frame of the derrick with a rattle like a fire of musketry. The column quickly reaches its maximum height of 200 to 300 feet, and in a few moments much of the excess water and loose debris are cleared out, leaving a huge jet of intensely hot roaring steam rushing from the well at high velocity, the noise of which can be heard for several miles and which at close range is absolutely deafening." Considering that the pioneers of so dangerous an enterprise had no previous experience of the kind and were even unaware that similar projects had been carried out in Tuscany, it is remarkable that the first wells were completed without serious accident.

Gases accompany the steam, making up between 1 and 2 per cent. of the whole. Carbon dioxide is, as usual, the dominant gas, but hydrogen and methane are present to the unusual extent of about 15 per cent. each, and there are smaller quantities of sulphuretted hydrogen, nitrogen, and ammonia. This is a characteristically volcanic assemblage, and taken together with the meagre supply of meteoric water, and the enormous volume of high-pressure steam rising in a superheated condition, it points indubitably to a magmatic source. In general, it is found that the deeper the well the hotter the steam, but not uniformly from well to well, indicating that the rock is not equally pervious to steam in all directions. The steam probably rises through a fault zone of shattered rocks which interpose a resistance that is generally, but not everywhere, completely effective. Only so can the difference in activity in the different fumarole and hot spring localities along the St. Helena Range be explained.

Following along the lines justified by their earlier investigations, the authors direct attention to the profound significance of the occurrence of volcanic gases as "the one thread logically connecting all phases of igneous activity, the cause alike of the volcanic explosions with their imposing steam clouds, the rise of lava in craters, the intense surface temperatures in some volcanic eruptions, the formation of fumaroles with their various characteristics, and finally of the heat of hot-spring waters and of the distinctive features in hot-spring areas."

ARTHUR HOLMES.

[1] "Steam Wells and other Thermal Activity at 'The Geysers,' California." By E. T. Allen and A. L. Day. Carnegie Inst. of Washington, Pub. No. 378, 1927, pp. 106.

Movements of British Industry and Trade.

THE latest report of the Committee on Industry and Trade, entitled "Further Factors in Industrial and Commercial Efficiency," provides much useful information regarding the important and far-reaching changes which have recently taken place in the relative prosperity and the geographical distribution of British industries.

Between 1901 and 1911 the number of persons employed in the main export industries increased by 20 per cent., as compared with an increase of 12½ per cent. in the total occupied population. In the next decade (including the abnormal War period) the total occupied population grew by 5½ per cent., but the rate of increase in the great industries was 21 per cent. In particular, coal mining and the metal and engineering trades increased much faster than industry as a whole. In the earlier decade the increase can be accounted for by the normal development of overseas trade. In the later period expansion was mainly in the munition industries, so that after the War Great Britain was left with an unduly expanded group of 'hypertrophied' industries. Statistics based on returns relating to the number of insured workers show that from 1923 to 1927 the number of persons engaged in the insured trades increased by nearly 6 per cent. from about 11¼ millions to about 12 millions. This increase was, however, very unevenly distributed. Coal mining, iron and steel, general

engineering, shipbuilding and marine engineering, and the woollen and worsted trades accounted in the aggregate for a decline of 200,000 persons. The only important export industries to show substantial increases were the electrical trades (27 per cent.), the motor industry (21 per cent.), and artificial silk (48 per cent.), all comparatively new and progressive branches of production. Among non-export industries which have shown a high rate of expansion are the distributive trades (25 per cent.) and the building and furnishing trades (19 per cent.). That the old established exporting industries have not kept pace with other trades is borne out by statistics of unemployment. Between 1923 and 1927 the percentage of unemployment averaged 13·5 per cent. in the exporting group, and only 9·2 in other insured industries.

Geographical Redistribution.

The migration of industry from the northern to the southern counties of England is perhaps the most interesting development in post-War Britain. The tendency has been noted by a number of observers, but it does not seem to have received the attention which it deserves. The Committee on Trade and Industry points out that in July 1923 the insured persons were divided between the southern and northern sections of the country in the proportion 45·7 (south) to 54·3 (north). In 1927 the proportion in the south had increased to 47 and in the north had declined to 53. Still more striking figures are obtained when smaller areas are examined, as will be seen from the following table:

Percentage Increase, 1923–27, in the Number of Insured Persons.

London	7·29	Midlands	6·03	Wales	1·81
South-Eastern	15·83	North-Eastern	3·00	Scotland	1·38
South-Western	8·60	North-Western	3·73	N. Ireland	0·47

The figures for unemployment tell the same tale of greater economic activity in the south than in the north.

Percentage Unemployed (Mid-Year).

	Whole Country.	North.	South.
1923	11·3	13·1	10·2
1925	11·9	14·3	8·0
1927	8·8	12·6	6·7

Statistics show that certain industries, for example, stove, grate, pipe, and general iron founding, glue, soap, ink, match, and carpet manufacture, have expanded in the south but have declined in the north. Other trades, such as constructional engineering, bleaching, dyeing, furniture making, motor vehicle construction, silk, electrical engineering, etc., have increased more rapidly in the south than in the north. Even the steel industry has shifted southwards, Lincolnshire and the Midlands having increased their steel production by 700,000 tons, while on the east coast and in Scotland output declined 500,000 tons. The coke industry has tended to follow the movement of iron and steel, and the coke production of Durham has declined relatively to that of Yorkshire, and the industry has appeared in Lincolnshire.

The Committee considers that an important cause of the shift southwards has been the exhaustion of the northern ores, which in 1924 supplied only one-third of the national output as compared with one-half in 1913. In other industries, different, but no less potent, causes of migration have been at work, among which the Committee cites the greater freedom in the south from restraints due to hard-and-fast trade customs and the desire to obtain the full benefit from more economic organisation. Another probable cause which does not seem to have been directly considered by the Committee is the fact that local rates are generally lower in the south than in the north.

Further industrialisation of non-urban areas in the south of England will probably be stimulated by the development of electric power distribution and other forces, such as the development of road transport, making for de-centralisation. It would seem that now the process of concentration of industry in the north which commenced in the eighteenth century may be reversed, and a gradual though perhaps partial process of de-centralisation substituted.

Tobacco Culture.

TOBACCO is no exception to the rule that plants require phosphorus for growth, but it needs little compared with other crops. Under certain conditions, the growers may profitably take advantage of this property. Field tests have been carried out at Windsor, U.S.A. (Report for 1926 of the Connecticut Agricultural Experiment Station), on *old* tobacco land which has carried the same crop for a long period of years regularly manured with a complete fertiliser. On such land, no response to phosphorus treatment was obtained, neither the yield, quality, nor burning properties of the tobacco being affected by withholding the application. This is considered due to the fact that, as so little phosphorus is taken up by the crop, and only a small quantity removed by leaching, a surplus supply has been built up through the continued manurial treatment. Growers on this land can therefore effect considerable saving by omitting phosphate from their fertiliser mixtures for an indefinite number of years without incurring any risk, as the organic constituents of the manure applied are considered capable of supplying sufficient phosphorus to guard against depletion. However, on tobacco land where some rotation of crops is practised or on new fields, the same conditions do not obtain, and it would probably not be economic to omit the phosphatic dressings.

Experiments have also been carried out on the new Heber process of sweating tobacco recently developed in Germany. After the leaves are cured, a fermentation or sweating process is necessary before they are suitable for manufacture into cigars. The two methods in common use are the 'bulk' and 'case' processes. In the former, large piles of tobacco are allowed to heat up to 120° F., then shaken out and repiled, the process being repeated a number of times and requiring three to six weeks. In the 'case' method the tobacco is tightly packed in wooden cases and kept artificially heated at about 100° F. for six weeks or longer. The Heber process is applicable to either method, and consists in spraying the layers of tobacco, as the 'bulk' or 'case' is being made up, with a solution containing an 'active principle,' fermentation being by this means completed in eight days. In a control test where water was substituted for the solution, the tobacco was still very raw when the treated tobacco was completely fermented.

Besides the immense reduction in time and labour obtained by using this process, further advantages noticeable were that the leaves were lighter in colour and incurred less breakage and loss in weight. On other points, however, such as aroma and burning properties, no consistent differences were found between leaves sweated by the old or new processes.

University and Educational Intelligence.

ABERDEEN.—Lord Meston has been elected by the General Council to the Chancellorship of the University in succession to the late Duke of Richmond and Gordon.

CAMBRIDGE.—Honorary degrees are to be conferred upon Prof. A. Einstein, Prof. Cumont, Prof. W. A. Craigie, Lord Lugard, Lord Justice Scrutton, Sir Cecil Hurst, and Sir D. Y. Cameron.

The Linacre lecture is being delivered on May 5 by Sir George Newman, chief medical officer, Ministry of Health, on "Linacre's Influence on English Medicine."

Emmanuel College announces a scholarship of £120 a year for mathematics, founded by Mrs. Braithwaite Batty in memory of the late Rev. R. B. Batty, second wrangler in 1853 and a fellow of the College. Preference will be given to candidates who are sons of clergymen or of certain officers in His Majesty's Army or Navy.

The continued generosity of three anonymous benefactors to the University, who have increased their contributions to the building and upkeep of the extension of the Fitzwilliam Museum to £37,000, £37,000, and £26,000, is announced in a Grace by which the University expresses its thanks.

OXFORD.—The subject of the Halley Lecture to be delivered on Monday, June 18, at the University Museum, by Dr. Harlow Shapley, Director of the Harvard College Observatory, will be "A Search for the Centre of the Milky Way," instead of "The Extent and Structure of the Milky Way," as previously announced.

THE latest date for the receipt of applications for grants from the Thomas Smythe Hughes Fund for assisting medical research is June 15. They should be addressed to the Academic Registrar, University of London, South Kensington, S.W.7.

APPLICATIONS are invited by the Senate of the University of London for the Laura de Saliceto studentship for the advancement of cancer research, tenable for not less than two years and value £150 annually. Applications must reach the Academic Registrar, University of London, South Kensington, S.W.7, by July 1.

APPLICATIONS are invited by the Salters' Institute of Industrial Chemistry for a limited number of fellowships of the normal value of from £250 to £300 each. The fellowships are open to chemists of post-graduate standing who are desirous of adopting a career in industrial chemistry. The latest date for the receipt of applications by the Director of the Institute, Salters' Hall, St. Swithin's Lane, E.C.4, is June 1. Forms can be had upon request.

THE British Institute of Philosophical Studies has arranged a course of six lectures on "Mind in Nature," by Prof. C. Lloyd Morgan, which began on May 1 at 5.30 P.M., and will continue on succeeding Tuesdays. Prof. Clement C. J. Webb will deliver a course of four lectures on "The Philosophy of Religion" on Wednesdays at 5.45 P.M., beginning on May 23. Both courses are being given at the University of London Club, Gower Street, W.C. Particulars can be obtained from the Director of Studies, British Institute of Philosophical Studies, 88 Kingsway, London, W.C.2.

WE have received from the University of Leeds a copy of its report for 1926–27—one of the most eventful, the report says, in its history. Conspicuous among the events of the year are Sir Edward Brotherton's gift of £100,000 for the new library, the definite adoption of a design for the future University buildings (a bird's-eye view of which forms the frontispiece of the report), the completion of the University playing fields and of a new building for the Department of Agriculture, the acquisition of a house for the Department of Geology, and the institution of a chair of experimental pathology and cancer research. Progress was made with the building of additional hostel accommodation for women students and with the dental block of the medical school. Arrangements have been completed for beginning during the current year the first unit of the new University buildings—the mining block—and a new wing for the textiles section of the clothworkers' buildings. This new wing will provide increased accommodation for the Dyeing Department and will also be able to house the laboratories of the British Silk Research Association. A scheme has been elaborated for enabling graduate students to carry on research work for higher degrees in the laboratories of the British Research Association for the Woollen and Worsted Industries. Day students numbered 1366, of whom 80 per cent. belonged to Yorkshire, 12½ per cent. came from other parts of England, and 4½ per cent. from Egypt, India, and the Far East. There has been a small but continuous decrease in the number of full-time day students from 1922–23 (1559) to 1926–27 (1366). The staff list contains the names of a fair number of Leeds graduates, but many more who have taken degrees elsewhere, including graduates of every university of Great Britain and Ireland except Sheffield and Reading.

ANOTHER milestone on the road to educational progress was reached at Kingston-upon-Hull on Saturday, April 28, when Their Royal Highnesses the Duke and Duchess of York visited the city, and the Duke placed in position the foundation-stone of Hull's new University College. This has been possible through the generosity of the Right Hon. T. R. Ferens, who has given nearly £300,000 towards the scheme; the Hull Corporation, which has given £150,000 and an annual grant of £2500, as well as 18½ acres of land (originally a gift to the city by Mr. Ferens), and by several other generous gifts made by prominent citizens and firms of Hull. A list of the various donations was handed to the Duke by Principal Morgan. The building of the College is well advanced, and it is expected that part will be ready for occupation by October. The College is extending its site to close upon seventy acres, all within the residential area of the city, and a large house and estate has also recently been secured at Cottingham, a neighbouring village, for residential purposes. Most of the professors have been appointed. A circular route of six miles was planned for the Royal procession, thus enabling a crowd estimated at 200,000 to view it without overcrowding in any part. At the College the chairman of the Council, Archdeacon J. M. Lambert, gave an address, after which the Archbishop of York dedicated the stone. The Duke of York replied and placed the stone in position. The Duchess hoisted the College flag, which had been presented by the Hull Women's Co-operative Guilds. Among those present were the Lord Mayor and Sheriff of Hull, the mayors and principals of neighbouring towns and universities, local members of Parliament, Sir W. Henry Hadow, the Right Rev. Bishop Shine, Lord Deramore, and Prof. A. C. Seward.

Calendar of Customs and Festivals.

May.

ADDENDA.—It is perhaps more than a coincidence that the stories of a disproportionately large number of the saints whose days fall at the beginning of May are obscure or legendary. In Ireland they are perhaps more frequently associated with holy wells and, significantly enough in relation to the prominence of goddesses in Celtic religion, female saints, often known only by name, are numerous. The lives of these early saints frequently record contact with paganism in various forms. Serpent worship, for example, appears in the story of St. Philip (May 1), whose martyrdom was a consequence of his opposition to the idolatry of Hierapolis in Phrygia, and especially to the worship of a huge serpent of which he procured the death by his prayers. The life of St. Amator, Bishop of Auxerre (May 1, A.D. 418), records an interesting conflict with pagan observances in the story of Germanus, chief man of Auxerre, who used to hang up the heads of the wild boars and stags he killed as offerings to Woden on the branches of a large pear tree in the middle of the town, which Amator caused to be destroyed.

ST. MARCULF (May 1, A.D. 558), of Frank parentage, as his name (Forest Wolf) shows, is connected with the last ceremony of touching for the king's evil. The relics of the saint were preserved at Corbeny in the diocese of Laon, and the French kings, after their coronation at Rheims, used to make a pilgrimage to Laon, and, after touching the relics of Marculf, heal the king's evil. This was observed for the last time by Charles X. in 1825, at Rheims.

An annual ceremony still commemorates the death of St. Evermar and his companions, who were slain at a fountain while on a pilgrimage through Belgium (May 1, 700). In each year, on May 1, a procession takes place which is headed by two 'greenmen' representing savages, clothed in leaves and armed with clubs, followed by seven pilgrims, and then by Hako, the robber chief, and his men. After High Mass the murder is re-enacted, Hako shooting one of the pilgrims with a pistol as he runs away.

A saint who is more obviously connected with well-worship is St. Fumack (May 3), of uncertain date and unknown history, who is said to have bathed every morning in a well situated in what is now the manse garden at Botriphnie, then to have dressed himself in green tartans, and crawled round the parish bounds on his hands and knees. The image of the saint in wood was long preserved and became degraded into a local idol. In 1726, it was still washed on May 3 in the well with much formality by an old woman.

On two occasions in each year, of which April 30 or May 1 is the first, the dried blood of St. Januarius, the patron saint of Naples, is liquefied. In the morning a golden bust of the saint, and in the afternoon the blood in two phials, is carried in procession. In the evening, at about 7 o'clock, prayers begin in the Church of Santa Chiara and the liquefaction of the blood takes place after a longer or shorter interval, any unusual delay portending ill-fortune.

May 6.

ST. AVIA.—Of uncertain date, possibly beginning of third century A.D. After her death she is said to have appeared at Ploermel in the diocese of Vannes, Brittany, and to have touched a stone and a fountain. Thereafter infants were laid on the stone, which is hollowed in the centre, and dipped into the fountain to enable them to walk.

May 7.

ST. DOMITIAN OF MAESTRICHT (A.D. 560), according to a popular tradition, delivered the neighbourhood of Huy from an enormous serpent which infested the waters of a fountain with venom. He is invoked against fever, and on May 7 his shrine is borne in procession around Huy and to the fountain where he slew the serpent, while all the fever patients of the town follow in their shirts and carrying candles.

ST. STANISLAUS, A.D. 1079, was flayed and miraculously restored to life. A pious legend explains that a votive offering of a wax horse to St. Stanislaus at Cracow was dedicated by the head of a family whose horse died while they were on their way to the elevation of the remains of the saint to a new shrine in 1254. The sacrifice of the horse was a feature of Nordic ritual which long survived and was expressly forbidden in churchyards.

May 8.

THE APPARITION OF ST. MICHAEL on Monte Gargano, near Manfredonia.—A bull when wounded by an arrow took refuge in a cave. When the herdsman attempted to withdraw the arrow it spontaneously sprang from the wound and wounded him. After a supplication and fast of three days at the instance of the bishop, the saint appeared to the prelate and informed him that the cave was his favourite resort, over which he wished a shrine to be erected. The story is curiously reminiscent of the Mithraic cult.

HELSTON FURRY FESTIVAL.—At Helston, in Cornwall, this day was celebrated as a general holiday. At dawn it was greeted with the music of drums and kettles and the singing of the well-known Furry Song. Anyone who attempted to work on this day was ridden on a pole to a brook over which he was compelled to attempt to jump, but usually failed. An excursion was made to the country (known as *to fadé*), from which flowers and oak branches were brought back worn in the hats. All then took part in dancing up and down the street, and passing through any, or perhaps originally every, house.

May 10.

ST. COMGALL, A.D. 601.—An Irish saint, a member of a Dalriadha family, of whom many stories are told. One nearly parallels the myth of Bishop Hatto. When the saint endeavoured to obtain corn from a noble in a time of scarcity, he was refused on the ground that the owner required all for his mother 'Old Mouse,' whereupon mice devoured all his grain. Several other stories turn on the magical ideas connected with saliva. Saliva ejected by the saint while fasting, when gathered from the ground, healed a leper. On another occasion it turned to a gold ring in the pocket of a beggar; and it changed the obdurate heart of a king when the saint spat on a stone and it split into pieces.

May 12.

ST. EPIPHANIUS, A.D. 403.—A protagonist in the controversies relating to heresy of this time. Of the Apollinarianism which assumed definite shape about 369 as the result of an extreme view of the divinity of Christ, one form was a denial of the perpetual virginity of the Virgin Mary, while by reaction another made her an object of idolatrous veneration. The influence of pagan ideas is to be seen in the custom adopted by the women first of Thrace, and afterwards of Arabia, of placing cakes (collyrides) on a stool covered with linen, offering them to the Virgin, and then eating them as sacrificial food. This custom was denounced by Epiphanius.

Societies and Academies.

LONDON.

Physical Society, Mar. 23.—**W. D. Flower**: The terminal velocity of drops. The distance a drop of given volume has to fall through in order that it may attain a constant terminal velocity has been determined for both water and methyl salicylate. The terminal velocities have been determined for drops 0·2-0·55 cm. in diameter.—**Satyendra Ray**: The longitudinal wave along a rod. That longitudinal waves are propagated with the same velocity for all wave-lengths only when the waves are 'geometrically similar' is here proved in exactly the same manner as for either strings, air columns, or transverse waves along stretched strings. The expression for the velocity is of course different.

Royal Meteorological Society, April 18.—**C. K. M. Douglas**: Some Alpine cloud forms. 'Banner clouds' are formed as the result of an eddy drawing air up the lee side of a steep mountain in a strong wind, and are very turbulent. Lenticular caps, or 'föhn clouds,' are smooth in appearance, and are formed in a damp current crossing the mountain top with vertical displacements, which do not seem to be large as a rule, most of the air apparently flowing round the mountain. Banner clouds appear to draw their moisture from lower down than caps, so that the two forms often exist independently, though both are produced by strong winds. The existence of caps, but no banners, may be attributed to a damp layer with dry air below, a condition known frequently to exist.—**N. K. Johnson**: A strong wind of small gustiness. Records of wind velocity and direction obtained at Leafield, Oxon, on two days in December 1926, are discussed. On the first day the weather was that corresponding to equatorial air, with overcast sky, slight rain, and a strong wind. The autographic traces of wind velocity and direction possess considerable width. The second occasion relates to polar air, the sky being practically clear but the wind velocity being approximately equal to that on the first occasion. The records of wind velocity and direction in this case are characterised by the extreme narrowness of the traces. Whilst polar air normally gives somewhat narrower traces than equatorial, the great difference found in the present examples is to be attributed to the difference in the lapse rates. During the clear night an inversion of nearly 3° F. existed between heights of 1 m. and 87 m. in spite of the wind velocity being 18 m./sec. (40 miles/hour).—**T. N. Hoblyn**: A statistical analysis of the daily observations of the maximum and minimum thermometers at Rothamsted. An account is given of the work carried out on 48 years' temperature records at Rothamsted. At this station, both maximum and minimum temperatures vary significantly from year to year at all periods of the year, although the variation is much greater in some months than in others. The correlation between the different measures differs quite definitely in the various months.

PARIS.

Academy of Sciences, Mar. 26.—**A. Mesnager**: The thickness required in triangular barrages; deduced from the official report of the failure of the reservoir barrage of Oued Fergoug (Perrégaux). A discussion of the effects of water pressure from below, and the effects of such pressures on the formulæ ordinarily in use. The usual factor of safety is insufficient in such cases.—**P. Helbronner**: The common sides of the fundamental Italian triangulation and the detailed geometrical description of the French Alps. The French and Italian measurements are fundamentally based on slightly different metres, and a minus correction of 1/74,000 must be applied to the Italian metre, to make the two series strictly comparable. The improvement produced by applying this correction is shown in tabular form.—**E. L. Bouvier**: The Saturnian Lepidoptera of the family of the Hemileucidæ.—**Pierre Weiss** and **R. Forrer**: New measurements of the atomic moments of iron and nickel at low temperatures. The experiments were carried out with the purest iron obtainable (Heraus), and two specimens of nickel containing 99·91 per cent. nickel (Heraus) and 99·76 per cent. nickel (Mond). The possible errors in the extrapolations involved are discussed and shown to be small. The atomic moments of iron and nickel are, with high accuracy, integral multiples, 11 and 3, of the same moment, the experimental magneton.—**A. Kolmogoroff**: A limiting formula of A. Khintchine.—**Finikoff**: The intrinsic equation of a surface.—**Bertrand Gambier**: Convex closed surfaces; ds^2 of Liouville; geodesic antipodes.—**A. Buhl**: Permutable operators and mobile trihedra.—**Renato Caccioppoli**: A general theorem for the passage to the limit under the sign of an indefinite integral.—**Soula**: Remarks on the principle of M. Picard.—**Paul Flamant**: An idea for integral functions analogous to that of the normal family for holomorph functions.—**S. A. Gheorghiu**: The growth of the denominators $D(\lambda)$ of Fredholm.—**Serge Bernstein**: Some asymptotic properties of the best approximation.—**R. Swyngedauw**: The characteristic differences presented by the movement of a pulley belt approaching and leaving the pulley.—**Jacques Mesnager**: The theory of heavy masses of masonry submitted to pressure from below and its application to the stability of barrages.—**Baticle**: The theory of equilibrium of heavy massifs submitted to pressures from below, and its application to the stability of barrages and talus.—**V. Nechvile**: The theory of two star streams and the ellipsoidal theory. The frequency curves given by the ellipsoidal theory (Schwarzschild) for certain values of ϵ assume forms exactly similar to those of the two stream theory (Eddington).—**Eligio Perucca**: The triboelectrical effect between solid bodies and gaseous bodies. Experiments are described proving that the electrification produced by a jet of mercury vapour impinging on a metal plate cannot be attributed to contact of mercury droplets with the collector, and the electrification produced must be regarded as due to the vapour.—**R. de Mallemann**: The electro-optical theory of quartz. The theory suggested by the author is confirmed by experimental results recently published by Ny Tsé Ze: the theory is developed in more detail in the present paper.—**Jean Rey**: Comparison of glass and metallic reflectors for lighthouse use. The metal reflectors are superior to glass.—**René Lucas**: The action of temperature on the rotatory powers of optically active substances.—**Jean J. Trillat**: The study of cellulose and the acetates of cellulose by means of X-rays. Cellulose, the oxycelluloses, and the hydrocelluloses, give similar X-ray diagrams. As regards the acetyl celluloses, the variations on the diagrams are sufficiently marked to serve as a control on chemical analyses.—**G. Guében**: The action of radioactive radiation on the dielectric constant of dielectrics. Various solid dielectrics were examined, paraffin, glass, celluloid, bakelite, sulphur, ebonite, wax, etc. No variation of the dielectric constant was produced by irradiation with the rays from radium. If any such effect exists, it is less than one-thousandth of the value of the dielectric constant.—**Paul Bary**:

A new property of certain silica gels.—**Trividic**: The absorption of iodine by carbon in some organic solvents. The solvents employed in these experiments included ethyl, methyl, and isoamyl alcohols, benzene, toluene, the three xylenes, chloroform, carbon tetrachloride, and carbon disulphide. The progressive increase of iodine absorption with the time observed by Davis could not be confirmed. Contrary to the views of Davis and of Schmidt, the general formula due to Freundlich fully expressed the experimental results. —**Jean Cournot**: The action of small additions of tin and cadmium on the qualities of lead. A series of nine alloys was prepared containing up to 3 per cent. of cadmium and 3 per cent. of tin, and the breaking load, elongation, elastic limit, crushing load (at two temperatures), and hardness determined for each. An improvement in strength and elastic properties is produced by addition of cadmium. To give good malleability, some tin as well as cadmium is required: the ternary alloys are also less oxidisable when fused. —**P. Cordier**: Phenylethylmaleic acid and its *cis-trans* isomer phenylethylfumaric acid.—**L. Palfray** and **L. Rothstein**: The stereoisomers of quinite (1, 4, cyclohexanediol).—**Mlle. Marthe Montagne**: New researches relating to the action of organo-magnesium compounds on some fatty dialkylamides.—**C. Gaudefroy**: An apparatus for measuring the true angle of the optic axes.—**Ch. Mauguin**: The study of micas by means of the X-rays.—**J. Repelin**: The Aquitaine basin at the Helvetian epoch: the continental formations.—**Louis Besson**: The visibility and amount of dust in the air of Paris. For the same season of the year, at the same time of day, and with the same humidity, the visibility in 1919–26 was clearly less than during 1896–1903. It is calculated that the number of smoke or dust particles has increased in the air of Paris about 50 per cent. in twenty-five years.—**A. Maige**: The phenomena of fatigue of the plastids during amylogenesis.—**Pierre Gavaudan**: The presence of the oil-bearing system in the organs of multiplication of the Jungermanniaceæ.—**Albert Guillaume**: The variations in the alkaloid content in the lupin under the influence of feeding.—**H. Colin** and **R. Franquet**: A new plant containing maltose, *Schizopepon Fargesii*. This plant, more commonly known under the erroneous name of *Actinostemma paniculatum*, has tubercles from which maltose has been extracted.—**Pierre Dangeard**: The release of free iodine in marine algæ. The emission of free iodine by Fucus is not dependent on the plants being crushed, since paper containing starch can be turned blue without actual contact. It is proved that the emission of free iodine by certain varieties of Fucus and Laminaria takes place during their normal life.—**G. Athanassopoulos**: The limited numbers of young eels ascending the rivers in the eastern part of the Mediterranean. The fact that young eels are not found in the Black Sea, or in the rivers flowing into it, has been attributed to the sulphurous nature of the sea-floor preventing breeding. The author shows that the number of eels diminishes as the distance east from the Straits of Gibraltar increases. He regards the young eels as entering the Mediterranean Sea through the Straits of Gibraltar, the number diminishing progressively owing to the ascent by the fish of the rivers nearer Spain.—**E. F. Terroine** and **R. Bonnet**: The influence of the amount of glycæmia on the magnitude of the exchanges and the problems of specific dynamic action of excessive food supply.—**Jules Amar**: The laws of physical education.—**E. Rothlin** and **Th. Oliaro**: The biological estimation of the quantities of cardio-active glucosides fixed by the frog's heart.—**Georges Bourguignon**: The transcerebral excitation of the pyramidal system in man. Measurements of normal and pathological chronaxy. —**Henry** and **Edouard Lassalle**: A new theoretical expression of the limiting intensities as a function of the duration of the stimuli.—**Mlle. Goldsmith**: The evolution of a tropism.—**E. Brumpt**: The rôle of the viviparous American fish *Gambusia Holbrooki* in the struggle against paludism in Corsica. Biological methods based on the marked predilection of certain fish for the larvæ of mosquitoes have the advantage of low cost and of not interfering with the habits of the population of regions infested with fever. The efficacy of the American fish *Gambusia Holbrooki* in reducing the number of mosquito larvæ has been proved by experiments in Corsica.—**C. Dawydoff**: The reversibility of the process of development. The extreme phases of the reduction of Nemertes.—**N. Bezssonoff**: The immediate physiological action of a vitamin. A marked change in the bromine absorption figure of the urine after administration of vitamin C can be proved after 48 hours.—**Mlle. Suzanne Guery**: A new method of auscultation called differential binaural auscultation and apparatus for permitting its realisation.—**R. Cambier** and **F. Marcy**: The composition of the air of Paris streets.

BRUSSELS.

Royal Academy of Belgium, Oct. 8.—**Ad. Mineur**: The Hamiltonian equations. A proof independent of the calculus of variations.—**A. Demoulin**: The point correspondence between two surfaces by parallelism of the tangent planes, and on the infinitely small deformation.—**Victor Willem**: Observations on the locomotion of Actinia.—**Louis van den Berghe**: Experiments on the cardiac origin of the inspiratory reflex in fishes.—**G. Erdtman**: Vestiges of the recent quaternary history of Belgian forests. Conclusions based in pollen statistics from the peat deposits in the Hautes-Fagnes and Ardennes. The predominating trees are classified for five periods, starting about 7500 B.C.—**L. Rosenfeld**: The five dimension universe and undulatory mechanics.

Nov. 5.—**Th. de Donder**: The relativistic and quantic problem of n bodies.—**Th. de Donder**: The relativistic problem of n bodies to the first approximation.—**E. de Wildeman**: The morphology of the male flowers in the genus Scleria (Cyperaceæ).—**Lucien Godeaux**: The regular involutions of order three belonging to an irregular surface.—**Serge Avsitidysky**: Note relating to the work of M. M. Barzin and A. Errera, "Sur la logique de M. Brouwer." —**Marcel Homès**: The evolution of the vacuome in the course of the differentiation of the tissues in *Drosera intermedia*.

Dec. 3.—**Paul Stroobant**: (1) Observations of the transit of Mercury on Nov. 10, 1927, made at the Royal Observatory of Belgium at Uccle. (2) Observations on the same, made at the Astronomical Institute of the University of Brussels.—**Th. de Donder**: The equation of quantification of molecules comprising n electrified particles.—**P. Bruylants** and **A. Castille**: The butenoic amides.—**R. Ferrier**: The theory of the Amperian.—**Seligmann**: An account of the third general meeting of the International Geodesic and Geophysical Union.—**Paul Ledoux**: The histological characters of the cylinder axis in *Entandrophragma Leplæi* and *Entandrophragma roburoides* (Meliaceæ from the Belgian Congo).—**L. Godeaux**: The asymptotic lines of a surface and ruled space.—**Mlle. L. de Brouckère**: The adsorption of ferric chloride by crystallised barium sulphate.—**P. Swings**: The change of magnification in the aplanatic telescope.

Dec. 15.—**Th. de Donder**: The invariant form of linear partial differential equations of any order.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 14, No. 1, January).—**Oscar Knefler Rice**: (1) The quantum theory of quasi-unimolecular gas reactions. (2) The theory of the decomposition of azomethane. The considerations of the earlier paper are applied to this reaction, which is unimolecular at high pressures; they give results in fair accord with experiment. It is concluded that activation is by collision and that the chance of reaction of an activated molecule depends on the energy in about the way to be expected if the energy is localised in a particular place in the molecule.—**John R. Bates** and **Donald H. Andrews**: Fundamental frequencies, interatomic forces and molecular properties. There appears to be some relationship between (*a*) fundamental frequency and force of binding, and (*b*) heats of linkage, boiling points, and directive influence in non-polar molecules.—**Worth H. Rodebush** and **John C. Michalek**: The effect of intensive drying on the vapour pressure and vapour density of ammonium chloride.—**C. Dale Beers**: Some effects of dietary insufficiency in the ciliate *Didinium nasutum*. Didiniums fed on excessive quantities of normal Paramœcia remained healthy; those fed on Paramœcia which had been starved for a week died off after showing decrease in fission rate, loss of ability to encyst, inability to ingest food, decrease in size, monstrosities due to incomplete fission, etc. (qualitative insufficiency). Didiniums on nine Paramœcia daily rapidly encysted (quantitative insufficiency).—**Edwin B. Wilson**: Mendelian inheritance with assortive mating. A mathematical discussion.—**Chas. W. Metz**: Genetic evidence of a selective segregation of chromosomes in a second species of Sciara (Diptera). During the first spermatocyte division of Sciara, the maternal chromosomes separate from the paternal chromosomes without synapsis, and one group is thrown out. In *S. similans*, as in *S. coprophila*, the paternal haploid group is thrown out and the males transmit only the maternal chromosome. Probably all the paired chromosomes in Sciara undergo this segregation.—**George H. Shull**: (1) The 'outside-in' Œnothera flower, a new morphological type produced by the interaction of two recessive Mendelian factors. The characteristic feature of this flower is the rhythmic repetition of calyx, corolla, and andrœcium. It appears to be a double recessive, *brevistylis supplena*, in which these characters are complementary. (2) Linkage with crossing-over between *rubricalyx* buds and old-gold flower colour in Œnothera. The linkage observed is contrary to previous results. The explanation found is that old-gold flower colour is a compound character produced by the interaction of a dominant, *S*, the normal allele of the *sulphurea* factor, *s*, and a recessive, *v*, the *vetaurea* or old-gold factor.—**H. Hopf**: A new proof of the Lefschetz formula on invariant points.—**H. P. Robertson**: Note on projective co-ordinates.—**Oswald Veblen**: Projective tensors and connections. An introductory account is given of a system of differential invariants the algebraic theory of which is closely analogous to that of ordinary affine tensors, though the analytical theory is quite distinct from classical tensor analysis. It may have physical applications.—**Jared Kirtland Morse**: The molecular structures of methane. Scale models of diamond, graphite, and ethane using a cube structure for carbon have already been discussed. The model for ethane has more positions available for hydrogen than can be occupied, and it is suggested that, in ethane gas, molecular collisions may lead to the displacement of hydrogen from one position to another, giving rise to 'dynamic isomers.' Similar 'dynamic isomers' are possible with methane, some of which, since they have different moments of inertia, can be predicted from measurements of band spectra.—**Bergen Davis** and **Harris Purks**: Additional lines in the *K*-series of molybdenum and the natural breadth of spectral lines. The resolving power of the double X-ray spectrometer has been increased by turning the second crystal to increase the angular reflection. The new lines are regarded as 'spark' lines arising from multiple ionisation of the atom rather than 'fine structure.' The natural breadth of a spectral line is calculated as 0·00012 A.; the measurements made here seem to suggest a narrower line. If this is so, the radiation cannot come from a damped oscillating electron.—**J. H. Van Vleck**: The correspondence principle in the statistical interpretation of quantum mechanics.—**Carl Barus**: Experiments with modified mucronate electrodes. It was previously recorded that anode and cathode behave alike; this is incorrect.—**Leonard B. Loeb** and **L. DuSault**: The mobilities of gaseous ions in $H_2S - H_2$ mixtures. The corrected absolute velocities of the ions in carefully purified hydrogen sulphide are 0·69 and 0·71 cm./sec. per volt/cm. for the negative and positive ions respectively. It was found that the electrons do not attach themselves readily to hydrogen sulphide molecules. Work with mixtures of hydrogen sulphide and hydrogen showed, first, that in very pure hydrogen the electrons remain permanently free, and secondly, that a trace of hydrogen sulphide reduces both the positive and negative mobilities below that computed from Blanc's law, thus indicating clustering.

Official Publications Received.

BRITISH.

Proceedings of the Royal Irish Academy. Vol. 38, Section B, No. 1: On some Doubtful Species of the African Section of the Sempervivum Group. By Dr. R. Lloyd Praeger. Pp. 24. 6*d*. Vol. 38, Section B, No. 2: The Cephalopoda of the Irish Coast. By Anne L. Massy. Pp. 25-37. 6*d*. Vol. 38, Section B, No. 3: Salmon of the River Shannon, 1924, 1925 and 1926. By R. Southern. Pp. 38-64+8 plates 1*s*. Vol. 38, Section B, No. 4: On the Boiling Points of the Normal Paraffins at different Pressures. By Prof. Sydney Young. Pp. 65-92. 1*s*. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

Education, India. Pamphlet No. 25: Experiments in Primary Education in the Orissa Feudatory States. By H. Dippie. Pp. 14. (Calcutta: Government of India Central Publication Branch.) 4 annas; 6*d*.

Catalogue of Indian Insects. Part 15: Cecidomyidae. By R. Senior-White. Pp. 23. (Calcutta: Government of India Central Publication Branch.) 7 annas; 9*d*.

Transactions and Proceedings of the Royal Society of South Australia (Incorporated). Vol. 51. Pp. iv+450+20 plates. (Adelaide.) 26*s*.

Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 15, No. 3: Fruitrot Disease of Cultivated Cucurbitaceae caused by *Pythium aphanidermatum* (Eds.) Fitz. By M. Mitra and L. S. Subramaniam. Pp. 79-84+3 plates. 6 annas; 8*d*. Botanical Series, Vol. 15, No. 4: Colour Inheritance in Rice. By Dr. S. K. Mitra and S. N. Gupta and P. M. Ganguli. Pp. 85-102. 6 annas; 8*d*. Botanical Series, Vol. 15, No. 5: Asterina spp. from India, by Dr. Ruth Ryan; and Meliola spp. from India and one from Malay, by Prof. F. L. Stevens. Pp. 102-111+8 plates. 4 annas; 5*d*. (Calcutta: Government of India Central Publication Branch.)

Survey of India. Map Publication and Office Work, 1926 to 1927. Pp. vi+28+5 maps. 1 rupee; 1*s*. 9*d*. General Report, 1926 to 1927. Pp. iv+95+2 maps. 1 rupee; 1*s*. 9*d*. (Calcutta.)

FOREIGN.

Transactions of the San Diego Society of Natural History. Vol. 5, No. 10: Notes on the Vaqueros and Temblor Formations of the California Miocene, with Descriptions of New Species. By Lionel William Wiedey. Pp. 95-182+plates 9-21. (San Diego, Cal.) 1 dollar.

United States Department of Agriculture. Technical Bulletin No. 20: A Study of Phylloxera Infestation in California as related to Types of Soils. By R. L. Nougaret and Macy H. Lapham. Pp. 39. (Washington, D.C.: Government Printing Office.) 10 cents.

Anthropological Papers of the American Museum of Natural History. Vol. 29, Part 3: Havasupai Ethnography. By Leslie Spier. Pp. 81-392. (New York.) 3 dollars.

Department of Commerce: Bureau of Standards. Circular of the Bureau of Standards, No. 139: United States Government Master Specification for Cells and Batteries, Dry. Federal Specifications Board Specification No. 58a. Pp. 10. (Washington, D.C.: Government Printing Office.) 5 cents.

University of Illinois: Engineering Experiment Station. Bulletin No. 175: An Investigation of Web Stresses in Reinforced Concrete Beams. Part 2: Restrained Beams. By Frank E. Richart and Louis J. Larson. Pp. 76. 45 cents. Bulletin No. 176: A Metallographic Study of the Path of Fatigue Failure in Copper. By Prof. Herbert F. Moore and Frank C. Howard. Pp. 31. 20 cents. (Urbana, Ill.)

CATALOGUE.

The Beck Pathological Microscope. Pp. F8. (London: R. and J. Beck, Ltd.)

Diary of Societies.

SATURDAY, MAY 5.

ROYAL SANITARY INSTITUTE (at Guildhall, Preston), at 10 A.M.—Prof. F. E. Wynne and others: Discussion on The Present Position of the Milk Supply.

ROYAL SOCIETY OF MEDICINE (Otology Section) (Annual General Meeting), at 10.30 A.M.—J. P. Stuart: The Histo-pathology of Mastoiditis.—Dr. R. Graham Brown: Case of Spherical Bulging of the Floor of the Third Ventricle, Secondary to Internal Hydrocephalus and Simulating a Pituitary Tumour.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (North-Eastern District Meeting) (at Thornaby-on-Tees).

BRITISH MYCOLOGICAL SOCIETY (at Cheshunt).—Phytopathological Meeting.

MONDAY, MAY 7.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Cavendish Laboratory, Cambridge), at 4.30.—Dr. A. A. Robb: On the Connexion of a Certain Identity with the Extension of Conical Order to *n* Dimensions.—J. Taylor: On the Action of the Geiger α-particle Counter.—J. Taylor and W. Taylor: The High Frequency Electric Discharge at Low Pressures.—E. J. Williams: Some Applications and Implications of Duane's Quantum Theory of Diffraction.—E. B. Moullin and A. D. Browne: On the Periods of a Free-free Bar Immersed in Water.—*To be communicated by title only*:—H. Lob: Note on Kuhne's Theorem.—J. M. Whittaker: The Electron in a Gravitational Field.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—G. S. Carter: The Work of an Expedition to Paraguay and Brazil, 1926–27 (Address).—G. S. Carter and L. C. Beadle: Fauna of the Swamps of the Paraguayan Chaco in Relation to its Environment. I. Physico-Chemical Nature of the Environment.—E. Meyrick: Micro-Lepidoptera from the Chaco in Paraguay.—H. W. Parker: Some Reptiles and Amphibians from the Paraguayan Chaco.—R. Gurney: Some Branchiopoda from Paraguay.—J. Stephenson: The Oligochæta from Paraguay.—D. A. Allan: Geology of the Highland Border from Tayside to Noranside.—F. Walker and J. Irving: Igneous Intrusions between St. Andrews and Loch Leven.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Pastor R. Saillens: Protestantism and Rationalism in France.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 6.—J. N. H. Duke: Technical Education in Relation to Industrial Development in India.

NORTH STAFFORDSHIRE INSTITUTE OF MINING ENGINEERS (in North Staffordshire Technical College, Stoke-on-Trent), at 6.—A. Marshall: 'Whitewash' and its Application to Underground Roadways.—*Paper open for discussion*:—Description of the Bullhurst Coal Seam, and the method of working same at the Rookery Colliery of the Bignall Hill Colliery Co., Ltd., having regard to its Liability to Spontaneous Combustion, by J. Cowcill.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.

SURVEYORS' INSTITUTION (at Institution of Mechanical Engineers), at 8.—Discussion: The Report of the Royal Commission on Land Drainage in England and Wales.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Lt.-Col. L. N. F. I. King and Capt. E. H. M. Clifford: The Jubaland Boundary.

ROYAL SOCIETY OF MEDICINE (Social Evening), at 9.15.—P. B. Tustin: Milk—from Cow to Consumer.

TUESDAY, MAY 8.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—H. S. Rowell and D. Finlayson: Experiments in Viscometry.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—A. T. Ridout: Non-chemical Method for the Prevention of Scale Accumulation in Boilers, Diesel-jackets, and Water Circulating Systems in general.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—E. A. Bierman and others: Discussion (with demonstration) on the Control of Gradation in Bromide Prints by Development.—H. E. Tomkins: Lunar Photography with a 24-inch Cassegrain Reflector.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Dr. E. J. Salisbury: Stomata.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 8.—Prof. C. H. Desch: The Chemical Properties of Crystals (May Lecture).

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—E. Torday: Dualism in Western Bantu Religious and Social Organisation.

WEDNESDAY, MAY 9.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-Section of Proctology) (Annual General Meeting), at 4.45.—At 5.—Sir William de Courcy Wheeler (Surgery), Dr. G. Hodgson (Radiology), Dr. C. Dukes (Pathology), and others: Discussion on The Early Diagnosis of Carcinoma of the Rectum and Colon.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—W. B. R. King: The Geology of the District around Meifod (Montgomeryshire).—H. Dewey: Exhibition of a Palæolithic Flint-implement found in Gravel on the Dover House Estate, Putney Heath.

ROYAL SOCIETY OF ARTS, at 8.—Capt. R. W. Lane: The Sterilisation of Milk.

EUGENICS SOCIETY (at Royal Society), at 8.30.—Dr. N. East and Prof. Van Loon: Crime and Heredity.

THURSDAY, MAY 10.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—Prof. I. P. Pavlov: Some Problems of the Physiology of the Cerebral Hemisphere (Croonian Lecture).

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. W. E. H. Berwick: Some Recent Advances in the Theory of Equations (Lecture).

CHEMICAL SOCIETY (at Royal Institution), at 5.30.—Sir James Walker: Arrhenius Memorial Lecture.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—B. N. Wallis: Design and Construction of Modern Rigid Airships.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Colour Group, Informal Meeting), at 7.—Major P. Bull: A Pocket Apparatus for Three-Colour Photography.—C. H. Clarke: A New Departure in Exposure Meters.

INSTITUTION OF AUTOMOBILE ENGINEERS (Derby Graduates) (at Cavendish Café, Derby), at 7.30.—C. Mercy: Free Wheel Devices.

OPTICAL SOCIETY (at Imperial College of Science), at 7.30.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Annual General Meeting) (at 30 Russell Square, W.C.1).—H. Hepworth: Nitrocellulose Lacquers.

FRIDAY, MAY 11.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Dr. E. G. Richardson: The Amplitude of Sound Waves in Resonators.—R. E. Clay: The Focus of a Gas-filled X-ray Tube.—Demonstration of an Electric Harmonic Analyser, by Dr. R. T. Coe.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. T. Henly: Notes on the Drying of Industrial Products.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (Annual General Meeting) (at Chemical Society), at 8.—F. H. Carr: Some Chemical Engineering Aspects of the Fine Chemical Industry.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. Doris L. Mackinnon: Life's Unsuspected Partnerships.

SATURDAY, MAY 12.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (at Bath).

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Western District Meeting) (at Totnes).

PUBLIC LECTURES.

SATURDAY, MAY 5.

ARTS SCHOOL, CAMBRIDGE, at 3.—Sir George Newman: Linacre's Influence on English Medicine (Linacre Lecture).

MONDAY, MAY 7.

UNIVERSITY COLLEGE, at 5.—Dr. G. E. Coghill: Anatomy and the Problem of Behaviour. (Succeeding Lectures on May 8 and 10.)

TUESDAY, MAY 8.

THE UNIVERSITY, BIRMINGHAM, at 5.30.—Prof. Fichter: Electrochemistry. (Succeeding Lectures on May 10, 11, 14, 15, 17, and 18.)

WEDNESDAY, MAY 9.

MEDICAL SCHOOL, LEEDS, at 3.30.—Prof. G. G. Turner: Cancer of the Rectum.

THURSDAY, MAY 10.

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, at 5.—Prof. E. C. Dodds: The Ovarian Hormone.

IMPERIAL INSTITUTE, at 5.30.—Dr. J. M. Rendall: The Empire.

KING'S COLLEGE, at 5.30.—Prof. J. O. Thomson: Problems of Ancient Geography.

FRIDAY, MAY 11.

UNIVERSITY COLLEGE, at 5.30.—Sir Samuel Hoare: The Value of Aviation to the British Empire.

CONFERENCES.

MAY 10 AND 11 (AT BATH).

RHEUMATIC DISEASES.—President: Sir George Newman. Presidents of Sessions: Social Aspects, Lord Dawson of Penn; Causation, Sir Humphry Rolleston, Bart.; Treatment, Sir E. Farquhar Buzzard.

MAY 11 TO 15.

CHEMICAL INDUSTRY CONFERENCE (organised by Society of Chemical Industry in connexion with its London Section, Chemical Engineering Group, and Institution of Chemical Engineers).

Friday, May 11 (at Les Gobelins Restaurant, 1 Heddon Street, W.1), at 8.30.—F. H. Carr: Some Chemical Engineering Aspects of the Fine Chemical Industry.

Saturday, May 12.—Visit to Rothamsted Agricultural Experiment Station.

Monday, May 14 (at Institution of Civil Engineers), at 10.30 A.M.—Sir Arthur Duckham: The Fuel Industries and the Work of the Chemical Engineer.—Prof. G. T. Morgan: The Chemical Study of Low Temperature Tar.

At 2.30.—Sir Alexander Houston: Water Purification.—J. H. Coste: The Pollution of Tidal and Non-Tidal Streams.

May 15 (at Institution of Civil Engineers), at 10.30 A.M.—Sir Alfred Mond, Bt.: Scientific Research as applied to Industry.—Sir John Russell: The Part played by British Workers in the Application of Fixed Nitrogen to the Soil.

At 2.30.—Lt.-Col. G. P. Pollitt: Developments in the Heavy Chemical Industry.

SATURDAY, MAY 12, 1928.

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The Technical Expert in the Civil Service.

IN his presidential address, given on April 17, on the occasion of the annual meeting of the Institution of Professional Civil Servants, Sir Richard Redmayne dealt briefly with the work of the Institution, the annual report of which for the past year supplies an impressive review of the whole field of national activities. He made, at the same time, some interesting remarks on the present position of the technical expert in the Civil Service.

In the annual report in question, the Institution, it is stated, has long held the view that an adequate solution of the problems affecting the employment of specialist officers in the Civil Service will only be arrived at as the result of an independent public inquiry. The reason given for this view is that although the increase in the numbers and in the importance of the work of the professional, scientific, and technical classes has been very considerable in recent years, nevertheless the public departments are still *entirely* controlled by 'administrators,' who not only constitute a close caste, but also have been unable satisfactorily to adapt themselves to the changed conditions which have come into existence in the activities of the public service. The chief problem relating to the technical expert in the Civil Service is essentially one of status, and it is recognised that its solution is unquestionably an undertaking of the first magnitude.

Realising that, in order effectively to attain its objectives, the membership of the Institution should be thoroughly representative of the professional, scientific, and technical groups in the several government departments, one of the chief aims of its council has been, almost from the earliest days of the inception of the Institution, to persuade the numerous associations which have come into existence in government departments for the protection of the interests of the specialist officers since the termination of the War, to link up with the main body of their colleagues organised in the Institution. Sir Richard Redmayne was able to announce that the policy of the council in this matter had in recent years met with marked success ; he further indicated that the membership of the Institution, which at the end of 1925 numbered 3000, would within a few months exceed 5000.

The technical expert must, Sir Richard urged, be recognised as indispensable for the carrying on of the complex task of government in the modern

State, and be afforded full and free opportunity for rising to the highest offices the public service could offer. He emphasised the fact that the position of the technical expert in the Civil Service is at the present time far from being a satisfactory one. The subordination of the technical experts now threatened in the Scottish Boards by the Reorganisation of Offices (Scotland) Bill affords an example of the need for a proper reconsideration of the functions and status of the technical expert in relation to the administration.

The objectives of the Institution of Professional Civil Servants have, needless to say, a wider importance than that of merely serving the purely personal interests of its members; they aim, in fact, also at the attainment of true economy and increased efficiency in the public service. It is common knowledge that the present organisation of government departments and their procedure promote neither of these two very desirable ends; indeed, in some respects, they militate against the attainment of them. What is wanted to-day is the complete modernisation of government departments with the view of bringing about such changes that the affairs of the public service may be conducted on the model of a well-managed business.

The claim for an improvement in the status of the technical expert is really intimately bound up with the subject of a root and branch reorganisation of the government departments, for the issue raised thereby ultimately resolves itself into a question of making a better use than is the case at present of the knowledge and abilities of the specialist officers in the employment of the State. This can alone result by introducing radical changes in the present hierarchical system of the Civil Service and in the methods now adopted in dealing with scientific and technical work in government departments. The method in vogue at present, whereby scientific and professional matters are discussed in writing, sometimes at inordinate length, between non-technical and technical officers, in practice too often creates a situation in which technical officers are called upon to afford instruction in some branch or another of technology to non-technical officers by a process somewhat akin to that of the much-advertised 'correspondence course.' On the face of it, such a method of conducting business cannot, and in fact does not, conduce to the attainment of either economy or efficiency; apart from the delays caused in arriving at a decision on the matters under discussion, owing to the time consumed in carrying on the correspondence, it will be evident that a larger number of non-technical and also technical officers must be employed by the State under these conditions than would be the case if a rational organisation existed in government departments. The spheres of responsibility of the administrative and technical branches should be so clearly laid down as to ensure in practice that the chief technical officer of a department should personally be solely responsible for the soundness of all technical projects and schemes prepared in his branch and submitted by him for the approval of the minister, as well as for the correctness of the advice on technical matters tendered by him.

The necessity for the modernisation of the organisation and the procedure of government departments is not a matter which rests on the views of those alone who are advocating the cause of the professional and technical groups in the public service. It is also made strikingly apparent in the reports issued during the past twenty years by numerous parliamentary and other official committees which have been called upon to investigate certain matters connected with some of the governmental activities, and, further, by the public speeches of ex-ministers delivered in recent years. These reports and speeches have made the public familiar with some of the unsatisfactory features connected with governmental enterprises of a technical nature; and, in particular cases, a need for a complete reorganisation of them has been stated in express terms.

The immediate question, then, is how to find an expeditious means for remedying a situation which unquestionably is prejudicial to the public interest. The members of the specialist groups in the Civil Service have very properly decided to act strictly on constitutional lines; this does not, of course, mean that they intend to fall into that state of pathetic contentment which is so disturbing to the mind of the ardent reformer. On the contrary, the majority constituting these groups have already organised themselves into regularly constituted associations and are gradually bringing about improvements in their separate organisations, and eventually, no doubt, the whole of the specialist officers in the Civil Service will be effectively organised, and ranged also under the banner of a central service institution. However, in view of the fact that government departments are controlled on traditional lines by a ruling caste whose inertia is proverbial, it seems improbable that the steps necessary for the modernisation of the public services and for securing a status for the scientific

and technical experts in the employment in the State compatible with the real needs of the situation will be set on foot by a movement for reform inaugurated within the public service.

The Institution of Professional Civil Servants has, it is true, played a considerable part in securing benefits on behalf of the professional and technical groups, owing to the large share it has taken in the work of the National Whitley Council; and it certainly has no intention of relaxing its efforts in this direction. However, the procedure of referring matters to the Industrial Court is cumbersome and dilatory. Moreover, the functions of the Industrial Court are strictly limited; it is not empowered to deal with the question of the modernisation of government departments, which is fundamental if the public services are to be placed on a sound footing. Indeed, even as regards matters now falling within the powers of the Industrial Court, the Institution of Professional Civil Servants is so far from satisfied with the existing arrangements that it has set up a special committee with the view of securing improvements of the arbitration and Whitley machinery. Further, it is certainly not in the interest of the State that improvements in the status of an important body of its officers should be won piecemeal and by slow degrees. A reform obtained in such a manner must in the long run prove costly to the nation.

The measures which have been taken by the specialist officers for bringing about the reforms so necessary in the organisation of government departments, and in their methods of conducting business, deserve the full support of the public; it seems to be a matter in which the leading professional and technical institutions can well take an initial step. These institutions now show a considerable interest in questions affecting the occupations covered by their members, and some of them have already intervened on behalf of the professional group in the Civil Service by making suitable representations to the Prime Minister on matters dealt with in the Report of the Anderson Committee (Report of Committee on Pay, etc., of State Servants, 1923. H.M.S.O. 6*d*. net). The prestige which these institutions enjoy, not only among professional men, but also in the eyes of the public generally, renders them very suitable bodies for taking up the cause of the specialist officers in the public service; moreover, in doing so, they would be performing a task of immense benefit to the nation. The first step would seem to be the preparation by them jointly of a memorandum dealing with the whole subject of the status of the professional and technical officers; having taken this step, they could appropriately press for the appointment of a Royal Commission to inquire into the subject and to recommend remedial measures.

The Artificial Silk Industry.

(1) *The Manufacture of Artificial Silk: with Special Reference to the Viscose Process.* By E. Wheeler. (Monographs on Applied Chemistry, Vol. 1.) Pp. xv + 150 + 27 plates. (London: Chapman and Hall, Ltd., 1928.) 12*s*. 6*d*. net.

(2) *The Rayon Industry.* By Moïs H. Avram. Pp. xxi + 622. (New York: D. Van Nostrand Co.; London, Bombay and Sydney: Constable and Co., Ltd., 1927.) 42*s*. net.

(3) *Acetate Silk and its Dyes.* By Chas. E. Mullin. Pp. 473. (London: Constable and Co., Ltd., 1928.) 26*s*. net.

ARTIFICIAL silk, despite its name, has not assumed the place of the product of the silkworm in the textile industries, for the visible output of natural silk is increasing, although much less rapidly than that of artificial silk, which now exceeds it in annual amount. It appears, therefore, that the new fibre has found a place of its own, unless in so far as it may have dispossessed the other natural fibres, and its designation by some other name would have conveniences; but the word 'rayon,' invented and adopted in the United States, has not found favour in Great Britain, though the Drapers' Chamber of Trade recently decided to recommend the adoption of the word instead of the misleading term 'art silk.' Such a replacement of the natural fibres by artificial silk cannot yet have gone very far, as the amount produced during 1928 is not expected to exceed two per cent. of the total amount produced of all the natural fibres.

The rate of increase in the production of the new material, exemplified by the 99,500 metric tons produced in 1926 being twice the amount produced in 1923, continues, however, to be high; and the future possibilities of the new industry must appear to be great when it is considered that, apart from the more purely scientific researches which may have a bearing on the industry, systematic technical investigations are in progress with the object of producing a fibre more suitable for use in clothing; the employment of other derivatives of cellulose than those now used may become practicable, or even the manufacture of artificial

fibres from other than a cellulose base. Meanwhile, the processes that hold the field are the viscose, the cuprammonium, and the nitro-cellulose processes, which yield fibres composed of regenerated cellulose, and the acetate process which yields fibres composed of acetyl cellulose.

(1) The object of Mr. Wheeler's monograph is "to present a description of the essential chemical and engineering details" of these processes "and of the properties and uses of artificial silk," with special reference to the viscose process, which is used for the production of about 90 per cent. of the world's output. As sources of cellulose, only cotton waste or linters and wood come into consideration at present; bleached sulphite wood pulp with a specified content of α-cellulose, prepared from spruce, fir, or hemlock, is commonly used for the manufacture of viscose, but the dearer cotton has the advantage of yielding a stronger artificial fibre; for the other processes cotton is generally employed, although wood pulp has been found to be suitable for the cuprammonium and acetate processes.

The viscose process depends upon the coagulation of an alkaline solution of cellulose xanthate by causing it to emerge from fine jets into a solution containing acids and salts, the composite thread formed from numerous filaments being afterwards desulphurised and otherwise prepared; the xanthate is made by the interaction of carbon disulphide and cellulose which has been impregnated with sodium hydroxide. Each of the numerous stages of the manufacture is carefully controlled; but the success of the viscose process is due in great measure to the ingenious mechanical arrangements, especially those employed for the spinning or conversion of the viscose into filaments. Mr. Wheeler accordingly, in his very clear and concise account of the normal process as carried out to-day in many factories, devotes considerable attention to the details of these arrangements; the text, supplemented by flow sheets, is freely illustrated by plates and diagrams, and reference is made to the patents and technical literature for further details and descriptions of alternative methods.

The other processes at present operated industrially are described equally skilfully, but more shortly. Of these the cuprammonium process, in which cellulose dissolved in an ammoniacal solution of copper hydroxide is regenerated in the form of filaments by passage into acid or alkaline solutions, is showing renewed vitality, although the proportion of artificial silk produced in this way is small; the nitro-cellulose process, which is the oldest, is on the wane; and the acetate process, which is referred to further below, is becoming increasingly important. Reference is also made to other methods proposed for the manufacture of artificial fibres, of which that depending on the production of cellulose ethers, now being developed on a large scale, is the most promising. The properties of artificial silk, both general and in relation to dyeing, its uses, besides other topics, are adequately discussed relatively to the scale of the book, which is a well-arranged and well-written outline of the subjects.

(2) The financial aspects of the industry are prominent in "The Rayon Industry," which appears to be intended mainly to inform the "groups of financial interests" who may be proposing to undertake the manufacture of artificial silk in the United States, although there is a list of the other numerous classes of readers for whom the book is designed. About one-quarter of the book of 600 pages is devoted to the history, finance, and economics of the industry, which are described with enthusiasm, tempered with warnings against unconsidered enterprises; forty pages are given to the natural textile fibres; thirty to the purification of water; fifty to yarn tables, and tables of weights and measures and such like; but only fifteen to dyeing. Useful features are the lists of patents and the bibliography of textiles generally, which together occupy about eighty pages. The actual processes of manufacture of artificial silk, described in a manner easily followed, occupy about one-quarter of the book; suggestions are made as to the plant required by an intending producer. Although the viscose process naturally occupies the chief place, the nitro-cellulose and cuprammonium processes are also described in some detail, but the discussion of the acetate process is somewhat meagre.

(3) Even in Mr. Mullin's conscientious and exhaustive work on "Acetate Silk and its Dyes," few details are given of the manufacture of this type of artificial silk, as "very little outside of the patent literature has been published." The preparation of cellulose acetate, and its properties, are, indeed, discussed at some length, but the book is essentially one on dyeing. As an ester of cellulose, acetate-silk is distinguished from the artificial silks composed of regenerated cellulose by special characteristics which at first hindered its dyeing. This book records the history of the development of suitable processes and describes the methods now employed, with copious citations of authorities. It will be of value to the dyer as a text-book and work of reference.

Modern Spectroscopy.

Handbuch der Experimentalphysik. Herausgegeben von W Wien und F. Harms. Band 21: *Anregung der Spektren, spektroskopische Apparate,* von Georg Joos und Ernst v. Angerer; *Starkeffekt* von Johannes Stark. Pp. xiii + 562. (Leipzig Akademische Verlagsgesellschaft m.b.H., 1927) 49 gold marks.

ALL those engaged in research in physical optics, and spectroscopists in particular, must feel deeply indebted for the publication of this volume. Although some of its contents were available already in other publications (such as Kayser's Handbuch and Baly's "Spectroscopy"), it was often only in a much more diffuse form, and the more important part has only been published hitherto in a vast number of papers in the different journals

Notwithstanding that the title of the work is experimental physics there is an admirable account of the theory of the origin of spectra by Georg Joos, which even contains a brief summary of and many allusions to the results of the new wave mechanics. For the most part however, this account deals with the theory of spectra in terms of the Rutherford-Bohr atom model and the old quantum mechanics modified to account for the complex spectra. There is, for example a good, though rather too condensed, account of the doublet problem,' the first great difficulty of the older theory, and the development of the situation is carried on to include atoms with several electrons and the solution by the assignment of an intrinsic moment to each electron of one-half of a unit of $h/2\pi$

This section of the book forms an admirable introduction to such a book as Hund's "Linienspektren"

The excitation of spectra is fully discussed, including the methods of electron impact (and the determination of ionising and resonance potentials), absorption spectra, subordinate series absorption, resonance and fluorescence, and finally collisions of the second kind, and brief mention is made of sensitised fluorescence and photo-chemical reactions. The only similar account in English known to the reviewer is Foote and Mohler's "Origin of Spectra," and this is by now necessarily incomplete and omits much of the recent important work.

In the discussion of the widths of spectral lines we think that, though this is essentially a book for specialists, for the benefit of students perhaps, the point might have been made that strictly monochromatic absorption and emission is impossible since it involves zero probability for the recapture or radiation by atoms.

There follows a very useful account of the different sources of light available for spectroscopic experiments.

The second part of the book, by E. von Angerer, is an account of the apparatus and methods of spectroscopy. In the discussion of prism spectrographs the great practical importance of a straight line focal curve for the camera objective is rightly emphasised, and a most useful account of several actual systems given. The treatment of grating spectrographs is equally comprehensive, and includes good practical instructions for cleaning gratings. We should like to have seen mention made of Newall's method of the 'diffractional index' for setting the slits of spectroscopes (*Mon. Not. R.A.S.*, **65**, 610; 1904); its value lying in the possibility of exactly reproducing of a setting. We welcome the account of the illumination in spectrographs and would have liked more on this topic. The problem of the use of a spectroscope in conjunction with an astronomical telescope is not discussed.

There follows a chapter in which are collected together accounts of the various interference spectroscopes, and their combinations with other instruments, and also of crossed interferometers.

The account of the determination of wave-lengths includes a valuable summary of the work on primary standards, but the actual method of finding wave-lengths by means of a standard comparison spectrum (of iron, say) is not explicit, in so far as the method of choosing standard lines for the calibration curve and correction curve of wave-lengths from Burns's table (in *Lick Observatory Bulletin No. 247*) and St. John's report to the I.A.U. (1923) is not given.

The chapter on photometry, and in particular photographic photometry, is opportune, and well up-to-date. The time has come when all tables of wave-lengths should also contain accurate measurements of intensity. It is astonishing how well some observers have been able to convert themselves into photometers, but the old system of eye estimates of intensity demanded a very considerable knowledge from the user of it, if he were not also its maker, if any results were to be deduced from it. Anderson's method (*Astro. Jour.*, **59**, 76: 1924) of obtaining an intensity scale is very much better, and we would have liked to have seen its use urged in this book, as being very little more trouble than crude eye estimates, but of course whenever the

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extra labour can be afforded (and we grant that it is considerable), a scale independent of wave-length is desirable.

The third part of the book is an account of the theory and experimental investigation of the Stark effect by the one most qualified to give it, namely, J. Stark himself, and the reviewer can only remark that comment on it by him is superfluous.

The book abounds throughout with references to the literature of the subject, which are very complete and are brought so well up-to-date that the only supplement needed should be recent numbers of *Science Abstracts*. The printing and illustrations are all that could be desired.

J. A. C.

Academic Mycology.

The Structure and Development of the Fungi. By Dame H. C. I. Gwynne-Vaughan and B. Barnes. Pp. xvi + 384. (Cambridge: At the University Press, 1927.) 15*s*. net.

THE increasing recognition of the significance of the fungi in agriculture and industry makes the publication of a treatise on this group of plants an event of notable importance. This is the more manifest when it is realised that, since the translation of De Bary's great work on the fungi in 1886, there has appeared no book in English which covers the subject as does the present volume, or which has been suitable as a mycological text-book for advanced students of botany. Further, during this period only one book—Gaumann's "Vergleichende Morphologie der Pilze," published in 1926—has appeared on the continent of Europe. The present volume by Prof. Gwynne-Vaughan and Mr. Barnes partially occupies, therefore, a niche which has been empty for some considerable time.

The authors have kept strictly to their title, which is "The Structure and Development of the Fungi," and have not attempted to consider wider issues such as the physiology, ecology, and general biological relationships of the group. This is, perhaps, a little unfortunate, for readers will gain little conception of the part played by these organisms in Nature, of their vast importance as disease-causing agents in agriculture, forestry, etc., or of the dependence of many great industries upon fermentative processes brought about by them.

The book is thus in no sense a general treatise on the fungi, but it is a well-written and readable account of their reproductive structures and processes. Accepted as such it is a notable success and is assured of a cordial welcome.

Beginning with the more primitive forms in each of the three great classes of fungi, and working through to the more advanced types, the authors present a clear picture of the present state of our knowledge. The systematic arrangement they have adopted is more simple than that of many continental mycologists, but with the increasing recognition of the entirely artificial basis of much, at least, of our fungal systematics and phylogenetic schematisation, simple diagrammatic arrangements have at present almost everything in their favour. The book contains a useful chapter on mycological technique and a bibliography that will be found of value by students desirous of consulting original sources. Two hundred and eighty-five illustrations, many of them original, add greatly to the value of the book, which is excellently produced and commendably free from misprints and errors. A certain amount of loose wording here and there which might give rise to ambiguity can easily be amended in the several editions into which the volume is sure to run.

W. B. B.

Our Bookshelf.

Electro-Farming: or the Application of Electricity to Agriculture. By R. Borlase Matthews. Pp. xvii + 357. (London: Ernest Benn, Ltd., 1928.) 25*s*. net.

THE introduction of mechanical power to the farming industry has proceeded more slowly than in other industries. Apart from the natural conservatism of the agriculturist, the main reason for this is the diffuse and spasmodic power requirements on the farm. In other industries, the processes are localised in a factory and are not subject to the constant change of plans that the weather conditions impose on the farmer. Nevertheless, steam power for cultivations, and the internal combustion engine for cultivations, haulage, and general work in the farm buildings, have all found a place in agriculture and the use of power is now rapidly extending.

The latest claimant is electric power, and the author of this book, who is a well-known pioneer in the subject, has produced a thoroughly up-to-date review of the position. The characteristic of electric power that most commends it to agriculture is the extreme simplicity of the motor as compared with other prime movers. For all work that can be done by fixed or portable engines the electric motor will no doubt seriously rival all other forms of power, immediately an adequate supply of electricity becomes available in rural areas. The weak point is its use for work on the land, which absorbs by far the greater proportion of the total power

used in agriculture. Flexible cables must be provided between the moving machine and the fixed distribution lines, together with some auxiliary form of power (or a heavy and expensive battery) for movement about the farm. Although several ingenious systems are in use on the Continent for reducing to a minimum the inevitable inconvenience of the flexible cables, the British farmer will need much persuasion before he adopts the system.

Electric stimulation of plant growth is discussed more optimistically than the present position of scientific investigation in this intricate subject really warrants, and the same is true, although to a lesser degree, of the chapters dealing with light treatment of plants and animals. A full account is given of the undoubted improvement that electricity could provide in the amenities of the farm homesteads and the rural areas generally.

Although the object of the book is to pave the way for electro-farming, perhaps its chief immediate value is that it directs attention to the numerous ways in which the forms of power at present available could be applied with advantage on the farm.

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland: a Record of the Work done in Science, Literature, and Art during the Session 1926–27 by numerous Societies and Government Institutions. Compiled from Official Sources. Forty-fourth Annual Issue. Pp. vii+416. (London: Charles Griffin and Co., Ltd., 1928.) 18*s.* net.

IT is with much pleasure that we welcome once more this useful annual; the publishers deserve our sincere thanks for the labour and expense they devote to it. Moreover, they realise that a reference book must be distinctively and strongly bound; lightly bound reference volumes, which fall to pieces after a few weeks of use, are most irritating.

An important part of the volume is the note on the title-page—"Compiled from Official Sources." It shows that the information provided can be depended upon, and our thanks should also go to the officials of societies, many of them busy men serving in an honorary capacity, who take the time and trouble to make it available. As regards the contents of the book, it is sufficient to say that the various societies are classified according to subject, and under each one is given its address, officers, meetings, publications, and so on. Local photographic and medical societies are dealt with briefly at the ends of the appropriate groups. Particularly valuable are the reports from the Government institutions. There is a good index.

The penalty of providing useful information is that it invites suggestions for improvements. We still lament the omission of most of the industrial research associations, an omission that is doubly strange in view of the increased attention that is given to research in the industries themselves and among the public. We also think that the Viking Society and the Spelæological Society would be more appropriately grouped under archæology than under biology, and that the Sociological Society and the Eugenics Society would come better under biology, which includes anthropology, than under psychology.

The Circle and the Cross: a Study in Continuity. By A. Hadrian Allcroft. In 2 volumes. Vol. 1: *The Circle.* Pp. x+370+4 plates. (London: Macmillan and Co., Ltd., 1927.) 12*s.* 6*d.* net.

MR. ALLCROFT's interesting book is devoted to the thesis that the sacred pagan symbol, the circle, surviving from prehistoric into Christian times, can be detected not only in occasional circular churchyards, but also in the modern word *church* itself. Beginning with the round barrow as the first expression of the sacred circle, Mr. Allcroft traces the evolution of the holy sepulchral ring, and maintains that this acquired additional importance from its frequent use as a moot. It is as moots, indeed, that he would explain the stone circles of Great Britain, and he couples with this interpretation the assurance that they are in reality of much later date than is commonly supposed; in fact, he seems to think most of them were built so late as the fourth century B.C., if not later still.

On this point the verdict will assuredly be that Mr. Allcroft's case is not proven, but his survey of the stone circles and earthen 'amphitheatres' in Great Britain is none the less an important and thorough piece of work. Moreover, he cannot be accused of too narrow an outlook, for he has chapters on the Achæan and Latin moots, and on the Danish *ting*; and he gives, furthermore, an interesting account of the Nordic peoples, about whom he holds views that are often in opposition to orthodox theory.

Especially interesting are Mr. Allcroft's remarks on the difficult subject of the Picts; but it should be observed that as a guide to the course of the Celtic invasions of these islands, his book must be read with considerable caution. However, he may reasonably claim the indulgence due to those engaged in pioneer work—for such is the nature of his book—and this is no less than his due. Indeed, it would be churlish to deny that he has given us a learned and entertaining work.

Lehrbuch der Geophysik. Herausgegeben von Prof. Dr. B. Gutenberg. Lieferung 4. Pp. 609-796. (Berlin: Gebrüder Borntraeger, 1927.) 11·40 gold marks.

PART 4 of Gutenberg's "Lehrbuch" deals mainly with atmospheric phenomena. A section on the structure of the atmosphere, by Prof. L. Weickmann, gives a very thorough account of existing theories of its composition, the distribution of temperature and density with height, and the propagation of sound. Atmospheric optics is then treated in considerable detail by Prof. F. Linke and Prof. A. Wegener (who was not included in the list of collaborators as originally announced). Atmospheric electricity is discussed by Prof. H. Benndorf.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Two Kinds of Martensite.

MARTENSITE is a structure characteristic of quenched steels and consists of an aggregate of very minute needle-shaped crystals. It is a solid solution of carbon in α-iron and is very hard. During tempering at a gradually increasing temperature, the precipitation of the carbon from the solid solution in the form of cementite takes place in two steps at about 170° and 270°, as shown in Fig. 1 by the two stepped changes in the electric resistance–temperature curve, or by similar abnormality in the magnetisation–temperature curve, etc. Since the precipitation or the decomposition of martensite takes place in two steps, it is necessary to distinguish two kinds of martensite, α and β, the former being less stable, and hence more easily attacked by acid, than the latter. By X-ray analysis, Westgren and others have found that the martensite has a body-centred cubic lattice, carbon atoms being present within the interspace of the lattice.

Recently it has been found that beside the body-centred cubic martensite, a body-centred tetragonal martensite with an axial ratio $c/a = 1{\cdot}03 \sim 1{\cdot}06$ is contained in quenched steels. We have found by X-ray analysis that the former martensite, which is more stable than the latter and is to be identified with β martensite, is found in the inner portion of a quenched specimen; while the latter martensite, which is to be identified with α martensite, is always found in the surface layer of the specimen. The

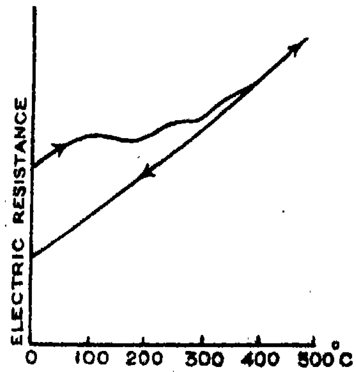

FIG. 1.—Resistance-temperature curve.

existence of the two kinds of martensite being thus far confirmed, the mechanism of their formation may be considered.

Since a face-centred cubic lattice may be considered a body-centred tetragonal one with an axial ratio $c/a = \sqrt{2}$ and also a body-centred cubic lattice as a body-centred tetragonal lattice with an axial ratio $c/a = 1$, the transformation from austenite to martensite takes place very probably in the order:

Tetragonal lattice ($c/a = \sqrt{2}$)
$\longrightarrow$ tetragonal lattice ($c/a = 1{\cdot}06$)
$\longrightarrow$ tetragonal lattice ($c/a = 1$),
or austenite $\longrightarrow$ α martensite $\longrightarrow$ β martensite.

Thus the mechanism of the formation of these martensites from austenite is very simple; the tetragonal lattice ($c/a = \sqrt{2}$) is first to be compressed uniformly in the direction of the c-axis and at the same time uniformly expanded in the perpendicular direction. α martensite is obtained when the axial ratio of the tetragonal changes from $\sqrt{2}$ to $1{\cdot}06$, and β martensite when the ratio changes farther to 1.

In the outer layer of a quenched steel, where the cooling is very rapid, the first change, austenite $\longrightarrow$ α martensite, is partially arrested, and the second

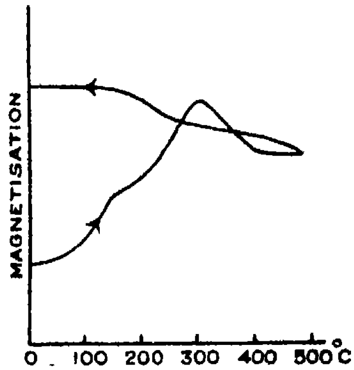

FIG. 2.—Magnetisation-temperature curve.

change, α martensite $\longrightarrow$ β martensite, is completely hindered, so that the outer layer must contain α martensite mixed with a small quantity of retained austenite; while in the inner portion, where the cooling is less rapid, the first and the second change will take place almost completely, so that the inner portion must contain almost pure β martensite. These conclusions agree satisfactorily with the results of our experiments.[1]

As regards the properties of α and β martensites, the following may be said with certainty:

Specific volume (V):

$$V_{\text{au.}} < V_{\alpha\ \text{mart.}} < V_{\beta\ \text{mart.}}$$

Magnetisability (I):

$$I_{\text{au.}} < I_{\alpha\ \text{mart.}} < I_{\beta\ \text{mart.}}$$

Specific electric resistance (R):

$$R_{\alpha\ \text{mart.}} < R_{\beta\ \text{mart.}} < R_{\text{au.}}$$

Hardness (H):

$$H_{\text{au.}} < H_{\alpha\ \text{mart.}} < H_{\beta\ \text{mart.}}$$

The following remark regarding the stepped change in Fig. 1 is very important. According to our view, the first step at about 170° is not due to the precipitation or the decomposition of the martensite, as it is usually believed to be, but to the transformation of α martensite to β martensite. Of course it is to be assumed that the decomposition of β martensite begins to take place far below 100°, its ratio being at first very small and rapidly increasing with the rise of temperature. In other words, the first step in Fig. 1 is not an abrupt change in the rate of decomposition of the martensite, but is due to the transformation of α martensite to β martensite, the rate of decomposition being assumed to increase steadily. The abrupt change in different physical properties in the vicinity of 170° agrees in its direction with what is to be expected from the inequality relationships given above.

KOTARÔ HONDA.
SINKITI SEKITO.

[1] See also the communication to Werkstofftagung, Nov. 21, 1927 (Berlin).

Directional Wireless and Marine Navigation: the Rotating-Loop Beacon.

IN a previous contribution to NATURE (vol. 120, p. 774, Nov. 26, 1927) under the title "Directional Wireless as an Aid to Navigation," a survey was given of the present position of the application of wireless signalling methods to the navigation of ships and aircraft. Towards the end of that article brief mention was made of the rotating-loop method of directional transmission, with the intimation that the application of the method to marine navigation was then under investigation. As these experiments have now given results which make it possible to state that the method will prove of great importance in the future application of directional wireless to marine working, it is considered to be desirable to complete the above survey by summarising briefly the main conclusions arrived at.

The rotating beacon system of directional transmission has been developed to a high degree in Great Britain by the Royal Air Force, as providing a method of navigating aircraft without the necessity of carrying additional and elaborate apparatus in the machine itself. The transmitter employs a vertical frame coil which rotates at a uniform speed about a vertical axis, and which is supplied with radio-frequency oscillations from a suitable valve. The radiation in any direction varies as the cosine of the angle between the direction and the plane of the coil, and thus the signal intensity at a fixed receiving point varies from a maximum when the plane of the coil is in the direction of the receiver to a minimum or zero when the coil is perpendicular to this direction. Bearings are obtained on this transmitter by observing the time at which the signal minimum occurs after the transmission of a characteristic signal, which is sent when the plane of the coil is perpendicular to the geographical meridian. From a knowledge of the time of rotation of the coil, usually sixty seconds, the bearing of the receiver from the transmitter can be calculated. The bearing so obtained can be checked for every 180° rotation of the coil, that is, at half-minute intervals. Since the accuracy of observation is directly dependent upon the speed of rotation it is necessary that this shall be maintained very uniform. A combination of a tuning fork and phonic motor has been found to provide a simple and efficient means of speed control giving an accuracy superior to that required in the practical use of the beacon. Since the timing is but an intermediate process in obtaining a bearing, it is possible for the observer to use a stop-watch or chronograph provided with a dial marked in the form of a compass card, with both degrees and points of the compass. By starting such a watch on the North signal and observing the position of the index hand at the occurrence of the signal minimum, the bearing can be read straight off the dial.

Using such a type of rotating beacon in a series of experiments carried out in ships, it was found that for clear open-sea ranges up to 50 or 60 miles the observed wireless bearings agreed within an extreme limit of 5° with bearings estimated by other navigational methods, and in about 70 per cent. of the cases the agreement was within 2°. In subsequent experiments it was shown that for ships at anchor at distances of 90 to 100 miles, the wireless bearings observed in the day-time agreed to within 4° with the bearings calculated from the ships' positions. At distances exceeding 60 miles, however, wireless bearings from the rotating beacon were found to be subject to night effects similar to those experienced in wireless direction-finding. The errors resulting from these effects were not found to be very serious until the range of transmission exceeded 90 miles over sea, beyond which the errors of individual bearings amounted to 21°. Even in these circumstances, however, a moderately accurate bearing could be obtained by taking the average of a series of consecutive readings over a period of ten to fifteen minutes. The minimum range at which night errors were encountered was considerably reduced when the transmission was entirely or partly over land.

It will be evident from these results that the rotating beacon gives bearings comparable in accuracy with those obtainable with an ordinary direction-finder. This conclusion has been verified in the course of the investigation by some special experiments in which a direct comparison was made between the bearings observed on the rotating beacon and those obtainable with a direction-finder used on board the ship in the ordinary manner. When used in fixed positions on land, the direction-finder gives a somewhat superior accuracy, as it is not easy to obtain bearings on the rotating beacon to a better accuracy than two degrees; whereas a good land D.F. station should give bearings reliable to one degree. When wireless bearings are taken on board a ship at sea, however, the case is somewhat different. The D.F. bearing is taken relative to the ship's head, and its accuracy depends upon the steadiness of the ship and also upon the accuracy with which the direction of the ship's head is given by the compass reading at any desired instant. The bearing obtained by the rotating beacon is entirely free from this limitation, and its accuracy is practically the same whether the ship is at sea (in motion or at anchor) or in dock. Furthermore, no correction or compensation is necessary corresponding to the quadrantal error associated with the ship direction-finder. The limitation of range of accurate bearings due to night effect has been shown, both theoretically and experimentally, to affect both systems to the same degree.

From a scientific point of view, it thus appears that while there is little to choose in direction-finding between the rotating-loop transmitter and the rotating-loop receiver, the former may have a slight advantage for navigation purposes. It must remain for the mariner himself to become familiar with the operation and performance of each system and determine the sphere of their application as scientific aids to modern navigation.

R. L. SMITH-ROSE.

National Physical Laboratory,
Teddington, April 12.

Devices for Increasing Accuracy in Weighing.

WHEN high precision in weighing is essential, a considerable improvement is effected by constructing a rider which is supported on a point instead of resting on the beam by contact at two or more places as in the ordinary pattern. In order that the graduated beam scale may carry such a rider, the former must be of reasonable thickness.

This method of construction eliminates the uncertainty regarding the position of the beam at which the weight of the rider is applied. With certain precautions a reading to less than 0·1 mgm. can be made, and slight readjustments of the rider to give an exact balance, if required, can be carried out much more easily than with the standard rider.

Whilst it is true that few chemical balances as ordinarily used will enable weight determinations to be made to an accuracy greater than 0·1 mgm., the sensitiveness of the balance is in many cases actually such that it will allow of this if certain precautions are taken. The inconsistency that is noticeable when working to the limit of sensitiveness is due to the lateral shift of the whole beam to left or right each time the beam is released from its fixed supports. This of course gives a perceptible shift in the zero

when observing swings on the fixed scale at the base of the main pillar.

If small differences in weight (of the order of a few milligrams) are being observed, where it is possible to obtain equilibrium by altering the position of the rider *without* raising the beam knife edge, this error does not arise, and a method of reading the exact position of the rider is at once of value. Where, however, it is necessary to raise the beam, accuracy can be obtained by making several observations of the zero of swings, between each of which the beam is raised and lowered again, and the mean of the zero positions taken. In this case a knowledge of the sensitiveness of the balance is of course essential for calculating the required difference in weight.

The rider in question can be constructed by using two pieces of clean nickel-chromium wire, one of which is bent as in Fig. 1*a*. One end of the other piece is wound round the horizontal part of the first, starting at the centre and leaving a small downward projection which acts as the *point support* of the rider. After a few turns, the wire is bent round to form a loop which is finished off by winding the free end towards the centre of the horizontal portion. Adjustment of the weight is made by cutting from the legs. The finished rider appears as in Fig. 1*b*.

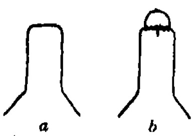

Fig. 1.

To avoid parallax in reading the exact position of the rider, a paper scale of the same dimensions as that of the rider scale can be pasted on to the glass front or back of the balance case, so that the eye reading the position of the rider may be placed at right angles to the beam at the point where the rider is situated.

Similarly, a suitable paper scale attached lower down, to the front glass of the balance case, enables accurate readings of the swings to be made even though the beam pointer be some distance in front of the scale at the base of the pillar.

Another device which has been found useful is a glass tube inserted through the side of the balance case and resting on the base. The tube is turned up underneath the left balance pan, and a rubber bulb is attached to the end of the glass tube outside the balance case. A slight pressure on the rubber bulb causes a puff of air on the under side of the pan, and this enables the beam to be set swinging to any desired degree, and the amplitude can be increased or diminished with ease.

F. C. Guthrie.

Chemical Laboratories,
The University,
Liverpool.

Light-scattering at Critical Opalescence.

Messrs. Ornstein and Zernike have published in a series of articles, notably one in *Phys. Zeits.* (**27**, 76; 1926), a theory of light-scattering, correcting that of Einstein, with the idea of accounting for the experimental fact that the scattered intensity at the critical opalescence of a pure substance or a binary mixture is not infinitely great. Their formula refers to the scattering at 90° of the incident beam. One can easily generalise it, for a direction of which the angle with the incident beam is θ. One therefore finds for Lord Rayleigh's ratio, and in their notations:

$$i = \frac{4\pi^2\mu^2\left(\frac{\partial\mu}{\partial v}\right)^2}{\lambda^4} \cdot \frac{\frac{RT}{N} \cdot v}{-\frac{\partial p}{\partial v} + \frac{8\pi^2}{3}\frac{RT}{v^2}\left(\frac{\epsilon\mu \sin^2\theta/2}{\lambda}\right)^2}. \qquad (1)$$

$-\partial p/\partial v$ vanishes at the critical point. For a binary mixture, $-\partial p/\partial v$ must be replaced by another term, which also vanishes at the critical point of complete miscibility. It is known that Messrs. Ornstein and Zernike have deduced from their theory that the opalescence ought to be in $1/\lambda^2$ instead of $1/\lambda^4$ for the ordinary scattering; that is, during the passage through the opalescence, the scattered light ought to be seen less blue. We were unable to verify that law in the literature, but we deduce from the formula (1) other consequences, capable of experimental proof:

(1) By integration of the scattered light in all directions at the point of critical opalescence, formula (1) gives an infinite absorption coefficient.

(2) If one observes in two directions θ and $180° - \theta$ the same part of the beam, the ratio of the brightnesses would be according to (1) $1/tg^2\theta/2$, that is to say, 7 or 8 for θ near 40° (instead of 1 as in the theory of ordinary scattering).

(3) If we are not quite at the critical point, $-\partial p/\partial v$ does not vanish, and, if the incident beam is white, the scattered light in the direction θ (between 0 and 90°) ought to be bluer than that scattered in the direction $180° - \theta$.

We have tried to check experimentally these last two consequences, comparing by means of a simple optical apparatus the light scattered in two directions θ and $\pi - \theta$, symmetrical in respect to the beam. We ascertained that the brightnesses were the same on both sides, as well as the tint of the light, and that only so long as the observations were really made on a uniform phase of opalescence, before the precipitation of the 'critical fog,' which is, of course, no longer opalescence. Observations were made principally on a water-phenol mixture. The necessary optical adjustments were previously made with a solution of fluorescein in an identical container.

We made no measurement of the whitening of the critical opalescence; we had the impression it exists, but that it results more from the disappearance of Purkinje's effect than from an inherent cause.

It would therefore be a fault in the very ingenious theory of Messrs. Ornstein and Zernike which prevents them from getting the best out of their new principle: the influence of the cohesion forces on the fluctuations in density. We think we can see that fault when they *admit* a proportionality between the quantity $1 - F$ to $-\partial p/\partial v$ (see paper cited above), which means, they suppose that the classical theory of fluctuations in density is valid for big volumes, but not for small ones, and, specially, the mean square of the fluctuations might become infinite in a big volume and not in a small one: that is not at all certain.

Y. Rocard.

Collège de France, Paris.

M. Ponte.

École Normale Supérieure, Paris.

The Velocity Coefficient for Bimolecular Reactions in Solution.

In a paper of the above title, in the January *Journal of the Chemical Society*, Norrish and Smith have attempted to find a relation between second-order velocity coefficients for reactions between organic molecules in solution and the temperature coefficients of the reaction rates. As is well known, Hinshelwood has found that for second order gas reactions the rate of reaction can be found by multiplying the number of collisions between reactant molecules by a term $e^{-E/RT}$, where E is the experimentally determined energy of activation. Such an expression might arise from any of several mechanisms of activation and reaction. Norrish and Smith have now found that when it is attempted to calcu-

late reaction rates in this same way for reactions in solution, the calculated rates are too large, and that a probability factor, P, must be introduced, which represents the chance of reaction at a collision involving activated molecules. The values found for P in a few reactions range from 4×10^{-11} to $4 \cdot 92 \times 10^{-5}$. The explanation which they offer for these very small values of P is that simple binary collisions seldom occur, and that a third molecule will often remove a portion of the energy and thus cause deactivation.

It seems to me that the effect of the third molecule should be activational in some cases, perhaps as often as it is deactivational, and that in any case the explanation of the small values found for P does not lie entirely in the frequency of ternary collisions. There are two other reasons, which were not suggested by Norrish and Smith, which would lead to small values of P, and to a great range of variation in these values. The first of these is the solvation of the reactant molecules, which should be expected to shield them from each other, reducing the chance of reaction upon collision by a factor which does not appear to be predictable. This effect should have a temperature coefficient, and there is thus the possibility that in some cases the value of E calculated from the overall temperature coefficient of the reaction will be too large; the calculated value of P would then be too large also, since the exponential term would be too small. An effect such as this is thus capable of accounting for large variations in the value of P.

The other reason why P should be small in all the reactions considered is to be found in the complexity of the reactant molecules. One of the reactions, for example, is between nitrobenzyl chloride and trimethyl amine. It is surely to be expected that a very special orientation at collision is a necessary condition for reaction in such a case; in the bimolecular gas reactions, which involve quite simple molecules, such as nitrous oxide, the orientation is of course of much less importance, but for those complex organic molecules a contribution to P of the order of 10^{-6} from this factor would not seem to be unreasonable.

There thus seems to be ample reason for expecting P to be small for reactions of the type studied by Norrish and Smith, and for it to vary markedly from one reaction to another, and even with change of solvent for the same reaction. There appears, however, to be slight chance of deriving even rough theoretical values. Indeed, the simple kinetic theory expression for the number of collisions is of doubtful validity in condensed systems.

LOUIS S. KASSEL.

Gates Chemical Laboratory,
California Institute of Technology,
Feb. 22.

Clot Bey and the Cairo School of Medicine.

MY attention has been directed to two paragraphs in the News and Views columns of NATURE of Jan. 14 concerning the centenary celebration of the School of Medicine, Cairo, and the International Congress of Tropical Medicine and Hygiene. It is stated in those paragraphs that "The story goes that one afternoon the Viceroy Mohammed Ali was driving through the streets of Cairo on the way to Shubra Palace when he ordered his coachman to stop, and summoning a well-dressed Frenchman who was walking along the streets, informed the stranger that he wanted him to create a Medical School in Cairo. . . . Clot Bey, in spite of his ignorance of medicine, was an able man, who accomplished the task thus entrusted to him with conspicuous success, which was recognised later by the conferring of the M.D. degree on him by the University of Paris."

The facts are that Dr. Clot, who was already a qualified French medical man, was called in 1825 to come to Egypt to organise the Medical Service of the Egyptian Army. He was followed by 154 European medical officers and apothecaries. It was only in 1827, that is, two years after his arrival in Egypt, that he started the Medical School. There is at the School of Medicine most of the literature of the time bearing out the authenticity of these facts. Dr. F. M. Sandwith, in a paper on the history of Kasr-el-Aini Hospital, A.D. 1466–1901, that appeared in the records of the Egyptian Government School of Medicine in 1901, mentions the details of the foundation of the School and gives many references on the subject.

In view of these facts, I can scarcely imagine that there could be any authentic source for the romantic account of the foundation of the Cairo Medical School referred to above.

M. KHALIL.

Faculty of Medicine, Cairo.

I AM sorry that Prof. Khalil has demolished the romantic tradition of Clot Bey, which for many years I had firmly believed to be the true story of the founding of the Cairo School of Medicine. In extenuation of my lapse in giving a new and wider circulation to this myth, I should explain that the brief statement referred to summarised my recollection of an elaborate and very circumstantial story given me years ago, when the late Dr. Sandwith was writing his history, by men who seemed to speak with intimate knowledge and authority. I am willing to admit that the British members of the staff of the Cairo School of Medicine in those days included several raconteurs of quite exceptional inventiveness, but I never had any reason to assume that this narrative was not true. The whole point of the story, as I heard it, was to emphasise the argument that the high efficiency of a medical school such as Clot Bey had created in Cairo was due to his administrative ability and judgment in selecting the right men for his staff.

THE WRITER OF THE NOTES.

The Correction of Astigmatism.

EVEN the more scientific members of the optical profession scarcely seem to be aware of their debt to mathematics for the discovery of the modern method of adjusting spectacle-lenses to suit astigmatic eyes. It is generally known that the first person to use cylindrical lenses for this purpose was Sir George Airy. During his tenure of the Lucasian professorship at Cambridge (1826–28), he had a pair of cylindrical lenses ground which corrected his own eye-sight. But we owe the complete general theory to a later Lucasian professor, Sir George Stokes (1849–1903), who was the first to prove mathematically that *any* eye (whether long-sighted or short-sighted) can be corrected for astigmatism (as well as those other defects) by using a lens which has one face spherical and the other cylindrical.[1]

To explain the importance (on the practical side) of Stokes's theorem, a few simple calculations may be added: an adequate outfit for an oculist may be taken to consist of 100 lenses (60 spherical and 40 cylindrical, the other faces being plane, in each case), combined with instruments to measure the

[1] For more details, any of the more advanced books, for example, Herman's "Geometrical Optics," ch. x. art. 174, may be consulted.

angle of rotation (of the second lens) round the line of sight. It is not very easy to give an exact estimate of the accuracy of the angles measured in practice; it would seem to vary from about 1° with high powers (5 to 7 diopters [2]) to about 5° with low powers ($\frac{1}{4}$ to $\frac{1}{2}$ diopter). As an *average*, we may perhaps assume that the apparatus admits of about 80 to 100 distinctive positions for the cylindrical lens: then the oculist has at his disposal the equivalent of

$$60 \times 40 \times 80 = 192{,}000$$
or
$$60 \times 40 \times 100 = 240{,}000$$

separate astigmatic lenses. In round figures, we may take the outfit as providing 200,000 lenses: and plainly, if each lens had to be ground separately, the cost of such an equipment would be prohibitive. Even at 1*s.* each, the cost would be of the order of £10,000; the actual cost of 100 lenses (at the same rate) would be £5, and we may perhaps add £5 to £10 to represent the cost of the instruments for measuring the angles of rotation. Further, the labour involved in choosing the lens best suited to a given eye would be increased very considerably; and much care would be required in storing the lenses, so as to be readily accessible when testing a patient's eyesight.

It was stated recently that more than a million pairs of astigmatic lenses are prescribed in Great Britain every year: but (without the discovery made by Stokes) it is doubtful if even a thousand pairs of eyes could be tested in the same time.

T. J. I'A BROMWICH.

Cambridge, April 7.

[2] The diopter is the power of a lens the focal length of which is 1 metre: thus, when the centimetre is the unit of length, the diopter is represented by $\frac{1}{100}$.

Science and Nature.

RETURNING last week from attending an International Moral Education Conference at the Paris Sorbonne, where the ambiguity of philosophical and scientific terms in current use was considered as being a serious bar to true international understanding, it was with especial pleasure that I read Dr. J. E. Turner's letter in NATURE of April 21. We did not, on this occasion, at the Sorbonne deal specifically with the word Nature, although we might well have done so in view of its notorious ambiguity. Dogmatism and ambiguity are generally contrasted, but they are nevertheless often allied.

May I direct readers' attention to John Stuart Mill's essay on Nature, which was published after his death. In this essay Mill contends that it would be difficult to find a word that is responsible for "more bad morality and bad law." He points out that a critical examination of all the confused uses to which this word has been put, reveals two main definitions:

1. That held by the early Greek and Roman philosophers, who enjoined, as a fundamental principle, that we should "follow Nature"; implying by Nature the entire system of things, including not only the blind physical and biological forces acting spontaneously, but also all human intelligence, belief, perception, understanding, and action. Mill argues that an injunction to follow Nature, thus comprehensively expressed, is obviously superfluous, seeing that no one could in any circumstances by any possibility do otherwise. He says, however, that to endeavour to understand Nature in that sense is another and indeed quite profitable task.

2. The popular definition, *Nature* considered as opposed to *art*: That is to say, *Nature* signifying the spontaneous course of blind physical and biological forces acting presumably in complete independence of human intelligence. Mill then argues that to follow this kind of Nature is clearly immoral, in that all the noblest human endeavours throughout the ages have invariably been directed towards stemming and counteracting its ruthless depredations. Mill makes this proposition clear by means of a large number of cogent and striking illustrations.

We must conclude, therefore, that Nature is often employed euphemistically as an evasive term, either to cover our ignorance or to express some passing feeling or predilection misconceived as a fundamental principle. When, more than fifty years ago, I was one of his devoted students, the great Thomas Huxley was wont to remind us that words and phrases were instruments of thought, not substitutes for clear thinking.

ST. G. LANE FOX PITT.

47 Chester Terrace,
London, S.W.1, April 24.

The Buoyancy of Whales.

IN letters recently published in NATURE (Mar. 17, p. 421; May 5, p. 710) Mr. R. W. Gray records the interesting fact that whales dying 'at a depth' invariably sink, while those (of certain species) which die at the surface always remain floating. He suggests that the failure to rise after death may be due to the escape of air from the lungs, and in his second letter he attributes this to the water-pressure, which at a certain depth becomes sufficient to overcome the resistance of the valves of the blow-holes.

It does not seem probable that these statements are based on actual observation of the escape of air, and I think the explanation should not be accepted unless Mr. Gray can bring forward definite evidence that his suggestion is correct. He has informed us that a Greenland Whale barely floats after death at the surface, and it follows that its specific gravity does not differ greatly from that of sea-water. At considerable depths, whether the animal be dead or alive, the volume of its thorax must be appreciably reduced by the pressure of the water. The diminution of size involves an alteration of the specific gravity, which might well become greater than that of the water, in which case the dead whale would remain at the bottom. The fact that the carcase may rise to the surface later, after gases of decomposition have generated in the tissues, does not seem to preclude this suggestion.

The statement (p. 710) that when a whale wishes to sink it compresses its lungs is also open to criticism. I think it descends by swimming downwards, and it seems unnecessary to assume that it must deliberately alter the size of its thorax before it can leave the surface.

In another issue (April 14, p. 576) Mr. T. H. Taylor suggests that the filling of the lungs of whales may be due to the elastic recoil of the thoracic wall and not to a muscular effort. Is this not also improbable? The diaphragm is highly developed in the Cetacea, and definite evidence is surely required before it can be concluded that its function is not the same in these and other mammals. The extent of its projection into the cavity of the thorax (in the dolphins at least) should make it specially efficient in enlarging the chest by its contraction. The ribs of a large whale are, moreover, so heavy and massive that it is difficult to imagine an elastic recoil of sufficient force to expand the cavity of the thorax fully. There is no difficulty in supposing that the movement of the ribs during the act of inspiration is due to muscular action, as in other mammals.

SIDNEY F. HARMER.

Melbourn, Cambs.

An Optical Paradox.

THE paradox propounded by Mr. T. Smith in NATURE of Feb. 25 lays emphasis upon an important aspect of physical measurement and demands explanation. The considerations recorded in NATURE of April 7, in the letters of Dr. Campbell and Mr. Smith, leave the question unsettled, and I venture to give an explanation which would appear to be less forced and touches principally the process of reasoning.

The solution to the paradox seems to lie in a critical regard for the nature of the identity which is implied by equality. The sense datum upon which the experiment ultimately depends is the direct perception of relative dissimilarity of the contributory sensations. In the absence of perceptible dissimilarity the derived judgment is arrived at, stating the equality of the two stimuli. At each successive observation the observer perceives the same appearance, and in effect asserts the absence of the sensation of what can be referred to as contrast. (Proceeding otherwise he might, as in other methods of photometry, estimate and compare degrees of contrast.)

Now it is elementary knowledge that in any calculus of reasoning a relation of equality subsists between given entities by virtue of the identity under certain conditions of certain essential properties stated in the definition of the equality. In the present case the statement of equality proceeds from the inferred identical similarity of the contributory sensations, this step in arriving at the final judgment of the observer being legitimate if it be premised that insensible increments in stimulus do not affect sensation. This would be granted unless it were proposed to modify arbitrarily the connotation of terms.

Although, however, the equality may be regarded as established by this means, it should be noted that no relation between the properties not involved in the identity is established. The step made in concluding that, physically regarded, such properties as, for example, the candle power are the same is thus not rigorously supported by the observational data, and in extending the relation to these properties in order to render their physical measurement possible a logical *non sequitur* is incurred. This is the fallacy which gives rise to the paradox.

J. W. PERRY.

London, N.W.1.

Lucretius's Anticipation of Mendelism.

IN his review of the new edition of Munro's translation of Lucretius, in NATURE for April 14, Prof. D'Arcy Thompson refers to the many scientific 'anticipations' that are to be found in that wonderful poem, which has fossilised, so to speak, some fragments of the lost world of ancient wisdom. I have never seen any mention made of a passage in the "De Rerum Natura" in which the three fundamental postulates of Mendelism are laid down as the rules of heredity, and I think it deserves to have attention directed to it.

The passage is in Book 4, ll. 1210 *et seq.*, and in the 1898 Cambridge edition of Munro's translation it runs as follows:

"Sometimes the children may spring up like their grandfathers and often resemble the forms of their grandfathers' fathers, because *the parents often keep concealed in their bodies many atoms mixed in different ways*, which, *first proceeding from the original stock one father hands down to the next father*, and then *from these Venus produces forms after a manifold chance*, and repeats not only the features but the voices and hair of their forefathers."

The three italicised passages enunciate (seriatim)

(*a*) The principle of recessive (and by implication, of course, of dominant) characters.

(*b*) The constitution of the organism out of combinations of immutable unit characters.

(*c*) The chance recombination of these in mating.

R. C. McLEAN.

University College,
Cardiff.

Stellar Radiation and the Nature of the Universe.

THE difference between theory and practice is admirably illustrated by our solid, three-dimensional brain-minds theorising about fourth and other dimensions of space and 'matter,' and yet visualising a cyclic universe the radiations of which are related only to the superficies of matter! It seems that most of us are still unable to form actual conceptions of the *depths* of space as a condition different from the depth of a three-dimensional form of physical matter in space. Tyndall believed that the sum of Nature's energy is constant, and that "the utmost man can do in the pursuit of physical truth or in the applications of physical knowledge is to shift the constituents of the never-varying total . . . *the flux of power is eternally the same.*" Tyndall surely did not imply by this that "just as much matter is created as destroyed" (NATURE, April 28, p. 674). He seems to distinguish the constituents from the *flux* of power with which, say, a sixth-dimensional mind might be quite happy without our physical constituents.

We are in equal darkness regarding both the origin and destiny of radiation, stellar or otherwise. From what interiors of space or matter come the 'flux of power' or the rays investigated by physicists? Into what 'depths' do they disappear by transmutation, electro-magnetic exchange, quantum action, or by 'actions' unknown on this planet?

W. W. L.

April 28.

Prices of Periodical Scientific Publications.

THE letters of Dr. Baini Prashad and Mr. Wilfrid Bonser in NATURE (Mar. 31 and April 7) directing attention to the prices of certain German scientific periodicals, particularly those published by the firm of Julius Springer, Berlin, are very timely; for to many libraries the question whether they can afford to continue to purchase such periodicals must be a serious one. The Library Committee of this University has had the matter under consideration more than once in the course of the last year or two; for in view of the high cost of several of these periodicals, taken by the Library, the Committee has not infrequently been compelled to forego the purchase of important biological works. One is naturally reluctant to discontinue subscribing to periodicals of long standing and established reputation, but for many libraries and institutions with limited funds at their disposal for the purchase of biological books, this would seem to be the only way out of the difficulty. It is to be hoped that the present high charges for the journals in question will be speedily reduced.

F. C. NICHOLSON.

University Library,
Edinburgh.

Conversion in Science.[1]

By Prof. G. ELLIOT SMITH, F.R.S.

ON Nov. 13, 1859, eleven days before the publication of "The Origin of Species," Darwin wrote: "If I can convert Huxley, I shall be content."

Before his work was published Darwin fully realised the difficulties of the task he was undertaking in trying to convince his fellows of the reality of evolution. Hence he was anxious to secure the help of Hooker, Lyell, and Huxley. When we recall the obstacles that throughout the ages have ever hindered the advancement of learning, and in particular the efforts of isolated pioneers to obtain recognition for views that ran counter to strongly entrenched traditions, we can appreciate Darwin's good fortune in securing the sympathetic consideration of three such exceptional men as Sir Joseph Hooker, Sir Charles Lyell, and Thomas Henry Huxley. Different as they were in temperament and mental attitude, each of them in his own department was endowed, not only with wide and exact knowledge, but also with rare powers of clear insight and sound judgment. If he could convert Lyell, Hooker, and Huxley, Darwin knew that the future could take care of itself.

There never was any doubt about Hooker's attitude: for he had been so intimately associated with Darwin in the building up of the argument that they may be said to have kept step in the advance. But Lyell and Huxley had yet to be won over. If Lyell did not give his active support to the great scheme until the battle was won—largely as the result of Huxley's persistent championship—it must not be forgotten that his book, "The Principles of Geology," was, as Huxley expressed it, "the chief agent in smoothing the road for Darwin."

"It brings home to any reader of ordinary intelligence a great principle and a great fact—the principle that the past must be explained by the present, unless good cause can be shown to the contrary; and the fact that so far as our knowledge of the past history of life on our globe goes, no such cause can be shown."

Huxley finished reading the proof of the "Origin" two days before the book was published, and on the following day Darwin received his verdict in these words: "I think you have demonstrated a true cause for the production of species, and have thrown the *onus probandi*, that species did not arise in the way you suppose, on your adversaries."

It is difficult for us at the present time to appreciate Huxley's reluctance to accept the fact of evolution. For once the morphological similarities of nearly related animals were appreciated, and the essential identities in ontogeny were admitted, what explanation was possible other than the recognition of a common origin? The idea of evolution was of course familiar to him, and had been the subject of repeated discussions with Herbert Spencer and others.

In his essay on "The Reception of 'The Origin of Species'" Huxley has given a characteristically frank account of his own conversion. While he "had long done with the Pentateuchal cosmogony," even the persistence and the dialectic skill of Herbert Spencer were impotent to persuade him to admit the reality of evolution. He justifies his stubborn refusal, not because the unconvincing arguments of Lamarck and the author of "Vestiges of Creation" antagonised him, for, as Dr. Chalmers Mitchell clearly showed in his Huxley Memorial Lecture a year ago, Huxley had a peculiarly keen sense of logic and cogency, but because "the evidence in favour of transmutation was wholly insufficient, and no suggestion respecting its causes had been made which was in any way adequate to explain the phenomena." He did not accept the hypothesis of natural selection as the adequate explanation: but Darwin's insistence on the facts revealed by selective breeding of domestic animals and plants convinced Huxley of the possibility of finding natural factors to establish the fact of transmutation. No longer did he harbour any doubt as to the reality of evolution. To quote his own words:

"I imagine that most of those of my contemporaries who thought seriously about the matter were very much in my own state of mind—inclined to say to both Mosaists and Evolutionists, 'A plague on both your houses!' and disposed to turn aside from an interminable and apparently fruitless discussion, to labour in the fertile fields of ascertainable fact. And I may therefore suppose that the publication of the Darwin and Wallace paper in 1858, and still more that of the 'Origin' in 1859, had the effect upon them of the flash of light which, to a man who has lost himself on a dark night, suddenly reveals a road which, whether it takes him straight home or not, certainly goes his way. That which we were looking for, and could not find, was a hypothesis respecting the origin of known organic forms which assumed the operation of no causes but such as could be proved to be actually at work. We wanted not to pin our faith to that or any other speculation, but to get hold of clear and definite conceptions which could be brought face to face with facts and have their validity tested. The 'Origin' provided us with the working hypothesis we sought. Moreover, it did the immense service of freeing us for ever from the dilemma—Refuse to accept the creation hypothesis, and what have you to propose that can be accepted by any cautious reasoner? In 1857 I had no answer ready, and I do not think that anyone else had. A year later we reproached ourselves with dullness for being perplexed with such an inquiry. My reflection, when I first made myself master of the central idea of the 'Origin,' was 'How extremely stupid not to have thought of that!' I suppose that Columbus' companions said much the same when he made the egg stand on end. The facts of variability, of the struggle for existence, of adaptation to conditions, were notorious enough; but none of us had suspected that the road to the heart of the species problem lay through them, until Darwin and Wallace dispelled the darkness, and the beaconfire of the 'Origin' guided the benighted."

This illuminating confession is the clearest and

[1] From the Huxley Memorial Lecture, delivered at the Royal College of Science, South Kensington, on May 4.

most searching analysis we have of the factors that play a part in the process of conversion in science. Huxley was a man of rare insight and courage: he had at his command all the information that was necessary to convince him, not only of the reality of evolution, but also of the fact that man could not be left out of the scope of the process of transmutation once he accepted it. Yet he held back. He needed a working hypothesis to convince him of the possibility that transmutation might be effected by some natural process.

Huxley's great service to learning was not simply the fact that once he was convinced of the truth of evolution he devoted himself to the task of converting the world of educated men and women, but that he concentrated attention upon the problem of man's status. By so doing he effected perhaps the greatest revolution that has ever been effected in the attitude of mankind to knowledge in general, for all learning is inevitably centred upon man and his relationship to the Universe.

It is the human aspect of the problem that I specially want to study in this lecture.

It is one thing to convert men of exceptional insight and understanding such as Hooker, Huxley, and Lyell, but quite a different matter to convince men of average ability. Darwin complained that he "found the most extraordinary difficulty in making even able men understand at what he was driving" (letter to W. B. Carpenter, 1859). In particular was he distressed by the unfair and ignorant criticisms of opponents who failed to understand his theory. In December 1860 he was forced to admit: "I can pretty plainly see that if my view is ever to be generally accepted, it will be by young men growing up and replacing the old workers, and then young ones finding that they can group the facts and search out the new lines of investigation better on the notion of descent than on that of creation." This is true of all learning that is coming for the first time under the influence of the scientific discipline. Its hope is in youth and the coming generation rather than in men already involved in the shackles of conventional views, who, as Anatole France expressed it, "are no longer curious."

This is a true picture of what usually happens in any progressive movement. The number of men competent to understand a new generalisation and apply it in practice is lamentably small. As Darwin confessed, we have to look at young men, who are free from traditional obsessions and are ready to embark on new adventures that seem hazardous to their elders. Before their views become set in a rigid mould men would welcome hypotheses that provide satisfying explanations of the growing knowledge and provocative ideas to stimulate new inquiries.

The two great obstacles that stand in the way of the acceptance of a new interpretation of evidence are exemplified in the cases of Lyell and Huxley. The former was hampered by tradition, the force of which it took eight years to overcome. Huxley was no longer under the influence of such restraints against clear thinking. His only reason for hesitancy was the fact that he could not imagine how evolution could be effected by known natural agencies. Hence when Darwin put forward a hypothesis to supply what was lacking, Huxley's conversion was, as he himself has explained, instantaneous.

Huxley has discussed with characteristic clearness and decision the much-misunderstood function of working hypotheses in science. I make no excuse for quoting him once more on a subject so directly relevant to my present argument.

In the preface to the English edition of Haeckel's book on "Freedom in Science and Teaching" (1879) he wrote:

"No profound acquaintance with the history of science is needed to produce the conviction that the advancement of natural knowledge has been effected by the successive or concurrent efforts of men whose minds are characterised by tendencies so opposite that they are forced into conflict with one another. The one intellect is imaginative and synthetic; its chief aim is to arrive at a broad and coherent conception of the relations of phenomena; the other is positive, critical, analytic, and sets the highest value upon the exact determination and statement of the phenomena themselves.

"Every science has been largely indebted to bold, nay, even to wild, hypotheses, for the power of ordering and grasping the endless details of natural fact which they confer; for the moral stimulus which arises out of the desire to confirm or to confute them; and last, but not least, for the suggestion of paths of fruitful inquiry, which, without them, would never have been followed. From the days of Columbus and Kepler to those of Oken, Lamarck, and Boucher de Perthes, Saul, who, seeking his father's asses, found a kingdom, is the prototype of many a renowned discoverer who has lighted upon verities while following illusions which, had they deluded lesser men, might possibly have been considered more or less asinine.

"Nor have I, for one, anything but cordial assent to give to his declaration, that the modern development of science is essentially due to the constant encroachment of experiment and observation on the domain of hypothetical dogma; and that the most difficult, as well as the most important, object of every honest worker is 'sich entsubjectiviren' to get rid of his preconceived notions, and to keep his hypotheses well in hand, as the good servants and bad masters that they are."

Assuming the rôle of champion of evolution, Huxley boldly attacked the most contentious issue and made "Man's Place in Nature" the cardinal issue of the conflict. The particular field that Lyell avoided, Huxley selected as his chosen battleground. In putting man into the centre of the picture Huxley was doing again, though in a vastly different way, what the French humanitarians did in the eighteenth century. Rousseau wrote in 1754: "The most useful and least advanced of all human knowledge seems to me to be that of man himself." However paradoxical this statement may seem, there can be no question of its truth. The question of man's origin and history, and the interpretation of human nature and behaviour, are problems that vitally affect and interest every human being. The essential subject matter of ethnology necessarily comes within the knowledge

of every human being. Each individual is aware of his own thoughts and actions, and is vitally interested in the behaviour of his fellow men and women. Everyone therefore knows from his own experience the essential truth concerning the great problems concerning which scholars have been wrangling for two centuries. Why then, it will be asked, is there any difference of opinion when everybody knows the truth? The answer to this query is provided by the history of the last two centuries, for to-day the truth is still obscured by the survival of the old conflict between the followers of Descartes and those who adopted the discipline of Newton.

In the remote past, all inquiries, whether astronomical or chemical, botanical or zoological, mathematical or physical, were essentially anthropocentric. In most early speculations what man was striving after was not knowledge, but the means of safeguarding his own life and prosperity. After the demolition of astrology, when this crude type of anthropocentrism was superseded, the attainment of the strict discipline of the scientific method was determined by the extent by which men could eliminate human emotions from their inquiries.

Huxley's achievement differed profoundly from the early revolutions in thought. While the latter aimed at subordinating the forces of Nature for man's benefit, Huxley's object was to assign man to his true place in Nature, and to discover his origin as a part of the natural processes. But his interest was not restricted to the biological aspects of the problem. He boldly plunged into the discussion of the cultural aspects of anthropology and, although he quoted the familiar phrase that had been handed down from the Cartesian scholiasts of the eighteenth century, he refused to accept the theory of "the similarity of the working of the human mind" as an adequate explanation of anything more than the simplest of inventions. Writing in the same year (1865) Mr. (afterwards Sir Edward) Tylor spoke with equal emphasis in favour of diffusion as the only possible interpretation of the facts; but in 1871 a subtle change was taking place in his opinions. Then he was admitting in the preface of his "Primitive Culture" the fact of his indebtedness to Adolf Bastian. While criticising in the most scathing terms, and with a wealth of forcible illustrations, his contempt for those who had pretended to ignore the historical method and the principles of diffusion of culture, Tylor himself was drifting towards the very views he was denouncing. He was developing his theory of animism (that there was an innate tendency in mankind to attribute life and soul to inanimate objects around them), and this enunciation of a 'natural law' brought about a sudden lapse into the Cartesian error, from which ethnology is still suffering.

It is a thousand pities that, when Tylor thus abandoned the Newtonian discipline, Huxley did not continue to insist upon the true principle of ethnology which he defined so clearly in 1865. But he was too fully occupied with biology to have time for ethnology, which he left to Tylor.

I have already referred to the important part played by Lyell's principle of continuity in geology in preparing the way for the acceptance of biological evolution. Yet a century before Lyell's time, essentially the same principle of continuity had been confidently applied to human affairs by Turgot, in words described by the late Lord Morley,[2] as "among the most pregnant, as they were among the most original, in the history of literature, and reveal in an outline, standing clear against the light, a thought which revolutionised old methods of viewing and describing the course of human affairs, and contained the germs of a new and most fruitful philosophy of society." The tragedy is that the true philosophy of society enunciated by Turgot in 1750 did not revolutionise old methods of viewing and describing the course of human affairs. In spite of Lord Morley's appreciation, as just as it is eloquent, of the greatness of Turgot's achievement, men failed to apply his teaching for the salvation of humanistic studies. It is, in fact, the most urgent need of ethnology at the present time that this long-delayed reform should begin. Turgot contrasted the operation of the laws of Nature with the behaviour of mankind.

"The phenomena of nature, subjected as they are to constant laws, are enclosed in a circle of revolutions that remain the same for ever! . . . The succession of men, on the contrary, offers from age to age a spectacle of continual variations. Reason, freedom, the passions, are incessantly producing new events. *All epochs are fastened together by a sequence of causes and effects, linking the condition of the world to all the conditions that have gone before it.* The gradually multiplied signs of speech and writing, giving men an instrument for making sure of the continued possession of their ideas, as well as of imparting them to others, have formed out of the knowledge of each individual a common treasure, which generation transmits to generation, as an inheritance constantly augmented by the discoveries of each age; and the human race, observed from its first beginning, seems in the eyes of the philosopher to be one vast whole, which, like each individual in it, has its infancy and its growth." (Lord Morley's Translation.)

This is a clear and definite statement of the principles of diffusion of culture, for the recognition of which some of us are still fighting to-day, more than one hundred and seventy years after Turgot.

Two centuries ago Fontenelle, the enthusiastic disciple of Descartes, was expounding the facts of human society in terms of his master's idea of "natural laws," and was pouring scorn on the historical method and the principle of continuity. In Scotland, where Cartesian philosophy retained a hold long after it had been replaced by the Newtonian discipline in England, and even in France, the ethnological teaching of Fontenelle survived the criticism of Turgot, and in 1777 was given a concrete form by Dr. William Robertson, Principal of the University of Edinburgh, in his "History of America." He maintained that the ancient civilisation of America was of independent origin; and in support of his speculation he referred to "such a resemblance in their manners and customs as necessarily arises from a similarity

[2] Lord Morley, in his article on Turgot in "Biographical Studies."

of their condition," a form of phraseology which, after nearly a century of half-hearted lip service, suddenly acquired the force of a dogma, when, having been revived by Adolf Bastian in 1860, it was adopted in 1871 by Sir Edward Tylor. Thus modern ethnology was brought under the influence of Cartesian philosophy.

Since Newton rescued astronomy and physics from the stranglehold of Descartes' method, every branch of science in its turn has been emancipated. Ethnology alone remains in the bonds of such superstition. For more than a century, it is true, men continued to render lip service to Turgot's recognition of the fundamental factors underlying human institutions, without, however, applying them with full understanding and consistency. Under the influence of Lyell's revival of the idea in reference to geology, Tylor in 1871 reaffirmed the fundamental importance of the principle of continuity and the historical method as the essential factors in the interpretation of the facts of ethnology. Thus in the first edition of " Primitive Culture " he wrote :

> " The notion of the continuity of civilization is no barren philosophic principle, but is at once made practical by the consideration that they who wish to understand their own lives ought to know the stages through which their opinions and habits have become what they are (p. 17). History, taken as our guide in explaining the different stages of civilization, offers a theory based on actual experience. This is a development-theory, in which both advance and relapse have their acknowledged places. But so far as history is to be our criterion, progression is primary and degradation secondary ; culture must be gained before it can be lost. Moreover, in striking a balance between the effects of forward and backward movement in civilization, it must be borne in mind how powerfully the diffusion of culture acts in preserving the results of progress from the attacks of degeneration. A progressive movement in culture spreads, and becomes independent of the fate of its originators " (p. 34).

Just as Huxley and Darwin in 1860 had to expose the fallacy that evolution did not necessarily imply progress, so Tylor had to explain, as Turgot had already done in 1750, that there is in man no innate impulse to compel him to embark on what we call progress. Yet this very error is the fallacy underlying present-day speculation. By a strange irony this reaffirmation of the sound principles that should find expression in all humanistic inquiries occurs in a book that was reviving the appeal to ' constant laws,' against which Turgot protested. For by claiming that mankind as a whole display an innate tendency to develop animistic beliefs Tylor was inventing a ' law of Nature ' for which there is no evidence. While referring to this flagrant defiance of the principle of continuity, one is tempted to quote Tylor's own warning. For the learned author of " Primitive Culture " himself discusses (vol. 1, pp. 378 and 379) with characteristic frankness the curious phenomenon that ethnologists enunciating certain views often cite evidence stultifying their own opinions. After giving specific illustrations of this neglect of logical consistency he makes this interesting comment : " Such cases show how deceptive are judgments to which breadth and generality are given by the use of wide words in narrow senses."

The late Sir Edward Tylor thus missed the great *opportunity of giving full expression to the principles* enunciated by Turgot. He was deflected from his purpose by his enthusiasm for the theory of animism—a lapse into the methods of Cartesian scholasticism that was fatal to a consistent exposition of the Newtonian method which Turgot had introduced into the study of mankind. If Tylor had not indulged in the speculation in animism that led him to accept the revival of this type of scholasticism by Bastian, he might have revolutionised the whole range of humanitarian studies, and have achieved in ampler measure what Lecky claimed for the great teachers of the seventeenth century, " destroying the old prejudices, dispelling illusions, rearranging the various parts of our knowledge, and altering the whole scope and character of our sympathies."

Air Conditioning in Industry.

By N. E. JACKSON.

AIR conditioning, as the term implies, is the treatment of air necessary to give certain conditions of heating, cooling, moistening, or drying of air contained in a given space. It may be more exactly defined as the application of scientific principles and engineering practice for the obtaining of specified and predetermined physical effects upon materials, human beings, or the atmospheric conditions in buildings, by treatment with air the temperature, humidity, and purity of which is definitely controlled. This treatment must, however, only be regarded as a means of securing a certain objective, either physiological effects on human beings, or physical effects on materials.

The general properties of air are well known. It should, however, be clearly understood that air is capable of very extensive treatment, such as heating and cooling, humidifying and dehumidifying. Its avidity for moisture is considerable ; the higher its temperature, the more water vapour it is capable of absorbing. Thus at a temperature of 45° F., one cubic foot of air when saturated holds in suspension 3·44 grains of moisture. At 100° F., one cubic foot of saturated air holds 19·98 grains of moisture in suspension.

Air conditioning is resorted to in a great many important industries which require special atmospheric conditions for the carrying out of some of the many processes involved. A few of its applications are enumerated below.

ARTIFICIAL SILK.

In this more recent and highly specialised branch of the textile field, correct atmospheric

conditions are absolutely essential. Fairly high humidities coupled with moderately high dry-bulb temperatures are required in the spinning rooms, otherwise crystallisation of the filament is likely to occur. In the reeling rooms, similar conditions must be maintained to avoid breakage of the yarn, whilst the sorting rooms must certainly be conditioned to ensure the silk maintains its correct moisture content, 11 per cent. of its weight being the maximum permitted.

DRYERS.

Dryers, generally constructed on the tunnel principle, are used in many trades, both with the object of speeding up production and ensuring uniformity of product.

In the brickmaking industry dryers are very essential, and when it is realised that a 10 lb. brick may contain from $\frac{3}{4}$ to $1\frac{1}{4}$ lb. of initial moisture, it is seen that for maximum output something more than natural drying by wind and sun is necessary. The time taken to dry bricks on the shed floor is 50 per cent. longer than with a modern tunnel dryer, and the cost of shed floor drying twice as great as with the modern apparatus; so in this trade the advantages of progressive drying are very obvious.

In timber drying by artificial means greater production (that is, more rapid seasoning) and a more uniform product are obtained. In progressive drying by hot air, the wet or 'green' material enters the dryer at the opposite end to the hottest air, so that the material is dried out gradually. If the reverse process is followed (as might be thought advisable on first consideration), the hotter air has a tendency to dry only the surface of the material, leaving the interior still wet.

The table following gives some of the more important articles in everyday use and their respective drying temperatures and length of time required for efficient drying.

TABLE I.

DRYING CONDITIONS.

Material.	Temp. (Degrees F.).	Drying Period.
Leather and hides	90°	2 to 6 days
Starch and salt	180°–200°	12 hours
Dried fruits	140°–180°	6 hours
Tobacco	85°–200°	..
Soap	100°	2 days
Wood (average timber)	105°	..
Rags	180°	18 hours
Pottery	120°	..
Bricks	150°–200°	30 to 60 hours
Cereals	180°	..
Beans and rice	140°–150°	..
Sugar (cane)	150°–200°	20 to 30 minutes
Coffee	160°–180°	24 hours
Glue	70°–90°	2 to 4 days
Paper	140°–150°	..
Rubber	80°–90°	1 to 2 weeks
Wool	105°	..

It will be noticed that in no case does the temperature at which drying is carried out exceed 200° F., whilst the drying periods vary enormously with the different products dealt with.

FOOD STUFFS.

Cool air is very essential for rapidly cooling pastry in order to prevent the contents of pies, and so on, from soaking into the pastry and spoiling its appearance, therefore making it unmarketable. In the fermenting department of a brewery a ventilating and cooling plant is very necessary, a large volume of cooled air being required to disperse rapidly the carbon dioxide given off from the vats, and to keep the temperature in this department below 66° F. to prevent the yeast going bad. Again, in the manufacture of chocolates with fancy fillings, after these have been coated with hot liquid chocolate they are placed on trays, and cleaned and purified air is blown over the trays. The air must be cooled in warm weather, the temperature in the coating department not being allowed to exceed 65° F., or a damaged and therefore unsaleable product results.

There are numerous other processes in food preparation that can only be properly carried out by the provision of air-conditioning equipment, generally automatically controlled to ensure exact temperature and humidity requirements.

HEATING AND VENTILATING BUILDINGS.

Many buildings are nowadays heated by the delivery of previously warmed air through a system of ductwork to the various rooms, the advantage being that rooms are heated and at the same time ventilated, instead of depending upon the opening of windows for ventilation, and on individual radiators or steam or hot-water pipes for the heating. The ideal system of heating by warm air is one which incorporates the previous moistening of the air, thus raising its relative humidity and preventing the parching effect of heated air, which, if not properly humidified, causes excessive evaporation of moisture from the skin of the individual.

Certain temperature and humidity conditions have been advocated by the medical profession as being most suitable for human requirements. Generally, in Great Britain, a room should be heated to a temperature between 55° F. and 65° F., the relative humidity ranging between 50 per cent. and 63 per cent. It is only by the maintenance of temperatures and humidities within the given range that ideal healthy conditions prevail in rooms occupied by human beings. By providing correct artificial atmospheres, the working efficiency of occupants of offices, etc., is considerably increased, there is less absence due to illness, and a great minimising of the tendency to respiratory and catarrhal diseases, so prevalent in overcrowded cities and manufacturing towns. In hospitals there is far less risk of contagion where there is a plentiful supply of fresh air at a suitable temperature.

(*Continued on p. 763.*)

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Research on the Control of Aeroplanes.[1]

By Prof. B. MELVILL JONES.

AN essential factor in the control of anything, whether it be a motor-car, a ship, or an aeroplane, is some means of applying the necessary force in the desired direction. The car requires its steering wheel, the ship its rudder. But this is not the only factor which decides the character of the control, whether quick or slow, difficult or easy. Other factors inherent in the craft to be controlled have to be considered. One such factor is inertia. A motor-car has very little inertia compared with the forces which can be exerted through the road wheels; consequently, it responds at once to a movement of the steering wheel, and the turning stops immediately the wheel is centralised. A ship has great inertia compared with the force exerted by the rudder; consequently the rudder must be applied some time before an appreciable turn is started, and reversed *against* the movement long before the ship has swung to its new course. The character of the control of a ship is thus entirely different from that of a car, on account of this factor of inertia, which has nothing to do with the controls themselves.

Another factor is the stability or instability of the motion when the controls are not moved. A stable motion is one which, if slightly disturbed, will settle back into its original form; an unstable motion is one which, after a slight disturbance, will depart further and further from the original form. In a modern car, the pivots about which the wheels turn in steering are arranged like the casters of a chair, so that the wheels have a slight tendency to turn to the side towards which the car is trying to slip. If the car moves round a curve, the centrifugal force makes it try to slip outwards, and the wheels, left to themselves, turn outwards and straighten the path. Such a car is stable and easy to drive straight; if the wheels had the opposite tendency, it would be unstable, and the driver would have continually to be correcting tendencies to swerve to one side or the other. An unstable car is not impossible to control, and may even, by practice, come to be controlled by unconscious reflex action, with no more fatigue than is felt in walking, but experience has shown that it is better to make it stable. It should not, however, be too stable, for then it will be heavy to steer round corners at high speeds, when the centrifugal force is large, and it will try to run down hill, so that, when travelling on the side of the camber of the road, it will have continually to be held out of the ditch.

The motor-car thus illustrates some important points which are common to the control of any kind of craft: although the control of an unstable craft may not be impossible, stability is on the whole desirable, but too great stability may introduce other undesirable qualities and may be as bad or worse than instability. A condition which might be described as benevolent neutrality is generally sought.

Again, a craft may be stable, in the sense that it tends to return when disturbed from a straight path, but it may overshoot on the other side farther than the original deviation, so that an oscillation of increasing magnitude may arise. Such an increasing oscillation is said to contain a negative damping term. Conversely, an oscillation which tends to decrease is said to contain a positive damping term. An example of a negatively damped oscillation occurs when a yacht's dinghy, loaded by the bows, is towed by a short rope. As the tow rope is shortened the dingy starts to yaw from side to side with increasing violence and may ultimately be swamped.

A negatively damped oscillation is difficult to control; an inexpert hand on the controls generally makes it worse. It is even possible to convert a truly stable motion into an increasing oscillation by inexpert use of the controls; this is generally due to lag, or the time interval between the impulse to control and the muscular response.

Long before successful man-carrying aeroplanes were developed, a division of opinion on matters of control was apparent. One side, which contained on the whole the practical men who tried to fly themselves, was mainly concerned with providing control organs and acquiring the skill to use them.

[1] Discourse delivered at the Royal Institution on Friday, Feb. 10.

The other side, which contained mainly the theorists and the constructors of uncontrolled models, were mainly concerned with the stability of the uncontrolled craft. This division of opinion continued well into the War, and traces of it are still present. A short historical sketch of this controversy may serve to make the present situation more clear, and the sketch can be used to illustrate certain important points in the control problem.

The great problem before the protagonists of the control school was to remain alive long enough to achieve sufficient practice and to perfect their apparatus. Their difficulty was greater than they could guess. Nature laid a trap for them, the full cunning of which we are only just beginning to realise. To understand this trap we must look a little into the matter. The first essential of steady flight is that the air shall exert a lift on the wings equal to the weight of the aeroplane. This lift depends upon speed through the air and upon the incidence, or angle, at which the wings strike the air. A typical relationship is shown in Fig. 1. If, in this example,

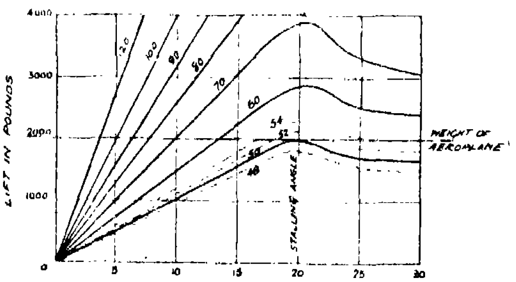

FIG. 1.—The aerodynamic lift, at different speeds and wing incidences, of an aeroplane which stalls at 50 miles per hour. (Numbers on curves show speed in miles per hour.)

the aeroplane weighs 2000 lb., it cannot be supported at speeds less than 50 m.p.h. At high speeds support can be obtained at a small incidence, but if the speed drops slowly towards 50 m.p.h., a point is reached at which the incidence will have to increase rapidly, and just above 50 m.p.h. flight will be possible at two alternative incidences, one considerably larger than the other. The minimum possible speed is called the stalling speed; the critical incidence, at which the minimum speed is just possible, is called the stalling incidence, and an aeroplane flying above this incidence is said to be stalled. So long as the speed is considerably greater than the stalling speed, the achievement of stability and control is relatively easy, but as the speed falls and the stalling angle is approached, changes occur in the air-flow about the wings which, unless special precautions are taken, render the aeroplane violently unstable and simultaneously destroy the power of control.

Now the nature of the trap is perceived. The early pioneers perhaps succeeded, with the help of the wind, in taking off at a speed greater than the stalling speed, which for their machines was very low. Possibly they carried out many flights without stalling and, delighted with the ease of control, were emboldened, on some favourable day, to glide to a considerable height above the ground. Sooner or later they were bound to stall and, if high up at the time, to kill themselves; for the motions following a stall are peculiarly violent, and liable to lead to heavy impact with the ground.

Herein lay the wisdom of the Wrights, the greatest exponents of the control school of thought. Warned by the experience of others, they suspected some such trap, and never in all their early work allowed themselves to get more than a few feet from the ground. They must have experienced the stall or the approach to the stall, for they discovered what is now known to be the simplest, though not the only counter to it—a powerful rudder. That was the turning-point in aeronautics, when the Wrights managed to get trained in control without being trapped and killed by the stall. After this, increased engine power and experience enabled the stall to be avoided more easily, and deaths from this cause became relatively less frequent, though it has still remained the principal cause of fatal accidents up to the present time. Early progress, however, lay all in the improvement of normal flight, and the study of the stalled condition was not taken up seriously until after the War.

The Wrights achieved their success with an aeroplane which was definitely unstable in several ways, counteracting the effects of this instability by acquired skill. Early design naturally followed this lead, and stability came to be regarded by many of the pioneer flyers as of no practical interest and indeed as a kind of bogy, invented by scientists for their own glorification. After a few important but not fundamental changes from the form in which the Wrights created them, control organs crystallised by about 1911 into a form typified by the BE 2 Aeroplane, produced in the Government Factory at Farnborough, under the guidance of Geoffrey de Havilland. Since that time the method of control, except for the introduction of balancing devices to lighten the pilot's effort on large aeroplanes, has scarcely altered, and the interest in the story shifts to the side of stability.

In 1896, Langley had worked out the general principles of stability sufficiently to make a model, driven by a small steam engine. This model was so stable and well balanced that it flew a distance of more than three-quarters of a mile.

About the same time, Lanchester, working with smaller gliding models, succeeded in unravelling the complicated factors which influence the stability of an aeroplane in normal flight (below the stalling angle), and his results, which he collected in a volume published in 1908, contained in essence most of the principles of practical importance which we employ to-day in the calculation of stability.

About 1911 two interesting things happened. Capt. Dunne made and flew successfully his remarkable tailless aeroplane with swept-back wings, which was undoubtedly extremely stable, probably far too stable for comfortable flying; and Prof. Bryan published a book in which he showed how calculations upon the stability of aeroplanes could be brought into line with conventional mathematics.

Dunne's line of development was not followed up, but we shall see something of the sort cropping up again towards the end of this lecture. Bryan's book was the foundation of modern methods of calculating stability.

Bryan's idea was to measure the effects of simple disturbances, such as rolls or pitches, separately, and thus to obtain a number of characteristic quantities, or 'derivatives' as they are called, which could be used in the calculations of stability. He did not have the means to make the necessary measurements, but the scientists of the National Physical Laboratory, who were already in possession of wind tunnels, set to work to determine these quantities for small models and to make the necessary calculations along the lines which he had indicated. The experimental campaign so started has been in progress ever since.

The application of this systematic study of stability to man-carrying flying machines was first made in the Government Factory at Farnborough by Busk. He modified the unstable BE 2A into the stable BE 2C by relatively small changes in the position of the centre of gravity and in the area and arrangement of the fixed surfaces on the end of the tail. This was a distinct step forward, and much notice was taken of it in the Press, where the opinion was freely expressed, mainly by non-flyers, that the safety of flying was now assured. This view was wrong; the provision of stability alone is not sufficient for safety, as Busk and his fellow-workers well knew. Safety is mainly concerned with the taking off and landing of aeroplanes, when a rapid response to control is even more important than stability.

The opposing school of thought—lineal descendants of the pioneer flyers—were naturally aggravated by this widely advertised and erroneous view of the relation between safety and stability, and the breach between the two schools widened still further, culminating in two extreme examples, the very stable SE 5, produced in the Government Factory at Farnborough, and the very unstable Camel designed by Sopwith. These two machines, diametrically opposed in every feature relating to stability, shared between them the brunt of the single-seater fighting during the later stages of the War; opinion ran high concerning their relative merits and the lines of thought which they represented. Readers of that remarkable diary " War Birds " will find the view of the supporters of the SE 5 forcibly expressed, but I have heard the other side equally strongly maintained. These two machines marked the culminating point in the controversy to which reference has been made. Later development has been all towards compromise, slightly on the stable side of neutrality: benevolent neutrality as I have called it.

Though the experimental technique and the mathematical calculations necessary for a thorough study of control and stability are difficult and elaborate, the main results are simply and easily stated.

The pitching motions of an aeroplane depend upon what is called its weathercock stability. An aeroplane hung up in a wind so that it can rotate about a horizontal axis through its centre of gravity has weathercock stability if, like a weathercock, it desires to face the wind and returns to its original attitude on being disturbed. As with a weathercock, this kind of stability is increased either by moving the pivot—in this case the centre of gravity—forward, or by increasing the area of the tail.

A free flying aeroplane which has this form of stability will, if disturbed from steady flight, first rotate rapidly so as to restore the incidence to the equilibrium value and then execute a series of long slow pitching movements, similar to a ship travelling over ocean waves. The length of these waves from crest to crest is between ½ and 1 mile, and the time taken some 30 seconds. These movements are so slow that they have little influence on control.

The weathercock *unstable* aeroplane, if pivoted like a weathercock, would very quickly turn round and face backwards. If this happened in free flight it would be unflyable, except by a pilot with the skill of a juggler, but it does not happen. Suppose the aeroplane is flying freely and the nose is accidentally deflected upwards; being unstable it will throw up its nose still farther, but at the same time the increased incidence will cause it to leap upwards with great suddenness. The direction of motion is thus *rotated upwards* faster than the aeroplane itself, so that the first quick adjustment is a fall of the incidence to nearly its original value. Afterwards the upward tilt and upward trend of the path increase relatively slowly, until the aeroplane slows up and stalls. There is, however, ample time for the pilot to correct this subsequent motion, provided that his attention has not wandered. This is the reason why the Wrights and others were able to fly aeroplanes which were unstable fore and aft.

So long as the instability is not too great, the aeroplane, like the motor-car, can be controlled effectively whether it is stable or unstable. As in the motor-car, too great stability is definitely objectionable, partly because heavy forces are then required to execute rapid manœuvres and partly because heavy forces, or adjustments of some sort, are required to 'trim' the aeroplane for different speeds. For alterations in speed must be accompanied by changes in incidence, which in a very stable machine will require large control forces. A neutral aeroplane, on the other hand, if trimmed for one speed will be in trim for other speeds within a wide range. The problem here before the designer is so to adjust the centre of gravity and the tail areas as to produce a very slightly stable aeroplane.

The rolling and yawing motions of an aeroplane can also be simply described, though in detail they are very complicated.

When the aeroplane rolls the falling wing meets the air at a larger incidence than the rising wing and experiences a greater lift; a very large couple opposing the roll is thus generated. This is the predominating factor in the lateral control, for it prevents rapid rolling and gives the pilot time to observe what is happening and correct it. This

is the reason why the Wrights could control an aeroplane which was laterally unstable.

If the aeroplane has a 'dihedral angle'—tips of the wings higher than the middles—side slip tends

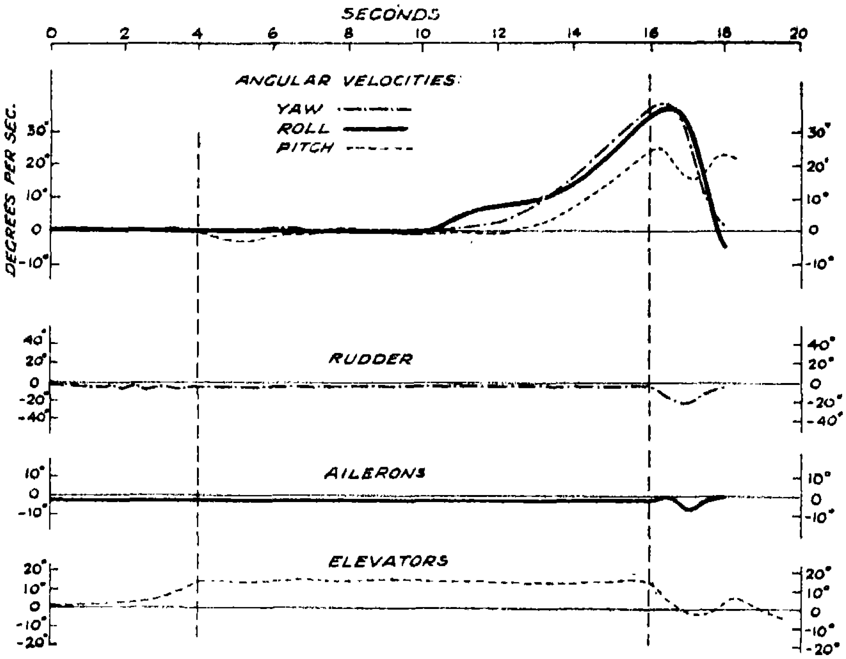

FIG. 2.—Controls fixed. The unstable rolling turn.

to raise the wing towards which the slip is occurring. If it has a large vertical fin on its tail, it will turn or yaw towards the slip. In normal flight the dihedral angle has a powerful stabilising influence, because if one wing falls below the other, side slip will occur towards that wing, and a couple will be generated raising the wing.

An aeroplane which has too large a vertical fin on its tail and too little dihedral angle will have what is called spiral instability; if slightly disturbed from straight flight, it will continue to roll and turn from its course, and ultimately descend in a spiral curve. This motion is, however, so slow in developing that it is of no importance so long as the pilot is in control, but like other forms of instability it is undesirable, particularly when long flights are contemplated.

Another motion possible to an uncontrolled aeroplane consists of a complicated rolling and yawing oscillation, generally of about six seconds period. This will become unstable and render the aeroplane practically unflyable if the vertical fin in the rear is too much reduced. Thus the exact proportions of these fin surfaces is a matter of great importance; if they are too small, the relatively quick oscillations will become unstable, with disastrous results; if they are too large, the slow spiral instability, which on the whole is undesirable, will occur. The problem is eased by giving a good dihedral angle, for this widens the limits permissible in fin size, without incurring either of these defects.

One other fact of interest has only lately come to light. If the dihedral angle is too small, the short period oscillation to which reference has been made may become of the type which is caused to increase by a control which contains a lag. As there is always some lag between the pilot's intention and his performance, this latent defect may cause trouble; even though it may not be so bad as actually to cause the oscillations to increase, it may lead to great difficulty in damping them down. In bumpy weather, therefore, the oscillations may be continuous from one air bump to the next, with disastrous results both on the strength of the pilot and the stomachs of the passengers. The improvement in the bad weather qualities of some of the later cross-channel aeroplanes is attributed partially to increased dihedral.

No more need be said now about control in normal flight. In what precedes an attempt has been made to explain why the provision of good control qualities is more a question of proportioning the aeroplane and adjusting its load properly than of devising new control organs.

This brings us to about the end of the War. More data have accumulated and measurements have been refined, but most of the foregoing statements

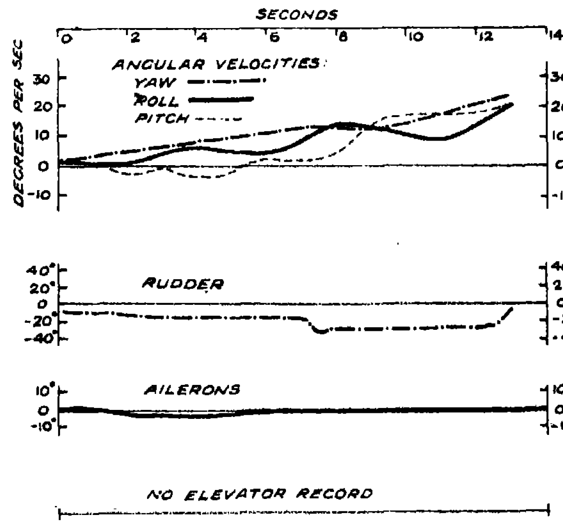

FIG. 3.—Controls fixed. The increasing oscillation.

might have been made then. The trap which killed the early pioneers still, however, continued to take its toll of life, though in a much lower proportion to the hours flown. Ample power had become available to allow the normal flying speed to be so much greater than the stalling speed that

accidental stalling became rare, except when a pilot was deliberately flying slowly with the object of making a landing. When it did occur, however, the same consequences followed as with the early pioneers: but the danger was increased, because

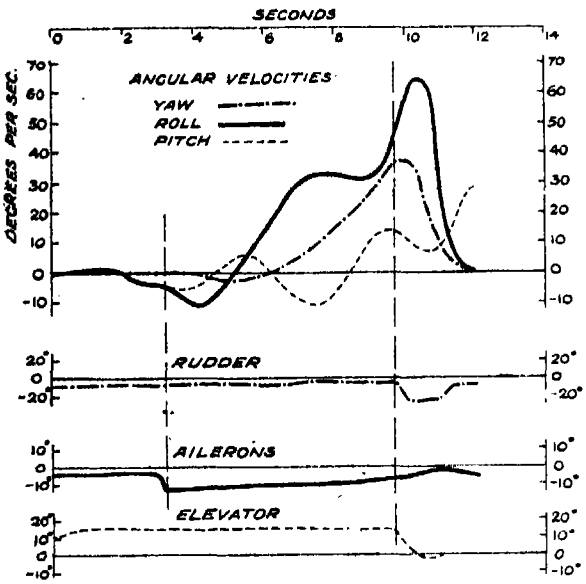

FIG. 4.—Failure of ailerons applied during steady flight. (Note apparent success at first.)

of the higher loading and consequent heavier impact of the later machines. Throughout the history of flying to the present day this has been, and still remains, the most frequent cause of fatal accidents.

Shortly after the War, the British Research Committee for Aeronautics started a research campaign into the causes and cures of this trouble. The research was carried on in wind tunnels, by theoretical work, and in actual flight at heights sufficient to rob the stall of its danger, with the result that the principles underlying the matter are now understood and several ways of eliminating the danger are known.

One small part of this campaign of research is being carried on by the University Air Squadron at Cambridge. Our task is to endeavour to obtain precise experimental records of the motions of stalled aeroplanes, both when left to themselves and when the pilot is trying to control them. The apparatus which we use was developed and constructed at the Government Research Establishment at Farnborough and lent to us for the purpose. It consists of a box containing three gyroscopes which are slightly deflected against a spring control when the aeroplane is turning. The deflexion of each gyroscope is proportional to the rate at which the aeroplane is turning about some particular axis, and they are arranged so that, between them, they measure the three rates of turn about three axes mutually at right angles. These three records are recorded continuously upon a moving photographic film. Three other instruments record independently the movements of the three controls—elevator, rudder, and aileron—and all these records are synchronised from a central clock, which records half-second intervals on all the films.

Figs. 2-9 show some graphs drawn from records selected from more than a hundred sets which we have obtained. These results, which will now be described, have all been predicted, at least in their general features, by calculations based on wind-tunnel observations of the forces acting upon models supported in various ways in the wind tunnels of the National Physical Laboratory and the Royal Aircraft Establishment. The wind-tunnel experiments and calculations were made long before precise records in free flight had been obtained, but for lecture purposes I shall reverse the chronological order of the events and describe the results first before explaining why they occur.

Fig. 2 shows a record of one such flight. The experiment began at the vertical line marked 4 seconds, when the elevator was pulled right back and the incidence of the wings (not shown in the figure) was between 19° and 20°. From that time the controls were held fixed until 16 seconds, when the experiment ended. This experiment began exceptionally favourably, with no rotation of any importance occurring. Straight flight continued undisturbed until 10 seconds, when some slight disturbance started the unstable motion characteristic of this aeroplane at this incidence. Increasing rates of rolling and yawing, both to starboard, were then recorded, which in six seconds

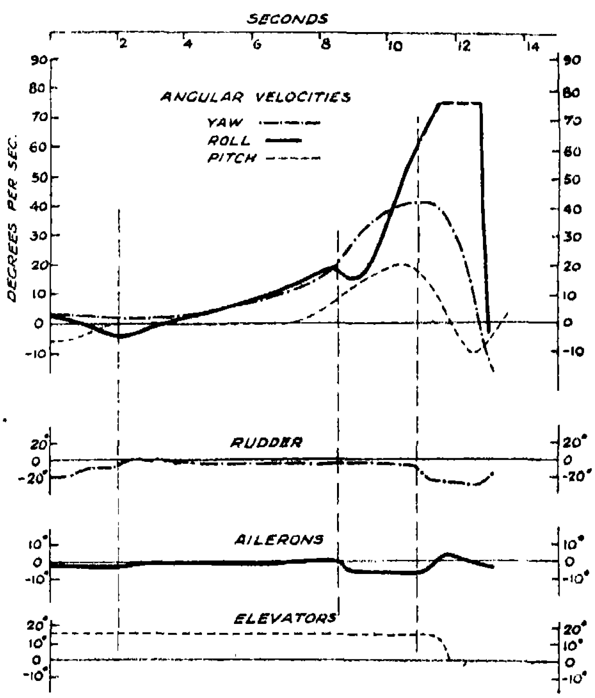

FIG. 5.—Failure of ailerons to check a rolling turn.

had grown to some 30° per second. The aeroplane by this time had rolled through some 60° from the horizontal, and the pilot then stopped the motion by pushing forward his elevator and reducing the incidence of the wings below the stalling point.

The rapid check to the roll which followed this last control movement should be noted. The reason

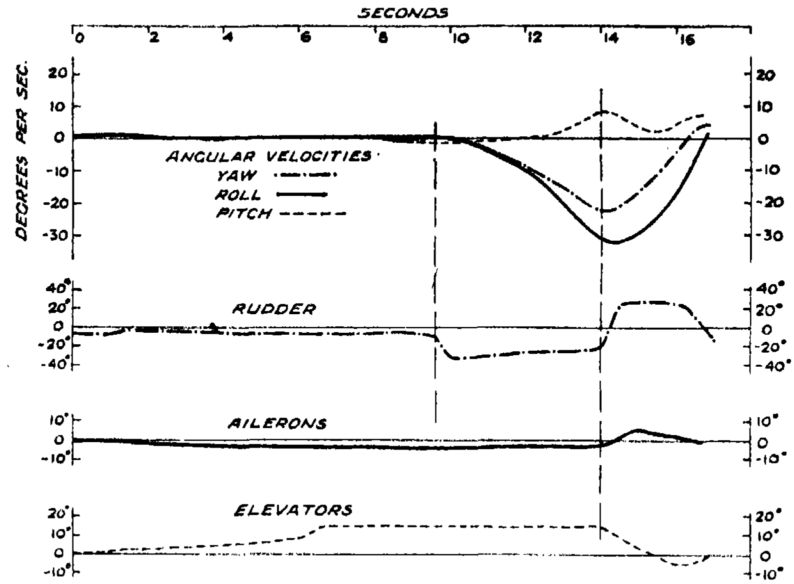

Fig. 6.—Effect of rudder applied during steady flight. (Note indirect influence on rolling.)

why a rapid roll at a low incidence is impossible has already been explained.

Superimposed on this unstable motion is a slight rolling oscillation; this feature of the movement is by some accident more clearly shown in Fig. 3, where the amplitude of the roll is seen to increase automatically.

This particular machine at this incidence shows, therefore, two distinct forms of instability, one technically known as a divergence, which approximately doubles itself in every second, and the other an oscillation with a tendency to increase.

Fig. 4 shows the effect of applying ailerons, in straight stalled flight, at about 20° incidence. For the first second after they are applied the aeroplane rolls in the direction to be expected, but almost immediately its direction of roll is reversed and it plunges wildly over on the opposite side.

Fig. 5 shows that this failure of the ailerons is even more marked when they are used to check a roll which has already started.

Fig. 6 shows that the rudder, applied in straight flight, has the desired effect of turning the aeroplane, but that it also causes it to roll in the sense that the wing which is being pushed forward rises.

Fig. 7 shows that the rudder can be used to check a roll which has already started, if it is applied so as to reverse the turn which accompanied the roll (*i.e.* to push forward the falling wing tip). The delay in the action and the violence of the reversed roll which follows should be noted.

Fig. 8, however, shows that if applied too late the rudder may, in certain circumstances, fail to check this unstable motion, though for the first two seconds after it was applied it appeared to be going to succeed.

Fig. 9 shows the ultimate history of an attempt to control these unstable motions by means of the rudder alone; note the liability of the oscillation to increase despite the pilot's efforts to check it.

These results have been chosen because each shows some particular aspect of the matter clearly. In many of the other results obtained these various aspects are so mixed together that a practised eye is required to disentangle them.

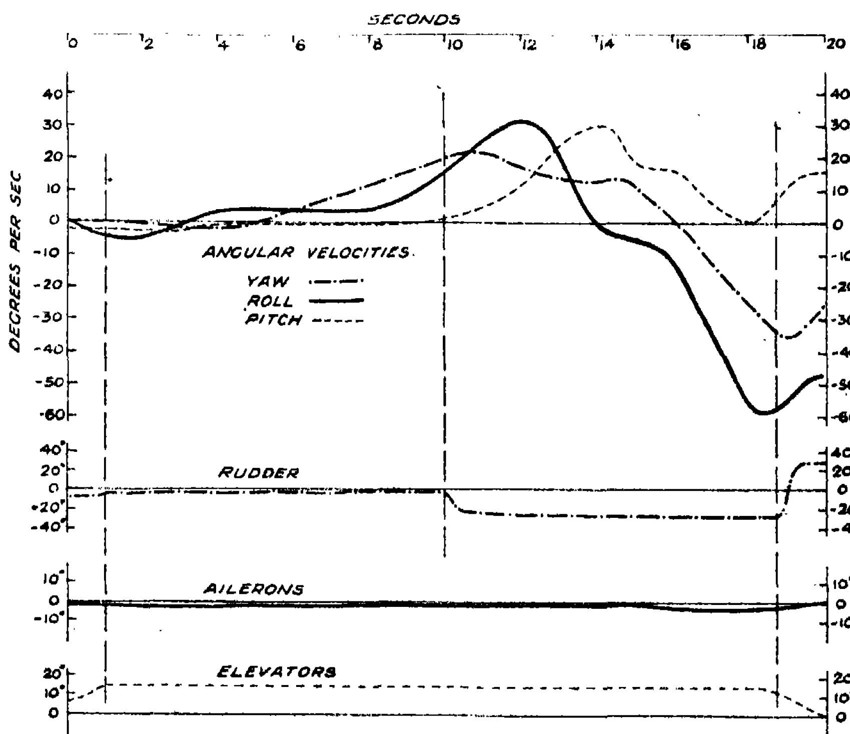

Fig. 7.—Rudder succeeds in checking a rolling turn. (Note delay in action.)

The utter uselessness for any practical purpose of control with the above characteristics requires no emphasis.

As has been stated, these results can all be explained, in general terms, by mathematical analysis based on data obtained from wind tunnels, and though the analyses are intricate the broad explanation can be given simply.[2]

The primary cause of the trouble lies in the change, when the aeroplane stalls, of the effect of rolling upon the rolling couple. Instead of a large couple opposing the roll being generated, as in normal flight, a slight couple is generated in the sense to increase the roll. This is because (see Fig. 1 at 20° incidence and above) the increased incidence of the falling wing tip no longer increases the lift upon it, but slightly decreases it. There is thus nothing but the inertia of the aeroplane to prevent rapid rolling. The complicated effects of inertia, such as those we observed in relation to ships at the beginning of the lecture, are thus introduced, and the valuable factor of time for the pilot to think is absent.

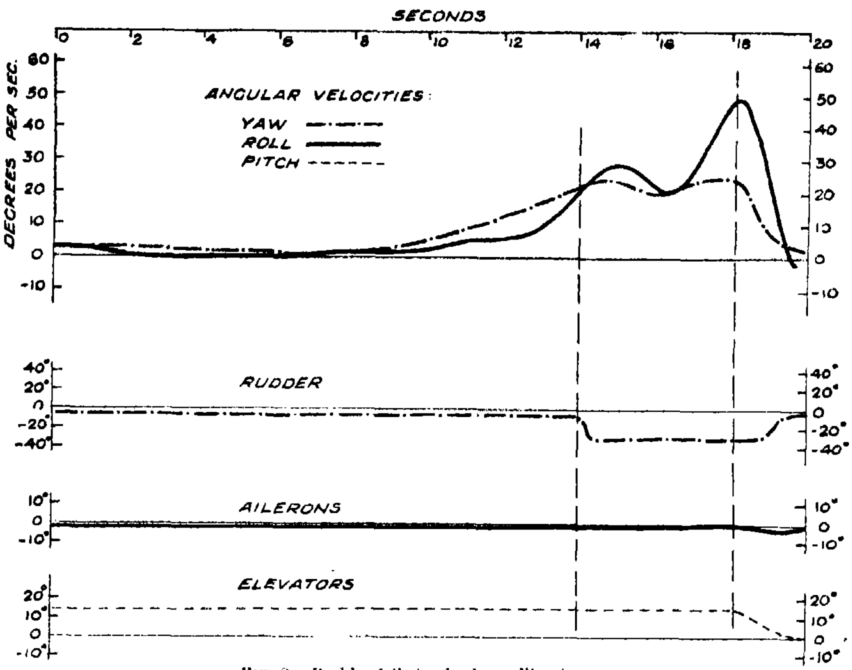

FIG. 8.—Rudder fails to check a rolling turn.

The instability of the motion is easily explained. When a stalled wing rolls there is not only a slight couple increasing the roll, but in addition a couple tending to retard the falling wing. This is because drag increases very rapidly with increase of incidence on a stalled wing. Now in stalled flight, even a small rate of yaw generates a large rolling couple depressing the retarded wing. This is partly because the advancing wing is travelling faster than the retarded wing and partly because of the side slip which follows the yaw. (It has been found that the rolling moment produced by side slip is, for some as yet unknown reason, very much greater on a stalled than on an unstalled wing.) Any slight disturbance in yaw therefore generates a rolling couple, and the resulting roll both tends to increase itself and to cause the rate of yaw to increase still further. Such a process is obviously cumulative.

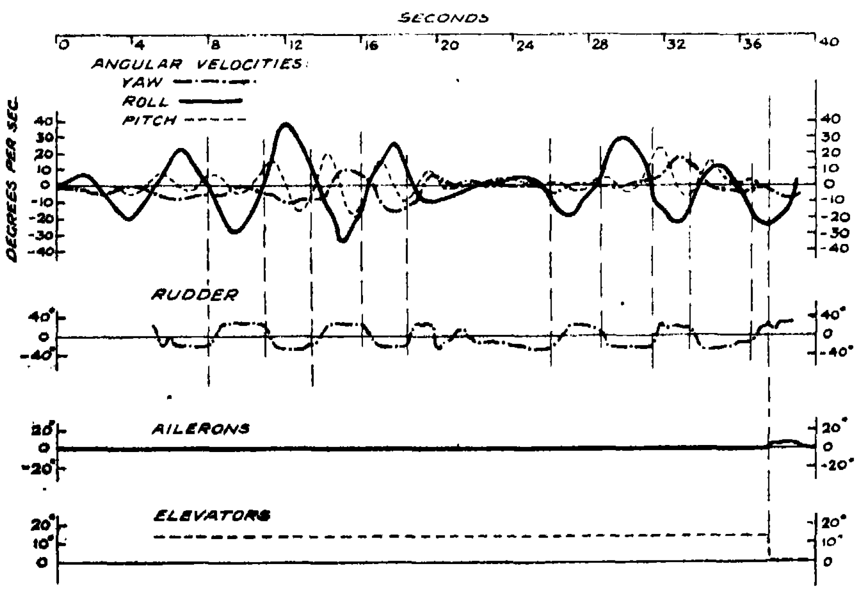

FIG. 9.—Attempt to control the roll by means of rudder alone.

The increasing oscillation can also be explained, but the explanation is too involved to be given in the time at my disposal.

The outstanding feature of the whole problem is, however, the great influence of yawing motions on rolling couples, and this should be borne in mind when the action of the controls is considered.

The characteristic feature of aileron control in stalled flight is that, whilst the rolling couple which they can exert is weak, they also exert a powerful yawing couple retarding the wing tip which they are trying to raise. This starts the aeroplane yawing, and a large rolling moment is soon

[2] The explanations which follow will be more easily understood with the help of a model aeroplane which can be held in the hand and moved in the ways described. Failing a model aeroplane, a piece of card in the form of a T to represent wings and body should suffice.

indirectly generated by the yaw, which entirely swamps the direct action of the ailerons. The apparent success, in Figs. 4 and 5, of the ailerons, for the first second after their application, followed by complete failure, is thus explained.

The action of the rudder in causing the aeroplane to roll, so that the retarded wing falls, is now easily understood; the roll follows after yaw has been generated. The difficulty of using the rudder in a way which will not cause an increasing oscillation arises from the fact that its effect on roll is delayed until it has succeeded in generating a yaw. We saw in the beginning of the lecture that delay in the control of a motion which automatically tends to increase, is fatal.

To sum up. The motion is violently unstable in two ways. The ailerons are a positive source of danger, since they produce an effect which at first appears satisfactory but is ultimately the opposite of that expected. The rudder, though effective, provides a kind of control very difficult to use and, moreover, is often too weak even to prevent the first unstable plunge from continuing.

The continuous series of accidents resulting from accidental stalls near the ground are thus explained, for, though the motion can always be checked by thrusting the stick forward, and so diving to regain speed, this remedy is of no use when the ground is near. The pilot's reflex response when he finds himself suddenly rolling over and diving into the ground is to pull the stick back and to the side away from the roll. This, as we have seen, has disastrous results.

There are two lines along which a cure can be effected. One is to eliminate the instability and the other to improve the control. After what has been said above, there will be no difficulty in realising that the final solution will be along both lines.

The simplest way of improving the control was that originally used by the Wrights: to supply a powerful rudder. This prevents the worst consequences of stalling, but it does not, as we have seen, provide a satisfactory control. Moreover, it can only cause the aeroplane to roll after it has started it yawing, and this may be very undesirable if there happens to be a house or tree on the side towards which the yaw has to be made. An effective rudder, however, though not a sufficient cure, is a *necessary* factor in any complete cure.

Another solution is to provide some form of control at the wing tips, which will lift the wing powerfully and simultaneously push it forward, rather than push it backwards, as does the standard aileron. The yawing action of the aileron will thus indirectly reinforce the direct rolling action, instead of opposing it as at present. There are several ways of doing this; one is to provide a surface beyond the wing tips which, even when the main wings are stalled, will be inclined downwards so as to meet the air edgeways. This surface will not itself be stalled, and if its angle is controlled by the pilot it can be made to exert either an upward and forward or a downward and backward force, which is just what is required. Such surfaces will also prevent rapid rolling and eliminate the instability. This device is used in Hill's Pterodactyl, a tailless aeroplane which is said to be as stable and controllable when stalled as in normal flight.

A second method of achieving the same result is to place one of Handley Page's slots in front of the wing tips. If these slots are left permanently open they will delay the stall on the tips until long after it has occurred on the remainder of the wings; the characteristics of unstalled wings which prevent rapid rolling from occurring will thus be retained, and the tendency for rolling to cause yawing will be eliminated. Stalled flight then becomes very stable and easily controlled, though the rate of control is not rapid. If in addition the slots are interconnected with the ailerons, so as to close on the side to be depressed, but to remain open when the stick is central, the power of rapid control will be secured in addition to stability, for the closing of the slot will cause the wing tip to stall, with a consequent large loss of lift and increase of drag by comparison with the other tip on which the slot remains open. The large direct rolling moment generated in this way is thus reinforced by the indirect effect of the yawing moment resulting from the increased drag on the wing tip which it is desired to *depress*. This is the reverse of the action of normal ailerons, which exert an increased drag on the wing which it is desired to *raise*.

Unfortunately, the slots cannot be left open permanently, because the wings will then absorb too much power in normal flight; hence schemes have had to be devised to cause them to shut automatically, when the incidence falls below the stalling angle. Handley Page has devised one very successful method of doing this, of which accounts have been given in the daily Press. Another somewhat different method of doing the same thing has been devised by McKinnon Wood at Farnborough.

Which of these methods will ultimately prevail is as yet uncertain, but that a complete cure in a practical form can be found is now beyond doubt, and we can confidently look forward to a time when, its principal danger having been eliminated, flying will be ready to take its place in the world's transport, on terms which, in respect of danger, will compare not unfavourably with the older and more established methods.

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PHOTOGRAPHIC INDUSTRIES.

The importance of air conditioning in this industry is very great. Absolutely pure, dirt-free air is required in the manufacture of film and sensitised papers, as the slightest atmospheric impurity is reflected in the developed photograph. The air filtration plants must be as nearly as possible 100 per cent. efficient. Temperature and humidity conditions are extremely important, especially the latter, owing to the danger of static electricity in winding and consequent risk of fire should the film become too dry. Again, in film studios, a dry pure atmosphere is required when 'shooting' pictures, otherwise the film is blurred.

PRINTING TRADES.

In newspaper printing, correct atmospheric conditions are essential to prevent breakage of the paper due to too much moisture in the press-room, and also to keep the ink at the right temperature, and the rollers pliable. Too low a temperature causes these rollers to become hard. In colour printing, correct temperature and humidity are very necessary, or the colours do not remain distinct.

THEATRES, CINEMAS, ETC.

Here again air conditioning plays an important part. Discriminating playgoers will not patronise a theatre or cinema which is chilly in winter and insufferably close in summer. Absolute comfort can only be ensured by proper heating and ventilating equipment, coupled with some means of air purification, and air cooling in warm weather. This question of air cooling is very obvious when it is remembered that an adult at rest emits about 400 B.Th.U. per hour; therefore, in a cinema with seating accommodation for 2000 people, 800,000 B.Th.U are given off hourly from the occupants.

Summarising the above, it will be seen that air conditioning enters into many spheres of our industrial life, both for ensuring human comfort, and also uniformity of product and more rapid output of many manufactured articles. There is scarcely a single important industry that can dispense with air conditioning in some form or another. In this short article I have only chosen a few examples at random.

Table II. gives a few typical uses to which air conditioning may be put, together with air changes, temperatures, and humidities usually employed.

TABLE II.

Type of Building.	Air Changes per Hour.	Temp. (Degrees F.).	Relative Humidities.
Offices	1 to 3	58°–62°	50 to 63 per cent.
Theatres	2 „ 4	60°	50 „ 63 „
Hospitals	2 „ 8	60°–70°	50 „ 63 „
Schools	2 „ 4	55°–65°	50 „ 63 „
Churches	1 „ 2	58°	50 „ 63 „
Factories (average)	1 „ 3	55°–70°	45 „ 65 „
Factories (textile)	3 „ 30	55°–72°	65 „ 85 „
Photographic trades	2 „ 20	60°–80°	55 „ 80 „

AIR-CONDITIONING EQUIPMENT.

There is no standard air-conditioning plant that will universally perform all the above-mentioned requirements; each individual application must be carefully considered, the method of obtaining the desired results decided upon, and the equipment must then be designed and installed by an expert air-conditioning engineer, to suit the prevailing conditions.

Briefly, the principal components of an air-conditioning plant and its method of operation comprise:

(1) Some positive means of moving the air being dealt with. This is usually effected by fans, of either the centrifugal-cased or propeller type, direct-coupled to some prime mover, such as a steam or internal-combustion engine, or an electric motor, or belt-driven from any convenient source of power.

(2) There must be some means of distributing the air where it is wanted. This is usually effected by blowing the air through ducts, constructed either of bricks, concrete, wood, galvanised sheet steel, copper, or aluminium. The materials used for duct construction are entirely decided by the use to which they are put, and the type of building in which they may be installed.

(3) There will be some form of heater for raising the temperature of the air; this usually takes the form of a battery of plain or gilled tubes over which the air is passed, the tubes being fed with either live steam or exhaust steam from engines and turbines. Alternatively, if the battery is required for cooling the air, then brine or expanded ammonia gas must be pumped through the tubes.

(4) It may be necessary to filter the air; this may be effected by the dry, viscous, or wet filtration processes. In the dry method, the air is either drawn or forced through canvas bags, or metal-plate filters with rough cloth linings, to which the particles of dirt adhere, or sometimes for very special filtration a combination of canvas-bag filter and metal-plate filter may be used. In the viscous method, the filter consists of a metal frame containing coils of wire immersed in oil, the dust in the air being arrested by the film of oil. In the wet filtration method the air either passes through copper gauze screens, the screens being flooded by a continuous stream of water, or else it is cleaned in a proper air washer and humidifier.

(5) Air is humidified in several ways, all of which demand the intermixing of the air with a steam or water spray. The usual humidifier, which also acts as a wet filter and air washer, comprises a body casing of sheet metal, of either galvanised steel or copper. This casing is mounted on a settling tank containing water. The air enters one end of the humidifier, where it comes into intimate contact with a bank of water sprays or atomisers. These atomisers are supplied with

water under pressure from a centrifugal pump, the effect being that the air is thoroughly intermixed with a very fine cloud of water particles and is therefore washed and saturated. The air then strikes against zig-zag baffle plates or eliminators, which remove all its entrained moisture, and leaves the humidifier at a relative humidity of 100 per cent. and is 98 per cent. pure and clean.

The above brief description of the chief components of an air-conditioning plant is by no means complete, but it may serve to indicate what are the essentials of some installations used in industry.

The Royal Academy's Exhibition.

THE opening of the Royal Academy Exhibition at Burlington House is a seasonal event which interests most of us, even if we are not endowed with special artistic perceptions. In art, as in science, there is specialisation into particular spheres; and therefore great variety of effort, with the necessary limitations, must be displayed in the works exhibited by an Academy. As in science also, creative ideas cannot be expected to be conceived so frequently as commonplace performances.

In portraiture there are, at this year's exhibition, as usual, a good many 'personalities.' Somehow, we always regard these frequencies with vague detachment, schooling ourselves into approval or disapproval. Contrasts are inevitable, but perhaps complete antithesis is exemplified in Sir William Orpen's study of Mr. Lloyd George (290), and that of Mr. Stanley Baldwin, by Oswald Birley (434), the one distinctive enough, yet flamboyant, and the canvas full of accessories; the other of marked sobriety of treatment, wholly pleasing. So much for our rulers. But Orpen's Sir George Maxwell (193), a ruler in lesser measure, and a gift to him, in tribute of service, from the Chinese community of Malaya, is a great possession. George Harcourt has painted Dr. Cyril Norwood (237), almost full length, for Marlborough College, with accuracy, and the dignity befitting a distinguished schoolmaster. There is a suggestion of an academical robe, otherwise we have the philosophy of clothes in meticulous display, which upper forms will note. Sir Arthur Keith, by W. W. Ouless (100), disappoints us in aspects of intellectual virility; surely here was a sitter who could wear no mask. On the other hand, we might apprehend possible trials with Sir Gowland Hopkins, but his portrait by George Henry (243), for the Bio-Chemical Laboratory, Cambridge, is good, if of rather ruddy tone. However, man does not live by calories alone. Richard Jack gives us a capital example in his Prof. A. G. Perkin (382), scarlet and green much in evidence. The catalogue places him outside the humanities, and names him "Perkins." Sir Arthur S. Cope supplies a conscientious presentment of Dr. Alfred Palmer (374) for the University of Reading. George Harcourt's oil of Mr. Llewelyn B. Atkinson, lately president of the Institution of Electrical Engineers, we find disappointing, lacking reminiscence. Lavery paints Dr. Nicholas Murray Butler with subdued and faithful effect. The late Thomas Hardy (in three-quarter) looks straight out at one on a canvas by R. Grenville Eves (55). It should please the novelist's admirers. Many will approve also of Fiddes Watt's "George Summers, Huntsman, Duke of Buccleuch's Hounds" (448), excellent and arresting in characterisation. Other portraits of special interest include the Master of Sidney Sussex (W. W. Russell), Sir Herbert Warren (Glyn Philpot), and Lord Hewart (Lander), painted for University College, Oxford.

Among landscapes Ernest Parton's "A Morning on the Kennet" (129) is of high order; also La Thangue's "A Sussex Stream" (181), where we have brilliant water, and a boy with net and bottle. Farquharson's "November" (165), "Winter" (268), and "A Winter Evening" (394) are specially good of their kind, while W. T. Wood's "Winter at Burpham, Sussex" (331), should be seen. Slade's "Sussex Weald from the Devil's Dyke" (537) portrays that much-discussed expanse, formal but faithful.

Apart from the natural aspects of landscapes the botanist may give attention to the numerous examples of flower studies, in mixed bunches, or selected, which are hung. Merit varies; and ugly vases on chessboard patterns do not enhance effect. We like Hayward's "Lenten Hellebore" (44), depicted in a tankard-shaped receptacle, and Wood's "Drooping Roses" (48).

Quite a number of old barns and their interiors are here, which is all to the good. They well repay study, especially Steel's "Unthank Hall Barn, Derbyshire" (64). Many ancient barns are now marked for destruction under the transport march; and, going off at a tangent, we are much interested in A. J. Munning's presentations of horses, particularly his "Solario" (84).

The Architectural Room claims mostly the attention of those interested in the style and progressive ideals of designers. On the whole there is much of an encouraging character. We like Mr. A. N. Prentice's "New Public Library for Westminster City Council," in course of erection on the site of Sir Isaac Newton's old home, Orange Street, and in proximity to the offices of this journal. Sir Edwin Lutyens's "Ambassador's Entrance: British Embassy, Washington," buildings of low pitch, dignified and restful, make one feel that residence in such quarters would duly regulate the blood pressure of diplomacy. The "New Mercantile Bank, Singapore," by P. H. Keys and F. Dowdeswell, is stately and satisfying. Designs for various English engineering, chemical, and zoological laboratories may also be seen.

News and Views.

IN his Royal Institution discourse on "Research on the Control of Aeroplanes," which appears as a Supplement to this week's issue of NATURE, Prof. B. Melvill Jones gives a very lucid exposition of a problem that has long been a subject of controversy among aeronautical experts, young though the science be. Broadly speaking, the question at issue is, whether safety in flight should be achieved along the lines of construction for aerodynamic stability, or along the lines of pilot controllability. The theoretical experts have rather inclined to the former, the practical flying men always to the latter; and Prof. Jones, who has played the part both of pilot and theoretician, is well qualified to appraise both viewpoints. It is not difficult to appreciate the influences that have stirred the theoretical experts. Bryan's masterly exposition of the disturbed motion of an aeroplane regarded as a rigid body and his analysis of the conditions that make for stability caught the imaginations of the interested mathematicians, trained as they were in the Newtonian school of simplified abstractions from reality, and for a long period determined the direction of aeronautical research.

THE fact remained, however, that to the pilot the aeroplane was never even remotely a rigid body, for he himself, as part of it, was continually operating its controls and guiding it to his will. A highly stable aeroplane was rather a nuisance to him, for he did not wish to rely on a self-willed machine, but on himself. The mathematicians, recognising the fallibility of the pilot and consequently tending to ignore him as a control, wished to depend rather on the machine. In the last resort it was the multiplicity of accidents on landing, that is, at low speeds of flight, that stimulated a searching and critical analysis into the aerodynamics of flight under these conditions and into the natural and sometimes disastrous responses of the pilot himself to rolls and dives. As Prof. Jones shows in his lecture, these have served to illuminate the whole problem of stability and control, to expose their respective limitations and to indicate that the final solution must partake of both factors. Incidentally, Prof. Jones's lecture illustrates two other points. In the first place, it demonstrates the extent to which experimental finish has been procured in the study of an intricate scientific problem under conditions of operation infinitely more difficult than those normally attendant in a laboratory experiment; and in the second place, it has brought out that the aeroplane industry, principally in the person of Mr. Handley Page, has played no small part in the elucidation and solution of these scientific problems.

THE Society for the Preservation of the Fauna of the Empire has undertaken a great and important work, and the inroads which have been made in recent years upon the wild stock of many British colonies and dependencies show that it has entered the field none too soon. It is a commonplace that the spread of civilisation, with its breaking in of wild territory, felling of forests, and draining of marshes, uproots and decimates the aboriginal fauna, and it is as patent that destruction even more rapid may follow upon unrestrained slaughter in the name of sport or commercial ventures. Even where laws are made to restrain these activities within reasonable bounds, and in almost all parts of the British Empire such laws now exist, it is difficult without a prohibitively large staff of wardens to enforce the law. Consequently, in many regions, of land and sea, destruction moves ahead of the natural replenishment of the stock, towards the inevitable goal of extermination. The Society properly accepts the view that the progress of civilisation cannot be stayed, and that the legitimate interests of sport must be safeguarded. It wisely concentrates its efforts, therefore, upon the sheltering of a nucleus of the wild life of any region in great reserves or national parks. An excellent pamphlet on "The Passing of Wild Life" describes the Society's point of view, and insists upon the need of public support and of immediate action in the creating of reserves. Copies of the pamphlet may be had from the Secretary of the Society, c/o Zoological Society of London, Regent's Park, London.

SIR ROBERT HADFIELD, Bart., has been elected a foreign associate of the National Academy of Sciences of the United States of America. The announcement has a fitting complement in the award by the Iron and Steel Institute, referred to below, of the Bessemer Gold Medal to Mr. Charles Schwab, one of the leaders of the steel industry of the United States. Incidentally, it may be mentioned that the Bessemer Gold Medal was awarded to Sir Robert Hadfield so long ago as 1904. Sir Robert's latest honour brings him into distinguished company. The National Academy of Sciences held its first scientific meeting in 1864, and immediately took advantage of a by-law permitting the election at any one meeting of not more than ten foreign associates, by electing this number; the names included Faraday and Brewster. Since that time, the National Academy has grown steadily in importance and in numbers. The membership roll has now increased to more than two hundred, but the list of foreign associates is less than twenty. Sir Robert's election brings the number of British men of science on this roll of honour up to twelve; it includes the two living past-presidents and present president of the Royal Society. The last British worker to be elected was Sir Frank Dyson, Astronomer Royal (1926).

ON May 3, at the annual general meeting of the Iron and Steel Institute, the Bessemer Gold Medal was presented to Mr. Charles Schwab, president of the American Iron and Steel Institute and the president of the Bethlehem Steel Corporation. Mr. Schwab was born in Williamsburg, Blair County, Pa., on Feb. 18, 1862, and started his distinguished career in the Edgar Thomson Steelworks of the Carnegie Company by driving stakes at a dollar a

day. By his own energy and ability he rose in seven years to be chief of the Engineering Department of the Carnegie Company. The great Homestead Steelworks plant, designed by him, and erected under his supervision, was arranged to be a practically continuous mill, so that the raw materials went in at one end and the finished products came out at the other. In 1896 he was made a member of the board of managers of the Carnegie Companies, and in the following year was elected as its president. The problem in the United States at that time was the manufacture of more steel, better steel, and more rapid production. In this, Mr. Schwab achieved the best practical results. Smaller concerns were combined until the Company attained an impregnable position in relation to raw materials, modern equipment, and skilful management. Further commercial development on economic lines was made possible by a fusion of interests between the larger companies, and the United States Steel Corporation came into being with Mr. Schwab as president. Mr. Schwab resigned this post after three years and obtained a controlling interest in the Bethlehem Steel Corporation, of which he is now chairman of the board of directors. The Bethlehem plant at that time was largely engaged in the manufacture of munitions. Under the control of Mr. Schwab it has become one of the best steel works in the world, and at the present time the manufacture of munitions takes up less than 5 per cent. of the productive capacity of the plant.

THE annual May Lecture was delivered before the Institute of Metals in London on May 8 by Prof. C. H. Desch on "The Chemical Properties of Crystals." Prof. Desch discussed the various ways in which atoms may be held together in a crystal: by the simple exchange or sharing of electrons, or by residual forces. In rock salt the molecule has disappeared, but there are many substances built up of molecules in the solid as well as in the liquid state. In a few simple cases it has been found possible to calculate the forces of attraction in a particular face of a crystal, and in that way the differing chemical properties of different faces can be explained. Such differences account for the varying habit of crystals of the same substance grown under different conditions. When a metal is attacked by an acid, distinct 'etch-figures' are produced, and the shape of these must be intimately related to the internal structure of the metal crystals. The figures vary in the most curious way when the solvent is changed, as is shown by large single crystals of copper. The compounds of metals with one another have puzzled chemists, as they do not follow the ordinary rules of valency, and have many anomalous properties. The modern view of the constitution of the atom makes it possible to explain them, and the relations which have been found between the forces of cohesion and of chemical affinity make it likely that there is a gradual transition from the simplest solid compounds, such as salts, through intermetallic and other compounds, to solid solutions, which are regarded as mixtures. The chemical properties of crystals are most easily illustrated by substances which do not consist of closely packed atoms, but have an open structure, such as graphite. Looseness of structure is also important for diffusion in solids, on which many technical processes depend.

DR. F. H. G. VAN LOON, formerly professor of psychiatry and neurology in the Medical School of Batavia, read a paper on "Primitive Instinctive Reactions in Pathological and Normal Malay Life," at a meeting of the Eugenics Society held on May 4. Dr. Van Loon illustrated his paper by a kinematograph film of a case of latah, the curious Malay insanity in which the patient copies any movements made in front of her. The problem with which Dr. Van Loon dealt is of much wider interest. He has been studying mental differences in race, not through the well-known avenue of mental tests, but by means of the insane behaviour shown when the normal intelligence and control are thrown out of gear by disease. He compared amok and latah, for example, with manifestations of insanity such as those against which legislation has been enacted in England to allow a judge to prevent undue litigation by an insane person who is frequently bringing cases into court. Clearly there is a wide distinction between such 'reasoning' madness and a more primitive and animal-like reaction, for running amok corresponds very definitely to the behaviour of some animals acting under the instinct of extreme fear; the hallucinations which are the first symptoms of amok are such as to induce terror. He also showed that these primitive and animal-like instincts come out in the white races when acting as a group. Mob psychology brings the group down to the primitive instincts which are rarely observed in the white individual; and a European or American mob, when it 'sees red'—virtually goes mad—behaves with all the primitive and brutal barbarity shown in the insane patients of primitive races. The obvious conclusion is that fundamental differences of race are of a hereditary nature.

A WELL-ATTENDED meeting was held, by permission of the Royal Society of Medicine, at 1 Wimpole Street, on May 2, for the purpose of furthering a scheme for founding in Oxford a science museum of instruments and exhibits to illustrate the history of science and medicine. Sir Humphry Rolleston, in taking the chair, spoke of the new life given to the famous museum of Elias Ashmole at Oxford by the splendid gift of the Lewis Evans historical collection. After referring to the whole-hearted support given to the scheme by the late Sir William Osler, he invited Dr. R. T. Gunther, to whose energy and enthusiasm is due the fact that the project is assuming practical shape, to give an account of ways and means.

DR. GUNTHER remarked that Ashmole's Museum, opened in 1683, is the oldest natural history museum in Great Britain. The building was originally devoted partly to the exhibition of specimens and partly to the meetings of the Oxford Philosophical Society. The ground floor was furnished as the oldest public

chemical laboratory in the country. The upper floor has now been recovered as a museum, but the remainder should surely be restored to something more resembling its original purpose than its present use as a book store. The meeting was addressed by Dr. Knobel speaking for astronomy, Dr. Calman for zoology, Prof. Gibson for pharmacology, Sir G. Fordham for cartography, and Prof. Boycott for medicine. Three resolutions in favour of establishing such a museum in the Old Ashmolean building, which already houses the Lewis Evans Collection and valuable supplementary exhibits, were carried unanimously. A further resolution, "That this meeting approves the formation of a society of 'Friends of the Old Ashmolean' for the purposes of assisting in the restoration of the Old Ashmolean building as a public *Ashmolean Museum of the History of Science* (comparable to the *Ashmolean Museum of Art and Archæology*), and for providing by means of annual subscriptions an income for the purchase of desirable objects of scientific interest for the Lewis E.ans Collection," proposed by Sir D'Arcy Power and seconded by Dr. F. A. Dixey, was also carried unanimously.

On May 4 the annual Romanes Lecture was delivered at Oxford to a large assembly by Prof. D. M. S. Watson, on "Palæontology and the Origin of Man." Prof. Watson pointed out that the minor periods of geological time are determined by palæontological remains. The changes produced by evolution tend generally to greater efficiency in relation to the mode of life. But though the general course of succession in any given group is often beyond question, the actual line of descent remains frequently in doubt. Pithecanthropus had bony superciliary ridges and a very small brain; Piltdown man (Eoanthropus) had an ape-like lower jaw, but slight brow-ridges; the brain was still small. The Heidelberg jaw was man-like. Neanderthal man had strongly developed ridges, and so had the Rhodesian skull, though it differed in other respects. The course of human evolution is thus uncertain. Prof. Watson said that Dryopithecus is probably in the line of human ancestry, but evolution has doubtless proceeded on greatly divergent lines. Many of these have depended on mental development, that is, on the arrangement of molecules in the nervous system; and so have transcended the province of the palæontologist, whose business is only with the obvious morphological facts.

Mr. Rollo Appleyard gives a complete account, in the *Electrical Review* for April 27, of the Penzance cable station of the Western Union Telegraph Co. This is the first time that a full description has been published of a submarine cable station fully equipped with modern types of amplifying and repeating apparatus. It is of great interest at the present time in connexion with the competition between radio and cable companies. The main cables of the Western Union Telegraph Co. are divided into two groups, one ending in Valentia and the other at Penzance. The introduction of cables sheathed with permalloy has enormously increased the speed of working. Every cable in the Company's Atlantic system is a link in one of nine through routes. All the manual work of the cables is done at terminal stations such as London or Liverpool and New York or Boston. The whole of the intermediate relaying is now automatic. There is no possibility of accumulation of traffic anywhere except at the terminal stations. The introduction of through working has greatly increased the accuracy and speed of transmission. The limit of manual working used to be about 150 letters per minute. Now a loaded cable having four channels works normally at 1300 letters per minute with much higher accuracy. It is interesting to remember that progress in cable design began by reducing the electrostatic capacity. The loading of cables with induction coils was then suggested, and finally the discovery of permalloy made uniform loading possible. At the present moment the Company is experimenting with modified loading to see if duplex working, which would double the speed, is possible. Unfortunately, trans-Atlantic telephony by submarine cable is not yet in sight.

Dr. W. R. Browne, assistant professor in the Department of Geology and Physical Geography of the University of Sydney, has been elected president of the Linnean Society of New South Wales.

The George Darwin Lecture will be delivered by Mr. W. H. Wright, of the Lick Observatory, at the ordinary meeting of the Royal Astronomical Society on June 8. The subject of the lecture will be "The Photography of Planets."

Sir Frank Dyson, Astronomer Royal, will deliver his presidential address to the Institute of Physics at 4.30 P.M. on May 15, taking as his subject "Physics in Astronomy." The address will be given in the rooms of the Institute at 1 Lowther Gardens, Exhibition Road, South Kensington, London, S.W.7.

The following have been elected honorary members of the Institution of Civil Engineers: His Royal Highness The Duke of York, Sir Alexander B. W. Kennedy, the Right Hon. H. P. Macmillan (Lord Advocate of Scotland), Mr. Samuel Rea, (Pennsylvania, U.S.A.), Sir Ernest Rutherford, and the Right Hon. Lord Wemyss.

The Linnean Gold Medal for 1928 has been awarded by the Linnean Society to Dr. Edmund Beecher Wilson, Da Costa professor of zoology in Columbia University, New York, and a distinguished worker in the fields of animal embryology and cytology. Prof. Wilson's early work dealt with descriptive embryology; in the 'nineties, he took a great part in founding the new science of experimental embryology, and many of his experiments, especially those on *Amphioxus*, *Nereis*, *Patella*, and *Dentalium*, remain classical. He is known to a world-wide circle as the author of that admirable text-book "The Cell in Development and Heredity." First published in 1896, a greatly enlarged third edition appeared in 1925 (reviewed in these columns on May 9, 1925,

p. 669). It is a model of what a text-book should be—encyclopædic, trustworthy, and judicial—and shows the hand of a master.

PROF. G. W. RITCHEY will deliver the Thomas Young Oration to the Optical Society on Wednesday, May 16. The subject of his address will be "The Modern Reflecting Telescope." Prof. Ritchey will give an account of his experience in making and using the great telescopes of Yerkes and Mount Wilson Observatories, and of the new cellular mirrors. The meeting will be held at the Imperial College of Science and Technology, South Kensington, commencing at 7.30 P.M., and will be open to all who are interested in this subject. Tickets will not be required.

THE Council of the Institution of Civil Engineers has made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1927–28:—Telford Gold Medals to Dr. Oscar Faber (London) and Mr. G. L. Watson (Newark, New Jersey). Telford Premiums to Prof. John Goodman (Skipton); Mr. James Williamson (Wallington); Mr. R. M. Wynne-Edwards (Vancouver); and jointly to Mr. F. C. Vokes (Birmingham) and Mr. C. B. Townend (Birmingham).

THE Rockefeller Medical Fellowships for the academic year 1928–29 will shortly be awarded by the Medical Research Council, and applications should be lodged with the Council not later than June 1, 1928. These Fellowships are provided from a fund with which the Medical Research Council has been entrusted by the Rockefeller Foundation. Fellowships are awarded by the Council, in accordance with the desire of the Foundation, to graduates who have had some training in research work in the primary sciences of medicine or in clinical medicine or surgery, and are likely to profit by a period of work at a university or other chosen centre in the United States before taking up positions for higher teaching or research in the British Isles. A Fellowship will have the value of not less than £350 a year for a single fellow, with extra allowance for a married fellow, payable monthly in advance. Travelling expenses and some other allowances will be made in addition. Full particulars and forms of application are obtainable from the Secretary, Medical Research Council, 15 York Buildings, Adelphi, London, W.C.2.

AT the annual meeting of the members of the Royal Institution, held on May 1, the annual report of the committee of visitors for the year 1927, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The report of the Davy Faraday Research Laboratory committee was also read. The following were unanimously elected as officers for the ensuing year:—*President*, The Duke of Northumberland; *Treasurer*, Sir Arthur Keith; *Secretary*, Sir Robert Robertson. *Managers*, Lord Blanesburgh, Sir James Crichton-Browne, Dr. J. Mitchell Bruce, Mr. A. Carpmael, Prof. F. G. Donnan, Sir James Dundas-Grant, Viscount Falmouth, Sir Robert Hadfield, Mr. J. S. Highfield, Mr. W. E. L. Johnston, Sir Henry Lyons, Mr. C. H. Merz, Mr. S. W. A. Noble, Sir Richard Paget, and Dr. G. C. Simpson. *Visitors*, Prof. E. N. da C. Andrade, Mr. A. Glegg, Commdr. A. C. Goolden, Mr. W. Vaux Graham, Mr. K. R. Hay, Sir Lawrence Jones, Dr. V. W. Low, Mr. W. Macnab, Mr. E. S. Mond, Dr. W. A. Milligan, Dr. C. C. Paterson, Dr. E. H. Rayner, Mr. H. M. Ross, Mr. S. Skinner and Mr. W. J. Tennant.

A LARGE earthquake was recorded at Kew Observatory on May 2 at 21 hr. 59 min. 42 sec. G.M.T. The epicentre is estimated to have been 1620 miles away and probably in the Grecian Archipelago. The intensity of the disturbance was about one-half of that produced by the earthquake which occurred in the same region on Mar. 31 and caused destruction at Smyrna.

A NEW enterprise on the part of the Ordnance Survey is announced in *Geography* (Spring 1918), which consists in the reproduction of one-inch maps of the country originally published 1801–1830. The series which the survey is prepared to reprint covers England south of a line through Chelmsford, St. Albans, Oxford, and Stroud, and certain other sheets, including the Humber, Lincolnshire, the Wash, Pembrokeshire, and the Gower area. In most cases four sheets cover a county. If the demand justifies the printing of an edition of 100 or more copies of each sheet, the price will be 5*s.* a sheet. These maps should prove valuable to students of geography and economic history.

IT is announced in *Science* that Dr. Henry Augustus Pilsbry, chief of the Department of Mollusca at the Academy of Natural Sciences of Philadelphia, has been awarded the Academy's Joseph Leidy Memorial Award for 1928 "in recognition of his researches on the phylogeny of the terrestrial mollusca, in which field he is universally regarded as a leading authority, and for his work on the classification of the Cirripedia which constitutes the most notable contribution to the subject in recent years." The award consists of a bronze medal and honorarium, given once in three years for outstanding work in the natural sciences. It was founded in 1923, and its first recipient, in 1925, was Dr. H. S. Jennings, of the Johns Hopkins University.

SIR JOHN ROSE BRADFORD contributes to the May issue of the *Nineteenth Century and After* an article on William Harvey, in which he gives an interesting account of the discovery of the circulation of the blood, of the state of medical knowledge at the time, and of Harvey's connexion with the Royal College of Physicians, London. In the coming week, the Royal College of Physicians will celebrate the tercentenary of the appearance of Harvey's "Exercitatio Anatomica de Motu Cordis et Sanguinis," which was published at Frankfurt in the spring of 1628 when its author was fifty years of age (see also NATURE, Mar. 31, p. 507).

THE twenty-third International Congress of Americanists will be held in New York City during

the week beginning Sept. 17 next. An organising committee has been formed, of which Dr. Franz Boas is chairman, and Mr. P. E. Goddard, of the American Museum of Natural History, is secretary. The Congress will be divided into six sections, dealing with the ethnology of America, the archæology of America, the origin, distribution, and ethnography of the American Indian, native languages, the discovery and early history of America, and finally, geographical and geological questions with special reference to human activities. The titles of papers and abstracts for submission to the Congress should be in the hands of the secretary not later than June 1.

In spite of the advances in medical knowledge and practice, maternal mortality has continued at a high level, and has shown little tendency to decline. The subject is engaging the concern of the Ministry of Health, and in a circular (No. 517) issued in 1924, the attention of local authorities was directed to the importance of providing facilities for assistance in the diagnosis of puerperal fever and puerperal pyrexia, and for the treatment of patients who are unable to secure adequate treatment for themselves. In a further circular (No. 888) recently issued, the Minister of Health again directs attention to these necessary services, and expresses the hope that in all areas all maternal deaths will be investigated by a competent and experienced medical officer.

Applications are invited for the following appointments, on or before the dates mentioned:—A Paterson research scholar in the Cardiographic Department of the London Hospital—The House Governor, London Hospital, E.1 (May 15). A professor of philosophy in the Egyptian University, Cairo—The Director, Egyptian Educational Office, 39 Victoria Street, S.W.1 (May 22). An assistant lecturer in zoology and geology in the University College, Southampton—The Registrar, University College, Southampton (May 28). Research chemists at research establishments of the Department of Scientific and Industrial Research—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (May 28). A student probationer (zoologist, botanist, or physiologist) at the Marine Biological Laboratory, Plymouth—The Director, Marine Biological Laboratory, Plymouth (May 30). The Grote chair of philosophy of mind and logic at University College, London—The Academic Registrar, University of London, South Kensington, S.W.7 (June 14). The Sir William Dunn chair of pathology at Guy's Hospital Medical School—The Academic Registrar, University of London, South Kensington, S.W.7 (June 15). A temporary reader in organic chemistry in the University of Dacca, East Bengal—The Registrar, University of Dacca, East Bengal (June 26). An assistant lecturer in chemistry at the Battersea Polytechnic—The Principal, Battersea Polytechnic, S.W.11.

Our Astronomical Column.

Bright Meteor from Halley's Comet.—On the morning of May 6, at 1 h. 40 m. G.M.T., a meteor quite equal to Jupiter was seen by two observers at Bristol, and the flight was recorded from 317° − 1° to 187° + 10°, which is equal to about 125 degrees. Such a lengthy course is very seldom recorded for a meteor of any kind. The path recorded shows the radiant was probably at 337° − 4° and from the position computed for meteors from Halley's comet (May 4). There is little doubt, therefore, that this small fireball was a particle from the famous Halley's comet. Though the full moon was shining strongly at the moment the object appeared, the latter presented a fine spectacle as it occupied five seconds in its transit and threw off a bright trail of sparks. As viewed at more southern stations and from the English Channel, the meteor must have been a very conspicuous object, and it is hoped that some additional observations of its path will come to hand. This shower, discovered by Tupman in 1869–70, is specially interesting from its association with Halley's comet.

Cometary Spectra.—Mr. N. T. Bobrovnikoff has recently published several papers on this subject (*Astro. Jour.*, October and December 1927; *Pop. Astr.*, January 1928). Halley's comet showed marked changes of type during the apparition; when near the sun reflected sunlight predominated; at distance 1·2 from the sun, the violet type of spectrum due to inherent light predominated. A sudden change happened on May 24; the bands of CN IV disappeared, those of C + H became much weaker, those of C IV somewhat weaker. Barnard at the same time noted a swelling up of the nucleus. A note is made of the tendency of the head of this comet to repeat its behaviour at successive returns; many of the drawings made by Bessel in 1835 resembled phases seen in 1910; bright jets from the nucleus were also drawn in 1682 and 1759.

The comet Pons-Winnecke last summer exhibited the violet type of spectrum, which could be traced as far into the ultra-violet as in the case of Altair, which was in the same region of the sky. The bright knots of the spectrum of the head indicated the following diameters: C + H, 5000 km.; CN IV, 3600 km.; C IV, 3000 km.; continuous spectrum, 2000 km. A change in the spectrum occurred between June 10 and 19, CN IV being first brighter, then fainter than C + H. This was one of the first comets to be examined spectroscopically, by C. Wolf in 1869; he noted the three bands of the Swan spectrum.

The Einstein Deflexion of Light in the Eclipse of September 1922.—*Lick Observ. Bull.*, No. 397, contains the full discussion, by Prof. W. W. Campbell and R. J. Trumpler, of the photographic investigation undertaken in West Australia. The diagram gives very convincing evidence of the closeness with which the observed deflexions of star-places agree with those calculated on Einstein's law. A discussion follows as to the possible effect of abnormal terrestrial refraction owing to the fall of temperature during totality; it is convincingly shown that the effect would be very small compared with the observed shift. It is also shown that Courvoisier's yearly refraction could not be traced and was apparently not present. It may be pointed out that as some people are still unconvinced by the evidence, the Einstein effect is to be further investigated at next year's eclipse in Sumatra by Dr. Jackson and Mr. Melotte.

Research Items.

PIT RIVER INDIAN TRIBES, CALIFORNIA.—An attempt to reconstruct the culture and distribution of Indian tribes of north-eastern California, before the coming of the whites, in field work carried out in 1926, is made by Mr. F. B. Kniffen in vol. 23, No. 5, of the *University of California Publications in American Archæology and Ethnology*. The Achomawi and Atsugewi were oriented around the Pit River in a region with a certain general unity of climate and resource which contained a series of semi-isolated habitable tracts. There were certain unifying factors in a common culture and a largely common language which encouraged trade, exchange of food privileges, and unity against a common foe. Even within groups, however, political unity was generally circumstantial rather than natural. The population was roughly in the neighbourhood of 3000. The Indian has now been pushed back to the rocky edges of the valleys or works for the white rancher. They once claimed as their own a vast territory extending from Mount Shasta and Goose Lake to the Madeline Plains and Mount Lassen on the south, and from the Warner Range on the east to Montgomery Creek on the west; but it was especially along the Pit River that the centres of attraction were found. The valley areas offered an amazing variety of animal and vegetable food, the vegetable being capable of being either consumed immediately or stored for winter. The Indians recognised eleven groups, each composed of those living on a single site or on several nearby sites, nine of them being collectively termed Achomawi in anthropological literature, though they had no collective name for themselves. The two Atsugewi groups differed from the Achomawi in language and, while friendly with some, were at enmity with others. The four western groups of Achomawi and the Atsuge buried their dead, built round winter houses, used dug-out canoes, possessed the full Californian acorn technique, owned food-tracts privately or by families, but recognised no chieftainship over the group as a whole. The five eastern groups and the Aporige cremated their dead, built their winter houses over rectangular or oval excavations, had no canoes or acorn complex, and recognised a group chief, but no private ownership of food-bearing tracts of land.

MODEL HOUSES OVER GRAVES IN OCEANIA.—In *Man* for April, Mr. Patrick Buxton describes a burial custom followed in Nanomea in the Ellice Group, now that the older customs have died out owing to the introduction of Christianity. Formerly it was the practice to bury the dead in houses in the village. Now that burials take place in a cemetery, a small house is erected over the grave. The body is buried in the ground and white coral is strewn over the grave. Above this a small house is erected, the largest observed being about 5 ft. high and having a ridge-pole about 6 ft. long. Nothing quite like this has been recorded from any other part of Polynesia, although the erection of huts in the burying ground and the strewing of black and white pebbles over the grave have been noted. Mr. Buxton also records two remarkable rock-cut basins of unknown use and date from Tanna, New Hebrides. They are cut in two large masses of rock—a very soft red tuff—which have been roughly squared and faced. In each has been cut a basin. In one case the basin is circular, about 26 in. in diameter and 6 in. deep, with two overflows and circular depressions around the margin. In the other, the basin is rectangular, and about 26 in. by 9 in. long and 6 in. or 7 in. deep. Each held water. No similar objects have been recorded by any other visitor to the island.

PLUMAGE AND SEXUAL DEVELOPMENT.—On many of the mud-flats of British estuaries, as well as on the sandbanks of Holland, groups of waders remain during the summer months, while their kin have departed for the arctic regions, to which the breeding range is confined. These laggards are generally regarded as young and immature birds, and yet although in the majority the plumage indicates immaturity, in a very small percentage of cases, the full summer plumage is apparent. Dr. G. J. van Oort, in order to investigate the possibility of correlation between coloration of plumage and development of the gonads, collected a number of the delayed birds during the summer months, and now reports upon the Knot and Turnstone (*Tijdsch. Ned. dierk. Vereen.*, p. 25; 1928). In the twenty-two examples examined, he found that in both species the testes of the majority were inactive, and that in such birds the plumage varied greatly, but that all possessed some feathers of the adult summer plumage. On the other hand, in the few individuals in which the testes were active and many spermatocytes had been formed, the plumage is identical, or nearly so, with the normal adult summer plumage. Dr. van Oort reaches the conclusion that the full summer plumage cannot develop unless spermatogenesis has started and many spermatocytes have been formed.

DRAWINGS OF INDIAN FISH.—Dr. Sundra Lal Hora (*Jour. As. Soc. Bengal*, vol. 22, pp. 93-125; 1926) states that in the library of the Asiatic Society of Bengal there are bound volumes of zoological drawings made by Mackenzie, Buchanan-Hamilton, and Lord in the early part of the nineteenth century. The volume of the manuscript drawings of Mackenzie at present contains 2 plates of pencil sketches and 55 plates of coloured drawings, although originally there were 65 plates. Among the twenty-six illustrations of fishes in this volume there are two of a globe fish from St. Thomé River, near Madras. It is probable that the globe fish referred to belongs to the genus *Kanduka*, recently described from the Ganges delta. It would appear that the Society came in possession of these manuscripts in December 1822. There are four volumes of Buchanan-Hamilton's drawings. It is suggested that the originals found their way to the India House and are the same in the main as the set described by Günther in *Zoological Records* for 1869, and that the drawings in Bengal are only replicas. In the first volume there are 22 plates of fish illustrations, representing 51 species, and the rest of the plates are of mammals; the second and third volumes are drawings of birds made by Mr. Gibbons; and the fourth are those of fishes, representing 150 species. Lord's manuscripts are those of fishes in the collection of Sir Alexander Burnes. There are 47 illustrations; of these 35 are of whole animals, 9 outline sketches showing the fish from above, and 3 of special parts. In the 'forties, efforts were made to publish these drawings with the author's notes, but unfortunately the notes were lost and the publication was not completed.

THE FALL ARMY WORM.—Among the insect fauna of North America the Fall Army Worm (*Laphygma frugiciperda*) is of especial interest, since it is one of the few insects that frequently disperse and breed throughout the greater part of the United States, only to perish at the end of the season. It is only in the warmer parts of Florida and Texas that this insect remains a permanent resident, and it redistributes itself elsewhere through annual migrations of the moths. A very complete account of its

biology and control is given in the *Technical Bulletin*, No. 34 (Feb. 1928) of the U.S. Dept. of Agriculture, written by Mr. P. Luginbill, of the Bureau of Entomology. The caterpillars feed upon a wide range of plants, but are more especially addicted to various grasses, and they rank as a pest of the first order. Periods of cool weather and rainfall favour the spread and multiplication of this species, while these same conditions are known to be deleterious to the multiplication of its natural enemies—notably predaceous and parasitic insects. The abundance or scarcity of these enemies determines to a very large extent whether or not there will be an outbreak of the Fall Army Worm in a particular season: local outbreaks are often checked entirely by such natural agencies. In view of the importance of this aspect of the economy of the Army Worm, a very full and interesting account is given of the relationship between it and its parasites and hyperparasites.

VEGETATIVE PROPAGATION BY SEED.—In *Science*, vol. 62, No. 1733, Dr. Chas. F. Swingle directs attention to an account of four apple seedlings (variety, Transparent de Croncels) which have developed from unfertilised ovules of emasculated and bagged flowers to the bearing stage. The apparent identity of these plants with the seed-mother tree, together with the results of Kobel's cytological studies, seems to warrant the conclusion that under certain conditions (not yet defined), unfertilised ovules of this variety of apple may set viable seeds, genetically constituting true vegetative reproduction. These results differ from the somewhat similar observations of Frost, that in *Citrus* the stimulus proceeding from fertilisation seems necessary for the production of such 'asexual' seeds. The importance of apogamic seeds as a possible means of obtaining uniform clonal rootstocks should at once be apparent. Although under the conditions of his experiments Kobel was unable to get a sufficiently high percentage of these apogamic seeds to make them a factor in the production of uniform rootstocks, still his results point to the desirability of continuing and extending such experiments with as many different varieties of apple under as many different conditions as possible, in the expectation that the complex of varietal and environmental conditions necessary for vegetative propagation by apogamic seeds will be discovered. (See also "Zytologische Untersuchungen an Prunoideen u. Pomoideen," *Archiv Julius Klaus-Stiftung f. Vererb., Soz., u. Rassenhygiene*, vol. 3, No. 1, 1-84, 1927. Zürich.)

'FALLEN STARS' OF THE BENGHAZI STEPPE.—In a note published in the *Atti della Pontificia Accademia delle Scienze* for 1927, D. Vito Zanon describes small globules resembling drops of resin found in the steppe to the south of Benghazi. These globules are mostly orange-yellow or brownish-red, but occasionally white outside, and are so hard that the blow of a hammer is necessary to break them. The interior has the yellow colour of the finest amber and is shining and glassy, with a conchoidal or sub-vitreous fracture. It was at first thought that this material, the Arab name for which signifies 'fallen star,' consisted of amber, but chemical analysis indicates the presence of albumin and, in the inner portion, of lecithin. The obvious inference is that the spherules are eggs, presumably of a small reptile, which have been prevented by the high temperature of the soil from putrefying or undergoing other changes except drying and slight external deformation. A curious feature observed is the inclusion in the material of large numbers of both fresh-water and marine diatoms of many different forms. These were doubtless wind-borne, and were imprisoned when the egg-substance had been rendered so spongy by the action of surrounding moisture as to become permeable to atmospheric dust.

WEED KILLERS AND GARDEN PATHS.—Results of weed killer trials on garden paths, in which the effectiveness of a number of chemicals was compared with that of several proprietary weed killers, are described by A. Hill in the *Scottish Journal of Agriculture* (vol. 11, p. 203). Although common salt, washing soda, iron sulphate, sulphuric acid, carbolic acid, and sheep dip all gave disappointing results, copper sulphate applied as a fine powder at the rate of 1 lb. per 100 sq. ft. proved entirely successful, a plot treated twice in June 1924 remaining free from weeds up to November 1927. Weather conditions, however, were of the greatest importance, the best results being obtained if the path was treated on a sunny day after rain, and fine weather followed the application. If heavy rain followed the treatment, the effectiveness of the dressing was greatly reduced. Various types of proprietary weed killers also gave good results provided several applications were made, but they were less effective than the copper sulphate, and further, if they contained arsenic, caused a blackening of the paths. A non-poisonous weed killer (1 per cent. solution) in which sodium chlorate was the active constituent, also proved useful provided dry weather followed the application, but, as is apt to occur with some other weed killers, there was a tendency later for the path to become covered with moss. Iron sulphate was decidedly better than copper sulphate or caustic soda for eradicating moss, though the latter is recommended for removing green growth from concrete paths in shady positions. For this purpose the alkali is applied as a powder and allowed to absorb moisture from the air; the path is then swept with a stiff brush and finally well flushed with water.

WHALING RESEARCH.—On April 2, at the Æolian Hall, London, Prof. A. C. Hardy lectured before the Royal Geographical Society on the work of the R.R.S. *Discovery* in the dependencies of the Falkland Islands. Prof. Hardy outlined the objects and scope of the *Discovery* Expedition, details of which have already appeared in our columns. It is evident that both the shore party and the staffs of the *Discovery* and the *William Scoresby* have collected a vast amount of material, and a considerable period of time must elapse before the actual results of their research will be available. Prof. Hardy, however, was able to give the broad conclusions of the results of an intensive plankton and hydrographic survey of the whaling grounds round South Georgia that are of extreme interest. The euphausians, which form the bulk of the food of the whale in that locality, were found to be concentrated on the north-east side of South Georgia; on the west side of the island was a very rich zone of diatom plankton, which encircled the island on either side some distance from the shore. The island is placed at right angles to the westerly drift of water coming from Drake's Straits, and Prof. Hardy indicated how this current would set round either side of the island to meet some distance behind it, leaving an area of 'dead' water on the north-east side. This current, striking the shelving bottom on the west of the island, would cause upwelling of phosphate-rich water which could support a heavy crop of diatom life; these diatoms would be carried round either end of the island, and by eddies into the sheltered water where the euphausians occurred. This dead water would thus form a sheltered nursery for the euphausians. The theory suggested fits well with the results of the phosphate analyses obtained. Work is still continuing at the shore station and in the *William Scoresby*.

COLLISIONS BETWEEN ELECTRONS AND MOLECULES.—A big advance towards solution of the difficult problem of the motion of an electron projected towards a neutral molecule has been made by Dr. I. Langmuir and Mr. H. A. Jones in a long series of experiments carried out in the Research Laboratory of the General Electric Company at Schenectady. The simplicity of the apparatus employed, which was essentially a cylindrical thermionic tube containing a trace of gas, with the grid replaced by a space charge of positive ions, and a pair of auxiliary electrodes inserted, was in marked contrast to the heavy analysis involved in the reduction of the observations. Their main results are collected into three tables in the March number of the *Physical Review*. The first (p. 399) is a list of ionisation and resonance potentials for the gases used (mercury, neon, argon, helium, hydrogen, nitrogen); it is remarkable that the resonance potential important for the discharge is not necessarily the lowest excitation potential of the gas. The second (p. 402) gives the free paths for inelastic collisions of electrons with speeds equivalent to a number of potentials between 30 volts and 100 volts; these prove to be very close to the values calculated on kinetic theory from the viscosities of the gases. The third (p. 403) includes both data on the probability of various types of collisions and the average deflexion of an electron when it excites or ionises a molecule, and the maximum number of ions that can be produced by an electron with a specified initial velocity. The paper contains in addition considerable information about the groups of electrons which are present in an ionised gas, and confirms earlier records of the existence of several sets, each with a Maxwellian distribution of velocities.

THE GREEN AURORAL LINE.—The recent *Bulletin of the American Physical Society* (No. 3 of the current volume) includes an abstract of a paper by J. Kaplan, in which it is stated that the spectrum of the afterglow of nitrogen which has been mixed with a few per cent. of oxygen shows only two of the lines of the latter in the visible region. One appears to be the auroral line, and the other is in the red at 6655 A. The absence of other lines due to oxygen, which is accompanied by a strong development of the alpha bands of nitrogen, indicates that the two which are present are produced in some very simple way (*v.* also NATURE, May 5, p. 711). The actual mechanism which is effective in the upper atmosphere is discussed by Dr. G. Cario in the April issue of the *Journal of the Franklin Institute*. He criticises Prof. McLennan's views, and offers the suggestion that the action occurs in two stages, in the first of which ultra-violet solar radiation induces a photochemical dissociation of molecular oxygen into atoms in a normal singlet state, whilst in the second the atoms are excited to the upper level of the green line transition. Dr. Cario states that he has experiments in progress designed to test this hypothesis.

SILVER NITRATE CONCENTRATION CELLS IN ACETONITRILE AND BENZONITRILE.—The Nernst formula for concentration cells, which has been confirmed for aqueous solutions, is known to hold for several non-aqueous solutions such as silver nitrate in ethyl alcohol. In the *Journal of the Chemical Society* for February, F. K. V. Koch gives measurements of electromotive forces which show that at 0° C. and 25° C., silver nitrate concentration cells in acetonitrile and benzonitrile also support this formula. These solutions appear to conform to the solution laws almost as nearly as aqueous solutions.

EFFECT OF CATALYSTS ON THE COMBUSTION OF CARBON DIOXIDE AND OXYGEN.—In the *Journal of the Chemical Society* for February, W. E. Garner and C. H. Johnson describe a very interesting apparatus, which they have used to investigate the rate of emission of radiation, the duration and extent of ionisation, and the speed of flame during the explosion of carbon monoxide and oxygen mixtures. Various substances were employed as catalysts, and it was found that those containing hydrogen decrease the infra-red emission, but increase the flame speed and ionisation. Very small quantities of water vapour have a large effect upon the amount of energy radiated. The ionisation persists for a much longer period in the absence of hydrogen-containing substances, but does not appear to be due to 'after-burning,' since the extinction of flame and steady radiation coincide. With dry gases it is also possible to distinguish a combustion phase responsible for the emission of infra-red energy, and a second phase characterised by ionisation and the emission of visible radiation. It suggested that this luminescence may be due to the slow recombination of ions. These effects are most marked with mixtures containing small quantities of carbon tetrachloride, but disappear in the presence of hydrogen.

'SUNVIRAY' ULTRA-VIOLET LAMP.—This small arc lamp, made by Messrs. Ajax, Ltd., for home use, which was described in NATURE of April 21, p. 641, has been greatly improved in design by the substitution of a rotary switch in place of the knife switch of earlier models. This eliminates the risk of a shock from the exposed electrodes at that point. It is regretted that in the previous description the lamp was incorrectly described as the 'Uviray'—the correct name is as given above. The arc is between cored carbons and will run on either D.C. or A.C. without change of adjustment.

MOVEMENTS OF THE HEAVISIDE LAYER.—Experiments with radio waves have proved fairly satisfactorily that there is a refracting and reflecting layer (Heaviside layer) in the upper atmosphere. Experiments carried out by the engineers of the Bell Telephone Laboratories, New York, have shown that the radio signals received at a distance of 50 miles indicate quite clearly interference between rays probably refracted by this layer and those which come directly along the surface of the earth. The time interval between the interfering waves enables us to find the length of the path of the indirect waves. A study of the experimental results by R. A. Heising appears in the *Bell Laboratories Record* for February. He concludes that at night the apparent height of the refracting region varies between 150 and 400 miles. Since ultra-violet light from the sun produces free electrons at altitudes so low as 16 miles, the apparent height of the refracting region is much lower by day than by night. He concludes that the refracting region does not remain in a fixed position but moves up and down. He has observed a rise of six miles per minute and a fall of twenty-five miles per minute. The rapid movement of the refracting region at night appears to be the cause of the rapid fading of those waves which travel well during the night time. If the refracting layer were fixed and the frequency of the waves from the transmitting station fixed also, fading would not occur. Any transmitting station operating with variable frequency will probably produce bad quality reception at the receiving station if there is more than one transmission path between the two. The greatest care, therefore, should be taken when designing a broadcast station to prevent variation of the carrier frequency during the course of an audio wave.

The Nature of Manual Dexterity and its Relation to Vocational Testing.

By Prof. T. H. PEAR, J. N. LANGDON, and EDNA M. YATES.

RECENT research to discover suitable tests of manual dexterity has concentrated upon two kinds, the sample or 'trade' test, and the 'analytic' test. The first kind explains itself; the second attempts to analyse the candidate's manual dexterity into simpler and, if possible, unitary dexterities. It then separately examines his capacities for them.[1]

To the immediately practical mind the sample test has advantages so obvious that it would appear foolish to supplant it. But the defects of its virtues are many. Though it measures a candidate's ability in the actual occupation for which he is wanted, it leaves quite undetermined a beginner's *capacity* for learning such a job; and ability is often acquired only at the expense of time and money. Except, therefore, for low-grade dexterities, the sample test will be useless for selecting those persons who, though they are not yet proficient in a particular job, are specially fitted for it. Furthermore, the risk of spoiling tools or machinery, and the physical danger in allowing potential failures to undertake complicated sample tests, are obvious.

Of these defects, the failure of the sample tests to discover capacity, as distinct from ability, is of chief psychological interest. For though such a failure must obviously occur with high-grade, complex skills, it is not certain that a sample test of low-grade dexterity, comprising only a few simple movements, would not test capacity.

Dissatisfaction with the sample test has encouraged attempts to discover simple or unitary capacities underlying more complicated forms of dexterity. Generally speaking, testing the simple muscular dexterities in the analytic procedure is far from simple, and requires a trained psychologist. This necessity, however, is admitted in many quarters. In Germany especially the analytic test is much in favour.[2]

Yet there is little evidence concerning the important question, whether the 'simple' factors which, after an analysis of any instance of muscular dexterity, are chosen to be tested, really compose that dexterity. While it seems that in a highly complicated skill the whole performance is not the mere sum of its parts, this seems less certain of a low-grade skill, which appears to be merely the simultaneous or successive combination of simple movements. For what is actually known concerning the functional inter-relationships of the simpler motor capacities suggests that they are not so intimate as was formerly supposed. Perrin,[3] Muscio,[4] and the present writers[5] have found very low correlations between simple motor performances. The manner in which they are 'tied together' is not certainly known.[6] As Prof. Edward L. Thorndike has pointed out from the result of experiments, "We see the possibility of a disciplinary effect[7] where superficial observation would have expected none, the difficulty of transfer in a case where speculative and verbal thinking would have assumed that it was easy, and, in general the ignorance that we suffer from, concerning the internal constituents of almost every act of learning."

Obviously, therefore, in searching for a test of *capacity* for manual dexterity (low-grade skill) it is necessary to examine, in the light of any procurable evidence, the relative claims of the sample and analytic tests.

EXPERIMENTAL TESTS USED.

The investigation described below was carried out with the support of the Industrial Fatigue Research Board in the psychological laboratory of the University of Manchester. It concerned a simple instance of manual dexterity closely resembling an actual process in the chain-assembling industry. Its main aim was to discover whether there is any transfer of training acquired in one kind of dexterity, to another in which there has been no such training.[8] It offers evidence, however, bearing upon the validity of the 'analytic' procedure in the vocational testing of manual dexterity.

A group of 28 subjects was trained intensively for eight days on an operation in which links were removed from and others replaced on spindles, the handling of which involved the rotation of a turntable. Improvement in general was more than fifty per cent. of the initial score. Before training was commenced, the performance of each subject was measured in various tests designed to show the presence or absence of transfer. These tests were selected in accordance with an observational and introspective analysis of the operation with the links and spindles described above. It will be seen from the following that many of them are simple tests of manual dexterity and may be of some interest in connexion with vocational selection.

(1) *Match insertion.*—The match-insertion board used in psychological testing was employed. Matches were taken one at a time from a standard position and inserted in the small holes, the score being the number of matches inserted in a two-minute period.

(2) *Placing matches in a box.*—Thirty matches were arranged in a row on the table, and were picked up one at a time and placed neatly in a match-box. The score was the time taken.

(3) *Placing rings on a rod.*—The subject took rings, one at a time, from a bowl, and slipped them over a rod. The score was the number dealt with in two minutes.

These three tests were performed with right and left hands separately.

(4) *Steadiness.*—The apparatus is described in Whipple's "Manual of Mental and Physical Tests," vol. 1, p. 152. It is the usual tracing board, with a slit bounded by converging metal strips. Along one edge is mounted a millimetre scale. The subject was instructed to draw the stylus along the slit without making contact with the sides. At the first contact the subject stopped and repeated the process. This was repeated eleven times. The score in each case was the distance traversed before contact, and the final score was the median of these eleven.

(5) *Steadiness.*—The metal plate pierced with holes of different diameters, as described in Whipple's "Manual," was employed. The subject had to hold the stylus in each hole in turn for 15 seconds. The total time before contact was made was recorded, and the score was the median of 7 trials.

(6) *Arm movement.*—The blindfolded subject was required to make a movement of the arm, the extent

[1] Cf. Prof. C. Burt's chapter on vocational tests in "Industrial Administration," edited by Muscio.

[2] Cf. F. Giese, "Psychotechnische Eignungsprüfungen" (Halle).

[3] "An Experimental Study of Motor Ability," *Journal of Experimental Psychology*, 1921.

[4] "Motor Capacity with special reference to Vocational Guidance," *British Journal of Psychology*, October 1922.

[5] In an unpublished report to the Industrial Fatigue Research Board.

[6] Cf. Pear, "Skill in Work and Play," pp. 22-3.

[7] i.e. transfer of training from one performance to a different one.

[8] J. N. Langdon and Edna M. Yates, *Memoirs and Proceedings of the Manchester Literary and Philosophical Society*, vol. 72, and "An Experimental Investigation into the Transfer of Training in Skilled Performances." *British Journal of Psychology*, April 1928.

of which was measured by apparatus which precluded all save a rotary movement. He was then instructed to make another movement of the same extent as before. The score was the coefficient of variation of ten such trials.

(7) *Moede's impulse meter.*—The subject holds a hammer in his right hand and is instructed to strike a specially devised anvil. The force of the blow is measured on a scale. (An illustration is given in the apparatus catalogue of E. Zimmermann, Leipzig.) He is then told to strike the anvil again with just the same force as before. He repeats this ten times in all. Here again the score was the coefficient of variation.

(8) A group test of intelligence, No. 33 in the National Institute of Industrial Psychology's series.

Provision of Adequate Incentives.

It is a valid criticism of many experiments upon the acquirement of skill that one is uncertain if the motives urging the learners to try their best are adequate. Since many of the tasks are very simple and may become monotonous, boring, or irksome, the stimulus is lacking which a recognised test of intelligence naturally offers to university undergraduates or graduates, who are the usual volunteer 'subjects' for such experiments.[9] The Industrial Fatigue Research Board made it possible to supply a financial motive for adequate performance; the subjects, unemployed boys aged fifteen to eighteen years, from the local Labour Exchange, were employed full time. They were paid a minimum wage of 12*s.* per week plus a piece-rate depending upon daily performance. A similar piece-rate was paid for success in the 8 tests described. The work therefore was to them extremely important. They were under close observation all the time. It is thus perfectly certain, both from their behaviour and from their own account of the work, that the incentive to try hard was adequate.

The correlations obtained between each of the tests and the abilities in the operation with the links and spindles at the end of 8 days' training will now be given. In addition, the scores of the first, second, and third periods of ten minutes' practice, and also the mean score per period of the first day's training, were correlated with the mean score per period of the last day's training.

The table shows that the supposedly analytic tests show little correlation with the practised operation. The coefficients are all lower than that between rank in the second period of ten minutes' practice and rank in the mean performance on the final day of training. The coefficient derived from the second period of ten minutes' practice when correlated with the practised operation is identical with that from the first day's practice when correlated with the operation. It is higher than that derived from the first period of 10 minutes' practice when correlated with the final practised ability in the operation with the links and spindles.

Conclusion.

In this investigation, involving simple manual dexterity or low-level skill of a kind similar to that required in industry, the present experimental results do not support the hypothesis of a close relation between the simple performances in the analytic tests and the more complex performance involved in the practised operation itself. This agrees with the major result of the investigation reported elsewhere, that there is no evidence for transfer of training from the practised operation to performances in the 'simple' tests.

Results pointing in a similar direction but obtained upon a smaller number of subjects have been recently published by Dr. Hans Kellner.[10]

If such results are further confirmed by experiment they would justify the use, as a selective test for an occupation at a *low* level of skill, of a sample 'try out' in the operation itself. But this would have to be done only after an initial trial had been given to secure adaptation to the experimental conditions. Even here it must be emphasised that the correlation between the second (adapted) performance and the final (practised) ability is very low.

Correlation with Ability in the Operation with the Links and Spindles at end of 8 Days' Practice.

Test.	Correlation coefficient.	Probable error.
First 10-min. period in the operation with links and spindles	0·43	0·11
Second 10-min. period in the operation with links and spindles	0·57	0·09
Third 10-min. period in the operation with links and spindles	0·52	0·10
Mean score of first day in the operation with links and spindles (sixteen 10-min. periods)	0·57	0·09
Match insertion. R. hand	0·24	0·13
Match insertion. L. hand	0·24	0·13
Placing matches in box. R. hand	0·46	0·11
Placing matches in box. L. hand	0·16	0·13
Placing rings on rod. R. hand	0·30	0·12
Placing rings on rod. L. hand	0·28	0·12
Steadiness (1)	0·34	0·12
Steadiness (2)	0·06	0·13
Impulse meter	0·23	0·13
Arm movement	0·22	0·13
Intelligence	0·21	0·13

Despite this fact, however, a 'try-out' on the operation appears to be fairly useful in diagnosis. For in the present investigation, after a preliminary trial for adaptation, it was found that of those boys who were in the upper half of the distribution in the 'try-out,' 86 per cent. were in the upper half of the distribution on the last day of training.

The investigation also throws light upon another common and natural view not supported by the present figures. This opinion is that in selection for a performance involving low-grade skill, an error in the choice of operatives would not be serious.

In the present investigation, at the conclusion of the 8 days' training, the difference between the best and the worst performance was 126 links per period. There were 16 such periods per day. Therefore, even in this short working-day, between the best and the worst performance there was an average difference of more than 2000 links. In other words, the practised ability of the worst worker was only 64 per cent. of the best. This offers strong evidence of the need for selection even in occupations requiring a low degree of skill. The present figures favour the 'sample' as against the 'analytic procedure' for selecting operatives for such occupations.

[9] Cf. F. C. Bartlett, "Psychology and the Soldier," pp. 69-76; Burnett and Pear, "Motives in Acquiring Skill," *British Journal of Psychology*, vol. 16, pp. 77-85.

[10] *Psychotechnische Zeitschrift*, December 1927, pp. 153-161.

Danish Plaice Investigations in the Baltic Sea.[1]

FOR many years the problem of how the stock of plaice in the Baltic Sea is recruited has occupied biologists of that region. Peterson's view, expressed in 1894 (*Report Danish Biol. Stat.*, **4**, p. 13) and again in 1906 (*Cons. Internat. Rap. et Proc. Verb.*, **5**), was that the numbers were renewed by immigration from the German coasts around Kiel Bay. A. C. Johansen came to the conclusion that the deep water of the Baltic itself was the real home of the O-group in the eastern Baltic, whilst Reibisch concluded that this was not sufficient to account for the renewal of the whole stock, and that an immigration of *adult* plaice took place from the Kattegat and the western Baltic.

As the result of a systematic investigation carried out in 1925, H. Blegvad, however, holds the view that the renewal of the stock of plaice is brought about by the appearance of *young stages* on the shores of the Baltic proper. The supply from this source is erratic. He shows that the temperature and salinity of the bottom water during the early months of the year exhibit a distinct correlation with the numbers of the fry which are able to become established. When the temperature and salinity were relatively high during this period, a favourable fry year resulted, as, for example, in 1923 and 1925, whereas 1922 and 1924 (with the reverse conditions) were bad years.

A. C. Johansen goes into this matter more thoroughly, but deals with the adjacent waters of the southern Cattegat and the Belt Sea. A similar correlation is observable here also. The question then arises, Is this influence direct or indirect? Johansen is inclined to believe that it is mainly indirect, and that the paucity of young plaice in certain years is due to the presence of comparatively fresh water, deficient in plankton, which flows out from the Baltic during the winter months. If this hypothesis should be further confirmed, he suggests that a forecast of the yield in any particular year will be obtained most cheaply and easily by estimating the plankton in those waters and not by fishing for the young. The need for a solution of this problem is becoming more and more urgent on account of the very large increase in the intensity of fishing in the Baltic which has come about in recent years. Thus, although the Danish catch in 1917 was only 31,485 kgm., in 1924 it reached 2,909,011 kgm.

[1] Report of the Danish Biological Station to the Board of Agriculture, 32; 1926: On the Renewal of the Stock of Plaice in the Baltic Proper. By H. Blegvad. Edited by Dr. C. G. Joh. Petersen. Pp. 37. 33; 1927: On the Fluctuations in the Quantity of Young Fry among Plaice and certain other Species of Fish, and Causes of the Same, by A. C. Johansen; On a Spawning Place for Winter Spawning Herring in the Northern Part of the Belt Sea, by A. C. Johansen; On the Annual Fluctuations in the Age-Composition of the Stock of Plaice—Investigations from the Danish Biological Station, 1923–26, by H. Blegvad; Studies on the Biology of the Oyster (*Ostrea edulis*), II-IV, by R. Spärck. Edited by Dr. A. C. Johansen. Pp. 65. (Copenhagen: G. E. C. Gad, 1927.)

University and Educational Intelligence.

CAMBRIDGE.—Mr. F. E. Baxandall and Mr. C. P. Butler have been reappointed as senior observers, and Mr. W. Moss as junior observer, at the Solar Physics Observatory, and Mr. H. E. Green has been reappointed as assistant observer at the Observatory.

LONDON.—A public lecture will be delivered at the East London College, Mile End Road, E.1, at 5 o'clock on Wednesday, May 16, by Dr. W. A. Goddyn, of the Rijks Herbarium, Leyden, on "Lotsy's Hybridisation Theory, demonstrated on South African Material."

Prof. Ross G. Harrison, of Yale University, will deliver a lecture on Monday, May 21, at 5.30 P.M., at University College. The subject of the lecture will be "Modern Trends in the Study of Animal Development."

ST. ANDREWS.—An additional lectureship in philosophy has been instituted, and the University Court has resolved to appoint to this lectureship Mr. A. R. Knight, of the Institute of Industrial Psychology, London. The work of the new lecturer will be principally in the Department of Psychology and Experimental Psychology. The Court has appointed Dr. F. Bath, formerly of King's College, London, as lecturer in mathematics in the University and assistant to the professor of mathematics in University College, Dundee.

VACATION courses for teachers and students in England and Wales, arranged for the year 1928, differ but slightly from those of last year. The list issued by the Board of Education (H.M. Stationery Office, pp. 23, price 6*d.*) shows among those arranged by the Board several courses for teachers of science: in rural science, botany, and biology (but not, this year, in laboratory arts) at Cambridge, in physical chemistry and engineering at Oxford, and in physics at Harrow. Courses for foreigners have been organised by the University of London, by University College, London, by the University of Oxford, and by University College, Exeter. Among the subjects of the twelve courses arranged by university bodies in connexion with the work of the Workers' Educational Association, economics, literature, history, and psychology figure in all or almost all cases: natural science, generally biology, in five. In the list of courses organised by associations, the Association for the Provision of Science and Specialist Teaching finds no place this year: nor does the Dalton Association.

ADULT education in America is developing rapidly. Some account of its recent growth is given in *Bulletins 18* and *21* of 1927 of the United States Bureau of Education, entitled "Public Education of Adults in the years 1924–1926" and "Public Evening Schools for Adults." Some of the activities described are concerned with attempts to promote by means of what used to be called 'Americanisation classes' the elementary education of illiterates. In such classes, organised by State departments of education, 315,000 students were enrolled in 1925–26. In public evening schools in cities of 10,000 or more inhabitants the enrolment was, in 1924, nearly a million. The most remarkable achievement in popularising such education is that of Gary, Indiana, where more than 12,000 men and women—one-sixth of the adult population—attend courses provided in the public schools. The total budget for evening schools, as reported by 412 towns, exceeded five million dollars, being at the rate of 15 dollars per student. Extension courses offered by colleges and universities are very various and are constantly assuming new forms. 'Radio talks' are increasingly used, and more and more institutions are installing, or procuring the use of, broadcasting plants and employing them in connexion with correspondence courses. So striking are the signs of growth of the adult education movement that the Bureau of Education's specialist in this subject anticipates developments during the second quarter of the century that will match the marvellous growth in the field of secondary education in the first quarter. A similar belief in a coming great revival in Great Britain was expressed by Prof. Robert Peers, of University College, Nottingham, in a public lecture on adult education delivered by him at King's College, London, some time ago.

Calendar of Customs and Festivals.

May 14.

St. Machudda or St. Cartagh (A.D. 637), one of the most noted of Irish saints, of whom many legendary stories are told. A celestial fire descended on his mother before his birth. As happened with many Irish saints, there was a lack of water at his baptism; but a spring burst from the ground for the office and flows to this day. Many miraculous acts are attributed to him, such as turning water into milk, and causing an apple tree to spring from the ground and bear fruit forthwith in a trial of strength with a pagan, Magus.

May 15.

St. Dymphna.—Seventh century. One of the most famous of medical saints, invoked in cases of possession, epilepsy, and lunacy, at Gheal, N. Brabant. She was the daughter of an Irish king who, inconsolable at the death of his wife, sought his daughter in marriage, and when she escaped to Gheal, followed and killed her. On May 15 her relics are carried in procession, followed by all the inhabitants and the lunatics, and on each day of the octave the lunatics, and those who seek the intercession of the saint for their friends and relatives, crawl around her shrine on all fours.

St. Cæsarea.—Date uncertain. An Italian saint from the neighbourhood of Otranto who, when persecuted by her father in the same manner as St. Dymphna, took refuge in a cave which opened in the cliff and closed again behind her. On Ascension Day and through the octave the cave opens and the saint is seen seated, while rays of light shoot forth from the cave. During the same period the people of the neighbourhood fetch water from a medicinal spring in a cave of St. Cæsarea near by.

May 16.

St. Carantog.—Sixth century. Son of a Prince of Cardigan. When the saint was conveying across the Severn a magnificent altar of stone sent by Christ from Heaven for a chapel which he had founded under the guidance of a dove, it was lost overboard. Confident that God would cast it up on the shore, he appealed to King Arthur for it to be restored to him. Arthur had intended to convert the altar into a table for himself and his knights, but returned it to the saint on his fulfilling the condition that he should capture a serpent which was devastating the Carr, a marshland district in Wales.

May 14-16. Rogation Days.

May 17. Ascension Day.

By the first Council of Orleans in the sixth century, it was enjoined upon the whole Church that the Rogation Days, previously only a preparation for Ascension Day, should have joined to them supplication for a blessing on the fruits of the earth. Rogation Week was also known popularly by the names of Cross Week, from the bearing of the Cross in procession, Grass Week, from the abstinences observed, such as salads, etc., being substituted for flesh, and Gang or Procession Week, from the perambulations for the purpose of blessing the fields. With this is associated the practice of making the circuit of the parish, otherwise "Beating the Bounds," and a curse on whomsoever moved a boundary was part of the Rogation Service.

As a popular custom, the civil purpose of fixing the bounds has overshadowed the religious side of the observance. In London the closing of the gates of the Temple to general traffic on Ascension Day is an affirmation of the boundaries which is more conspicuously observed in the formal procession of dignitaries to beat the bounds of the adjacent parish of St. Clement Danes. It is usual for the processions to be accompanied by boys carrying willow wands or staves. At Lichfield they bore green boughs, while at Wolverhampton children bore long poles decked with flowers. On Ascension Day at Nantwich, a hymn blessing the Brine was sung. An ancient pit called the Old Brine was decked annually with garlands. In Derbyshire, at Terrington, Ascension Day was observed as a holiday, and the five wells were elaborately dressed with flowers and overhung with boughs: the wells were visited in procession after services in church, and a hymn or psalm sung at each.

In many localities cakes and ale were provided for those taking part in the procession, while various devices were followed to impress the boundaries on the people, especially the boys. Sometimes a boy's head was bumped on a boundary stone; in Dorset someone was ducked in a brook, while at Exeter boys dammed streams in the streets and splashed passers-by with the water. At Wolverhampton 'gospel trees' marked the boundaries, and at Stanlake the gospel was read on a barrel-head in a cellar in the Chequer Inn, reported once to have been a hermitage or the site of a cross. About Keston and Wickham, in Kent, a number of young men used to assemble together and, making a hideous noise, run into the orchards, circling each tree and reciting a verse calling on God to send "Every twig, apple big, every bough applee now." For this "Youling" they expected a gratuity of money or drink.

The circling movement is important in many, especially of the more primitive, boundary observances. In the elevation of the Ceri at Gubbio each Cero circles three times before the specially favoured houses it visits, and in some of the observances of southern India the priest or officiant circles three times around the boundary stone. Apart from the act of circumambulation, the striking features of the custom in England, which connect it with primitive observance, are its essentially religious character, the meal of which the members partake, the carrying of an emblem of vegetation, and the marking of the boundary by some process painful to the individual, undoubtedly a remembrance of human sacrifice.

A suggested origin in the *Terminalia* or the *Arvalia* of ancient Rome must be referred to still earlier practice—the casting out of evil and the renewal of the benign magical influence of the deity. Hence at the festival of the goddess Mariamma in South India, the entrails of a sacrificed sheep are hung around the neck of a naked man of the scavenger class, who perambulates the boundaries, clearly representing both god and victim. The Tamils offer blood and rice on the boundary stones to renew the divine influence. Hence also the elaborate processions of the temple cars on special occasions. With these last must be compared the processions of the *alberi* and the *carrocci*, the poles and cars, which take place in a number of the Italian towns; and the elevation of S. Ubaldo, S. Antonio, and S. Georgio on the Ceri at Gubbio on May 15, the vigil of the first named, of which the elaborate ceremonial may possibly go back to the ritual prescribed in the Eugubine Tablets of Roman times, still preserved in the town. The similar processions of giants such as those at Lille, Bruges, and elsewhere, and recorded as having taken place in England until modern times, it has been suggested by Sir James Frazer, are to be derived from a practice such as the Druidical sacrifice of human beings in a wicker framework.

Societies and Academies.

LONDON.

Geological Society, April 18.—**G. H. Mitchell**: The succession and structure of the Borrowdale Volcanic Series in Troutbeck, Kentmere, and the Western Part of Long Sleddale (Westmorland). The area lies in the eastern part of the Lake District south of the High Street range. It is drained by the Rivers Sprint, Kent, and Trout Beck, all of which flow in a southward direction. Nine subdivisions are recognised in the rocks described. They have been subjected to severe earth movements. Two systems of folding are recognised, an earlier one of pre-Bala age and a later one of Devonian age. The former system, of simple character, shows axes trending in a north-north-easterly and south-south-westerly direction. In the latter the folding was intense, with an east-north-easterly and west-south-westerly strike, while the pitch of the folds was determined by the folds of pre-Bala date. The rocks are steeply folded in the south-east of the area, and the folds are even overturned to the north. Northwards the folding is less severe, and is marked by the presence of a broad anticlinal fold. No faulting of earlier date has been recognised. The rocks are strongly cleaved, the strike of the cleavage coinciding with that of the Devonian folding.—**L. J. Chubb**: The geology of the Marquesas Islands (Central Pacific). The Marquesas Islands, with one doubtful exception, are of volcanic origin. The southernmost, Fatu Hiva, consists of a caldera composed chiefly of lava-flows, within which an ash-cone has been built up. The western half of the whole structure has disappeared, apparently owing to submergence by faulting. Motane is a small ash island. Tahuata is larger, and it also is composed chiefly of ashes in its northern part; its south-eastern side has been faulted down. In Hiva Oa there are three great craters in the western part, some of the coasts are faulted, and there is an elevated plateau at a height of 1300 to 1500 feet above sea-level. Nuka Hiva has a structure similar to that of Fatu Hiva, and it bears a plateau at an elevation of 2600 feet. It is considered that the group is situated, not on a crustal fold, but on a system of intersecting fissures. Elevation has occurred followed by subsidence. All the islands are surrounded by a shore-shelf, now standing, owing to a recent fall in sea-level, 3 or 4 feet above high-water mark. The poor development of coral-reefs in the group is due chiefly to periodic chilling of the water by extensions of the cold Peruvian Current, connected with cyclic climatic changes.

Linnean Society, April 19.—**R. D'O. Good**: The geography of the Sino-Himalayan genus *Cremanthodium* (Compositæ). The range of *Cremanthodium* is roughly within the triangle made by joining the Indus valley where it enters the N.W. Frontier Province, Lake Koko Nor in Kansu, and Lake Tali-fu in Yunnan. This total area is divisible into three main topographic regions—the western or Himalayan mountains, the eastern or western Chinese mountains, and the plateaux of Tibet. A statistical study of the distribution of the species shows that: (1) 14 species are found in both western and eastern mountains. (2) 4 species are found only in the Himalayan mountains (all in the eastern half of the range). (3) 30 species are found only in the Chinese mountains (almost all in the southern half). (4) The greatest concentration of species is in Yunnan. (5) Only two or three species extend on to the Tibetan plateaux. The present areas of greatest species population in the genus are within the zone of very high monsoon precipitation, but this distribution results largely from the configuration of the mountains, and the elevation of the Himalayas has probably caused the progressive desiccation of the northern mountains of western China.—**F. O. Bower**: The size-factor in plant morphology, with special reference to the stele. Physiological interchange is conducted through limiting surfaces, external or internal, and it may be assumed that, provided the surface be unbroken, such interchange will be proportional to the area of the surface involved. Accordingly, in an enlarging body, if the original form be retained, a practicable size-limit will ultimately be reached. In the ordinary vascular plant there are three important limiting tissue-surfaces: (i.) the outer contour; (ii.) the endodermal sheath, which delimits the primary conducting tracts from the enveloping tissues; (iii.) the collective surface by which the dead tracheal system faces upon the living tissues that embed it. The present discussion deals only with (ii.) and (iii.), and all secondary or cambial developments are left out of consideration. The common form of axis in primitive plants is conical, enlarging upwards; and the conducting system enlarges with the axis. Thus it will constantly be called upon to meet a diminishing proportion of surface to bulk. This is carried out chiefly by: (*a*) penetration of the primitively solid tracheidal tract by living cells, or replacement of those that are central by parenchyma; (*b*) its enlargement of surface by fluting, or segregation into parts; (*c*) involution of the endodermis, which is apt to follow the changes in the tracheidal tract, but does not always do so. Comparison of various plants shows that the stele may react to the size-factor independently of the insertion of appendages. This is seen in marked degree in roots; it is also evident in aphyllous and microphyllous forms, but where the appendages are large these exercise a correspondingly great influence upon the stelar development.

DUBLIN.

Royal Irish Academy, April 23.—**Thomas J. Nolan and Michael T. Casey**: The nature of the pigment of the elder berry (Part 1). The anthocyan pigment of the elder berry has been isolated as the chloride in the form of a powder with strong bronze reflex showing a pattern between crossed Nicols. The picrate is a brick-red product crystallising in flat prisms. The anthocyan chloride is readily soluble in water and in hydrochloric acid of various strengths. From the chloride, by hydrolysis with strong hydrochloric acid, the colour base chloride has been obtained in the form of prisms with rounded ends. The product contains no methoxyl groups and resembles delphinidin closely in its colour reactions with alkalis and with ferric chloride, its ease of isomerisation, its power to reduce Fehling's solution, and its difficultly soluble picrate. Direct comparison with a sample of delphinidin chloride, however, shows that it differs markedly from the latter in its reactions towards water and 10 per cent. hydrochloric acid, the elder berry anthocyanidin chloride being practically insoluble in water.

PARIS.

Academy of Sciences, April 2.—**Gabriel Bertrand and Georges Nitzberg**: The preparation, by the sorbose bacterium, of a new reducing sugar containing seven atoms of carbon. α-glucoheptite can be oxidised under the influence of the sorbose bacterium into a new reducing sugar with the formula $C_7H_{14}O_7$, α-glucohep-

tulose. It is probably ketonic, and further experiments regarding its constitution are in progress.—**Constant Lurquin**: The statistical analysis of successive differences of deviations.—**Georges Calugaréano**: Polygene functions of a complex variable.—**Henri Milloux**: Some properties of the roots of meromorph functions.—**Georges Valiron**: Some properties of meromorph functions.—**S. Mandelbrojt**: A fundamental point in the theory of the series of Dirichlet.—**Portevin**: The determination of the internal strains in circular metallic cylinders.—**Pierre Salet**: The errors due to the personal equation in observations of the angular position of double stars. Reply to a criticism of the prism method by de Glasenapp.—**Albert Nodon**: Relation between the regular oscillations of terrestrial electric and magnetic fields and the diametral solar foci.—**E. Kogbetliantz**: The velocity of propagation of attraction. A laboratory experiment is suggested which would be capable of measuring the velocity of propagation of the Newtonian attraction, if it is comparable with the velocity of light.—**Conti, de la Ville le Roulx**, and **Coret**: The selection of communications of departure and arrival in telephonic networks with a central battery.—**Pierre Jolibois, Henri Lefebvre, and Pierre Montagne**: The reversibility of a reaction produced by a spark or by the electric current. Starting either with carbon dioxide or a mixture of carbon monoxide and oxygen under suitable pressures, after sparking for some time the same equilibrium was reached, about 74 per cent. of the mixture remaining uncombined.—**P. Laffitte**: The influence of the temperature on the formation of the explosive wave. A description of experiments carried out with mixtures of hydrogen and oxygen and of methane and oxygen, the temperature of explosion varying from 15° C. to 350° C. The results clearly prove that the elevation of the initial temperature of a gaseous combustible mixture retards the formation of the explosive wave.—**A. Seyewetz** and **D. Mounier**: The action of light on diazo-compounds. The amount of nitrogen gas evolved was taken as measuring the effect of exposure to ultra-violet light. With diazosulphonilic acid, the gas evolved was proportional to the time of exposure. In acid solutions (pH less than 7), the diazo compounds examined were very sensitive to light; in alkaline solution (pH above 7), the light effect was much reduced. With rise of temperature, the sensibility is greatest in alkaline solution and reduced in acid solution.—**Marcel Godchot** and **Mlle. G. Cauquil**: Molecular transposition in the cycloheptane series. Phenyl-magnesium bromide reacts with α-chlorocycloheptanol giving phenylcyclohexyl carbinol, $C_6H_{11}\cdot CH\cdot(OH)\cdot C_6H_5$. The probable mechanism of the change from a seven-carbon ring to a six-carbon ring is discussed.—**J. Bougault** and **J. Leboucq**: The 1 and 2 substituted semicarbazides. 1-Benzylsemicarbazide and 2-benzylsemicarbazide.—**P. Teilhard de Chardin**: The nature and the succession of the post-palæozoic eruptions in northern China.—**M. Baudouin** and **Morel**: A unique case of palæopathology. An arrow-point in a human dorsal vertebra. In a cave at Sainte-Énimie (Lozère), amongst bones of the neolithic period, two were of special interest. One shows clear indications of chronic osteo-arthritis, the other an entire vertebra in which a flint arrow-head is firmly imbedded.—**Const. A. Kténas** and **P. Kokkoros**: The phases of the parasitic eruption of Fouqué-Haméri (Santorin) in 1928.—**P. L. Mercanton**: Nocturnal radiation at Lausanne.—**H Chermezon**: The ensiform leaves of some Cyperaceæ.—**Paul Chabanaud**: The urohyal of some fishes of the Solea family.—**Raymond-Hamet**: The pseudo-non-excitability of the cardiac pneumogastric produced by uzarine and by extract of uzara.—**Léon Binet** and **René Fabre**: Variations of the amount of uric acid in the blood according to the state of the respiratory function: hyperuricæmia due to asphyxia. Mechanical asphyxia in the dog determines a marked increase in the proportion of uric acid present in the blood. The effect is temporary, and the uric acid assumes its original figure fifteen minutes after restoring normal respiration. The removal of the spleen does not affect the phenomenon.—**Mme. M. Phisalix** and **F. Pasteur**: Ultra-violet rays destroy the rabicidal power of the venom of *Vipera aspis*.—**R. Douris** and **J. Beck**: The action of mineral colloids on normal and syphilitic blood sera. In place of the unstable colloidal reagents employed in the serum diagnosis of syphilis by precipitation, the use is suggested of colloids of constant chemical composition and possessing the same physical state. The colloid reagent (sulphur, sulphides, etc.) are produced in the liquid under examination by a chemical reaction. Silicic acid has given the best results.—**Fauré-Fremiet** and **Mlle. Choucroun**: The measurement of the thickness of thin protoplasmic plates.

BRUSSELS.

Royal Academy of Belgium, Jan. 7.—**A. de Hemptinne**: Hydrogen activated by the electric discharge. Under certain conditions the chemical activity of non-ionised activated hydrogen can be demonstrated. The effects produced depend partly on the state of the body on which it is acting.—**J. Verhaeghe**: The arc spectrum of uraninite from Kasolo (Belgian Congo). An attempt was made to strike an arc between electrodes of the mineral instead of the usual carbon electrodes, but a background of continuous spectrum rendered exact measurement of the lines impossible. The secondary minerals were freely soluble in hydrochloric acid, and the chlorides thus obtained were introduced into the arc. A tabular statement of the lines measured is given. Elements not previously shown by chemical analysis include titanium, iridium, vanadium, thorium, and tungsten.—**L. Godeaux**: The asymptotic lines of a surface and ruled space.—**Constant Lurquin**: The methods of calculation of the mean deviations of probability.—**P. Swings**: Some formal analogies between certain orbits.

ROME.

Royal National Academy of the Lincei, Feb. 5.—**F. Severi**: Simple and double algebraic integrals (4).—**U. Cisotti**: The rotor of tensors.—**G. Scorza**: Major determination of the intercedent relation between the row and the type of a group.—**G. Giorgi**: The functions of matrices.—**C. Somigliana**: The definition of normal gravity.—**N. Parravano** and **G. Malquori**: Equilibrium of the reduction of tungsten disulphide by means of hydrogen. The equilibrium expressed by the equation, $WS_2 + 2H_2 \rightleftarrows W + 2H_2S$, is reached more rapidly when the reaction proceeds from left to right. The mean value of Q, calculated by means of Nernst's approximate equation from the dissociation pressures of tungsten disulphide, is 73,400 cal.—**S. Franchi**: An exceptional vein of augitic porphyrite in the triassic dolomites of the upper valley of the Neva (Ligurian Alps).—**P. Nalli**: Geodetic co-ordinates.—**S. Cherubino**: The characteristic matrices of the symmetrics on real Abelian varieties.—**Ernesta Porcu-Tortrini**: Calculation of any functions of matrices of the second order.—**A. J. McConnell**: Parallel transport of a vector along a finite circuit. Discussion of the variation of a vector subjected, as suggested by Levi-Civita, to parallel transport along a closed circuit in a space of N

dimensions, gives a double integral as the expression for this variation.—**L. Fantappiè**: The linear functionals of the functions of two complex variables (1).—**G. Krall**: Upper limits of dynamic cement.—**P. Straneo**: Kutta and Joukowski's theorem, Cisotti's supposed exception to this theorem is the result solely of the mode of interpreting the hydrodynamic phenomenon in the region of the irregularity, that is, at the edges of the lamina, where the velocity becomes infinite. The formal ambiguities leading to such interpretation may be eliminated by suitable consideration of the question *ab initio*.—**E. Persico**: Molecular velocities, conditions of excitation, and probability of transition in a degenerating gas (2). The formula previously deduced for expressing the distribution of kinetic energy among the molecules of a degenerating gas and the distribution of the molecules in the various quantic states, is applied to the two cases of slight and complete deterioration. It is found (1) that the number of molecules with kinetic energy exceeding $1 \cdot 04\ kT$ is greater, and the number of molecules with lower kinetic energy less, than required by Maxwell and Boltzmann's theory, and (2) that the molecules are divided among the different states of excitation solely on the basis of their volume and independently of the energy of the separate states. The same formula serves also to determine how Einstein's law is modified by the probability of transition from one quantum state to the other.—**R. Brunetti**: Polychroism and orientation of the ions in crystals of rare earths. The results of investigations on the absorption spectra of pentahydrated praseodymium sulphate at the ordinary temperature and at the temperature of liquid air, and of neodymium bromate at the ordinary temperature, lead to the conclusion that the spectra of the trivalent ions of the rare earth metals forming part of a symmetrical crystal contain (1) frequencies corresponding with linear vibrations in a direction close to that of the principal axis of the crystal, and (2) frequencies, in general distinct from the preceding, corresponding with vibrations occurring in the plane approximately orthogonal to the principal axis and decomposable into two vibrations equal in intensity and normal to one another in this plane.—**R. Bilancini**: The anemological regime of the Gulf of Spezia. The results obtained during the four years 1914–17, from ascents to heights of 8600 metres of about one thousand pilot balloons liberated at the aerological station in Varignano, on the Gulf of Spezia, show that, in general, the wind velocity increases with the height, the extent of the increase being greatest in summer and least in autumn and winter. The mean velocity is greatest in winter and least in summer, the value in the spring being approximately equal to that in the autumn at low altitudes but increasingly greater at higher altitudes.—**G. Malquori**: Thermal dissociation of cadmium nitrate. Anhydrous cadmium nitrate undergoes reversible decomposition at 325° C. in accordance with the equation,

$$2Cd(NO_3)_2 \rightleftarrows 2CdO + 4NO_2 + O_2,$$

the only two solid phases observed being the nitrate and the oxide. Nernst's equation gives the value 55,881 cal. for the heat of decomposition of the salt.—**A. Galamini**: The physiological action of alcohol. Further observations on rats fed with an insufficient aprotein, acarbohydrate, hyperlipinic diet.—**M. Tirelli**: Modifications of the chondroma and lacunoma in the intestinal cells of *Gambusia holbrooki* during the various phases of functional activity and during fasting.—**M. Benazzi**: The existence of particular interstitial cells in the connective tissue of the uterus of the rat.

Official Publications Received.

BRITISH.

The Journal of the South African Veterinary Medical Association. Vol. 1, No. 1, August 1927. Pp. 85. (Johannesburg.)

The Institution of Professional Civil Servants. Annual Report of Council for the Year 1927. Pp. xii+58. (London.)

University of Glasgow. Report on the Hunterian Collections for the Year 1926–27. Pp. 8. (Glasgow.)

Department of Commercial Intelligence and Statistics, India. Agricultural Statistics of India, 1925–26. Vol. 1: Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, Land Revenue Assessment and Harvest Prices in British India. (Forty-second Issue.) Pp. xxi+81. (Calcutta: Government of India Central Publication Branch.) 1.4 rupees; 2*s.* 3*d.*

The Passing of Wild Life. Pp. 8. (London: The Society for the Preservation of the Fauna of the Empire.)

Journal of the Society of Glass Technology. Edited by Prof. W. E. S. Turner. Vol. 12, No. 45, March. Pp. x+12+118+118+xxx. (Sheffield.) 10*s.* 6*d.*

Air Ministry. Aeronautical Research Committee: Reports and Memoranda. No. 1103 (Ae. 280): The One-foot Wind Tunnel at the National Physical Laboratory; including Particulars of Calibration made with a Pitot Tube and Vane Anemometer at Low Speeds. By L. F. G. Simmons and L. J. Jones. (T. 2428.) Pp. 9+10 plates. 9*d.* net. No. 1107 (Ae. 284): Further Experiments on a Model of the 'Bantam' Aeroplane with special reference to the 'Flat' Spin. By H. B. Irving and A. S. Batson. (A.2.a. Stability Calculations and Model Experiments, 127.—T. 2362.) Pp. 26+11 plates. 1*s.* 3*d.* net. (London: H.M. Stationery Office.)

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 39, Part 1, April 25th, 1928. Pp. 102. (London: Edward Stanford, Ltd.) 5*s.*

Legislative Assembly: New South Wales. Report of the Director-General of Public Health, New South Wales, for the Year 1926. Pp. vi+160. (Sydney, N.S.W.: Alfred James Kent.) 7*s.* 6*d.*

FOREIGN.

Det Kgl. Danske Videnskabernes Selskab. Biologiske Meddelelser, Bind 7, Nr. 2: On some Biological Principles. By C. G. Joh. Petersen. Pp. 54. (København: Andr. Fred. Høst and Son.)

Sudan Government. Report on Agricultural Research, Season 1926–27, and Programmes of Work for 1927–28; submitted to the London Supervisory Committee, October 1927. Pp. 185. (London: Sudan Government Offices.) 2*s.* 6*d.*

Proceedings of the United States National Museum. Vol. 73, Art. 2: Two new Nematodes of the Family Strongylidae, Parasitic in the Intestines of Mammals. By Benjamin Schwartz. (No. 2723.) Pp. 5+2 plates. Vol. 73, Art. 3: Further Consideration of the Shell of Chelys and of the Constitution of the Armor of Turtles in General. By Oliver P. Hay. (No. 2724.) Pp. 12+2 plates. (Washington, D.C.: Government Printing Office.)

United States Department of Agriculture. Technical Bulletin No. 41: The Sugar-Cane Moth Borer in the United States. By T. E. Holloway and W. E. Haley and U. C. Loftin; with Technical Descriptions by Carl Heinrich. Pp. 77. (Washington, D.C.: Government Printing Office.) 25 cents.

Department of Commerce: U.S. Coast and Geodetic Survey. Instructions for Tide Observations. By G. T. Rude. (Special Publication No. 139.) Pp. vii+70. (Washington, D.C.: Government Printing Office.) 20 cents.

CATALOGUES.

General Catalogue, 1928. Pp. 90. A List of New Books, Summer 1928. Pp. 28. (London: Chatto and Windus.)

Continental Holiday Cruises. Pp. 16. *Holiday Tours to Madeira or Canary Islands*. Pp. 6. Special Tour to South Africa. Pp. 6. (London: The Union-Castle Mail Steamship Co., Ltd.)

Students' Balances and Weights. (List No. 71E.) Pp. 4. Surplus Stock. (List No. 101F.) Pp. 12. Laboratory Coats, Aprons and Short Jackets. (Circular 251B.) Pp. 2. Genuine Becker Balances. (Circular 263A.) Pp. 4. (London: A. Gallenkamp and Co., Ltd.)

Catalogue of Books on Geology, Ornithology and General Natural History, including Conchology, Entomology, Fishes, Mammalia and Minor Classes. (No. 159.) Pp. 36. (London: Dulau and Co., Ltd.)

Diary of Societies.

SATURDAY, MAY 12.

BIOCHEMICAL SOCIETY (in Department of Brewing and the Biochemistry of Fermentation, Birmingham University), at 11.45.—S. H. Edgar: The Composition of the Blood in Acute Rheumatism of Childhood.—E. M. Hume, H. H. Smith, and I. Smedley-MacLean: The Biological Examination of Irradiated Zymosterol for Vitamin D.—J. Butterworth and T. K. Walker: A Study of the Mechanism of the Fermentation of Citric Acid by *Bacterium pyocyaneus*. Part 1.—Prof. A. R. Ling: Researches on the Polysaccharides.—F. W. Norris: The Hemicelluloses of Cereals.—A. G. Norman: The Chemistry of the Pectins.—W. L. Dulière: The Estimation of Creatine in Alkaline Solution.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Eastern District Meeting) (at New Malden), at 1.30.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students' Section) (Annual General Meeting) (at Neville Hall, Newcastle-upon-Tyne), at 2.30.—R. White: The Use of Carbon Monoxide Gas Masks in Mines.—*Papers open for further discussion*:—Notes on the Conversion of Main Pumping from Steam to Electricity, with Special Reference to the Plant Installed at Messrs.

The Stella Coal Company's Clara Vale Pit, by L. H. Forster; Roof Control on Longwall Faces, by J. F. C. Friend.

Royal Society of Medicine (Balneology and Climatology Section) (at Bath), at 5.30.—Annual Meeting.

Institution of Municipal and County Engineers (South-Western District Meeting) (at Totnes).

MONDAY, May 14.

Royal Geographical Society (at Lowther Lodge), at 5.—Col. Sir Henry Lyons and others: *Notes on Early Geographical Instruments.*

British Psychological Society (Education Section) (at London Day Training College), at 6.—A. G. Hughes: The Scientific Interests of Little Children.

TUESDAY, May 15.

Institute of Physics, at 4.—Annual General Meeting.—At 4.30.—Sir Frank Dyson: Physics in Astronomy (Presidential Address).

Royal Statistical Society (at Royal Society of Arts), at 5.15—D. Caradog Jones: The Cost of Living of a Sample of Middle-Class Families.

Royal Society of Medicine, at 5.30.—General Meeting.

Zoological Society of London, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the Month of April 1928. —W. C. Beebe: Under-sea Studies of Tropical Coral Reefs.—Dr. W. T. Calman: On the Prawns of the Family Atyidæ from Tanganyika.—Prof. A. Meek: On *Sagitta elegans* and *Sagitta setosa* from the Northumbrian Plankton.

London Natural History Society (at Winchester House, E.C.), at 6.30.—Dr. E. J. Salisbury: The Plant Population of Britain.

Royal Photographic Society of Great Britain (Kinematograph Group), at 7.—E. W. Mellor: A Few Films.

Institution of Welding Engineers (at Caxton Hall), at 7.30.—P. L. Roberts: Standardisation of Welding.

WEDNESDAY, May 16.

Royal Meteorological Society, at 5.—Sir Gilbert Walker: On Periodicity and its Existence in European Weather.—D. Brunt: Harmonic Analysis and the Interpretation of the Results of Periodogram Investigations.—Dr. C. E. P. Brooks: Periodicities in the Nile Floods.

Overhead Lines Association (at Institution of Electrical Engineers), at 5.30.—D. C. Redfern and others: Discussion on Standard Overhead Lines: Their Advantages and Number of Different Standards Required.

Royal Microscopical Society, at 7.30.—Dr. H. Moore: The Mode of Formation of the Image in the Microscope.—G. F. Marrion and Dr. A. S. Parkes: The Effects of Inanition and Vitamin B Deficiency upon the Testes of the Pigeon.—Miss M. E. Shaw and Dr. F. W. R. Brambell: An Aberrant Ovary in a Frog.

Optical Society (at Imperial College of Science and Technology), at 7.30.—Prof. G. W. Ritchey: The Modern Reflecting Telescope (Thomas Young Oration).

Faraday Society (Annual General Meeting) (at Chemical Society), at 8. —Prof. C. H. Desch: Diffusion in Solids (Presidential Address).

Royal Society of Arts, at 8.—W. Worby Beaumont: Modern Motor Car Design: Some Criticisms and Some Suggestions.

Folk-Lore Society (at University College), at 8.

Electroplaters' and Depositors' Technical Society (at Northampton Polytechnic Institute), at 8.15.—J. W. Perring: Notes on Electroplating and Polishing Plant.

British Psychological Society (General Meeting) (at Royal Anthropological Institute), at 8.15.—W. Line: Some Experimental Data concerning the Growth of Visual Perception.

Royal Society of Medicine (Dermatology and Surgery Sections), at 8.30.—Prof. Sicard (for Section of Dermatology), T. Higgins (for Section of Surgery), Sir Sidney Alexander, Dr. Goldsmith, and others: Special Discussion on Treatment of Varicose Ulcers by Intravenous Injection.

THURSDAY, May 17.

Royal Society of Medicine (Dermatology Section), at 5.—Annual General Meeting.

Chemical Society, at 5.30.—F. M. Hamer: Neocyanine.—I. Vogel: Syntheses of Cyclic Compounds. Part III. The Reduction of Some Unsaturated Cyano-esters with Moist Aluminium Amalgam. A New Synthesis of Mono-substituted Malonic Acids and of $\beta\beta\beta'\beta'$-Tetramethyladipic Acid. Further Evidence for the Multiplanar Configuration of the Cycloheptane Ring.—F. Fichter and E. Brunner: The Action of Fluorine upon Aqueous Solutions of Chromium and Manganese Salts.

Institution of Mining and Metallurgy (at Geological Society of London), at 5.30.—Annual General Meeting.

Institution of Electrical Engineers (Annual General Meeting), at 6.

Royal Society of Tropical Medicine and Hygiene (at 11 Chandos Street, W.1), at 8.15.—Dr. G. W. Bray: Vitamin B Deficiency in Infants—its Possibility, Prevalence, and Prophylaxis.

FRIDAY, May 18.

Royal Society of Medicine (Disease in Children Section), at 5.—Annual General Meeting.

National Institute of Industrial Psychology (at Royal Society of Arts), at 5.30.—F. M. Earle and A. Macrae: Choosing a Career.

Royal Photographic Society of Great Britain (Informal Meeting of Pictorial Group), at 7.—A. C. Banfield: Demonstration of Retouching.

Geologists' Association (at University College), at 7.30.—A. J. Bull and I. G. Jardine: A Section in Drift North of Upminster, Essex.—Miss B. R. Saner: On Some Features of the Taplow Terrace between Charing Cross and the Valley of the Fleet.—E. E. S. Brown: On an Unusual 'Pipe' in the Blackheath Beds at Bromley Hill.—Dr. S. W. Wooldridge: An Unmapped Outlier of the Boyn Hill Terrace at Herne Hill.—F. Gosling: A New Section in the Blackheath Beds of the Addington Hills.

Royal Society of Medicine (Obstetrics and Gynæcology Section), at 8.—Annual General Meeting.

Royal Institution of Great Britain, at 9.—Morley Roberts: The Sea in Fiction.

PUBLIC LECTURES.

MONDAY, May 14.

Gresham College, at 6.—W. H. Wagstaff: Geometry. (Succeeding Lectures on May 15, 16, and 18.)

TUESDAY, May 15.

Guy's Hospital Medical School, at 5.—Prof. J. B. Leathes: The Human Kidney and the Physiological Study of Human Urine. (Succeeding Lectures on May 16, 22, and 23.)

London School of Economics, at 5.—Prof. S. D. Wicksell: Some Aspects of Population Problems. (Succeeding Lectures on May 16 and 18.)

University College, at 5.—Prof. L. J. Henderson: Blood: a Study in General Physiology. (Succeeding Lectures on May 17, 18, 22, 24, and 25.)

British Medical Association (Tavistock Square, W.C.1), at 8.15.—Major W. Elliot: Sunlight—Natural and Manufactured, and its Use in Modern Medicine (Chadwick Lecture).

WEDNESDAY, May 16.

Royal Society of Medicine, at 4.30.—Prof. K. F. Wenckebach: The Heart and Circulation in a Tropical Avitaminosis (Beri-beri) (St. Cyres Lecture).

East London College, at 5.—Dr. W. A. Goddyn: Lotsy's Hybridisation Theory, demonstrated on South African Material.

THURSDAY, May 17.

Institute of Pathology and Research, St. Mary's Hospital, at 5.—Prof. H. Hartridge: Poisoning by Coal Gas and Products of Combustion.

FRIDAY, May 18.

Imperial College of Science and Technology, at 5.30.—Sir William J. Pope: Recent Progress in Stereochemistry. (Succeeding Lecture on May 25.)

King's College, at 5.30.—R. G. Collingwood: Roman Britain and Recent Excavations. (Succeeding Lectures on May 25 and June 1.)

Oxford University, at 5.30.—Prof. A. M. Carr-Saunders: Professions: their Organisation and Place in Society (Herbert Spencer Lecture).

SATURDAY, May 19.

Physiological Society (at Cambridge).

CONGRESSES.

May 11 to 15.

Chemical Industry Conference (organised by Society of Chemical Industry in connexion with its London Section, Chemical Engineering Group, and Institution of Chemical Engineers).

Friday, May 11 (at Les Gobelins Restaurant, 1 Heddon Street, W.1), at 8.30.—F. H. Carr: Some Chemical Engineering Aspects of the Fine Chemical Industry.

Saturday, May 12.—Visit to Rothamsted Agricultural Experiment Station.

Monday, May 14 (at Institution of Civil Engineers), at 10.30 a.m.—Sir Arthur Duckham: The Fuel Industries and the Work of the Chemical Engineer.—Prof. G. T. Morgan: The Chemical Study of Low Temperature Tar.

At 2.30.—Sir Alexander Houston: Water Purification.—J. H. Coste: The Pollution of Tidal and Non-Tidal Streams.

May 15 (at Institution of Civil Engineers), at 10.30 a.m.—Sir Alfred Mond, Bt.: Scientific Research as applied to Industry.—Sir John Russell: The Part played by British Workers in the Application of Fixed Nitrogen to the Soil.

At 2.30.—Lt.-Col. G. P. Pollitt: Developments in the Heavy Chemical Industry.

May 12.

Annual Conference of the Universities of Great Britain and Ireland (at the University, Liverpool), at 10 a.m.—The Contribution of the Universities to the Preparation of Teachers for their Vocation:—(*a*) Sir Charles G. Robertson, Prof. J. Strong, and others: Discussion on What is the Essential Service which a University can render to the Education of the Intending Teacher? (*b*) Mrs. S. D. Simon, Prof. T. P. Nunn, C. F. Mott, and others: Discussion on What should be the Relation of Universities to the Specialised Professional Training of Teachers?

May 14 to 16.

Italian Society of Medical Radiology (at Florence).

May 19 to 23.

Congress of Radiology of the Union of S.S.R. (at Kiew).—Subjects of Discussion:—The Consequences of the Changes of Elements of Cells under the Influence of Radiation. Classification and Radiodiagnosis of Diseases of Joints. Functional and Anatomical Changes of the Gastro-intestinal Canal after Operative Intervention. X-ray-therapy of Diseases of the Circulatory System. Temporary Sterilisation with X-rays. Radiodiagnosis of Intestinal Diseases.

May 25 to 27.

French Societies of Oto-neuro-ophthalmology (at Marseilles).

SATURDAY, MAY 19, 1928.

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Imperial Agricultural Research.

THE augmentation of the scientific research services of the British Empire is such an immediate necessity that at the conclusion of the preliminary plenary sessions of the Imperial Agricultural Research Conference, held last October, the view was expressed in these columns that the representatives of the home government should have been in a position to state "what further financial provision the government is prepared to make, and what financial support has been promised or is expected from the dominions and non-self-governing dependencies, for the effective carrying out of the schemes submitted to the delegates for their consideration." The hope was also expressed that some definite statement of this character would be made before the break-up of the conference.

It is very unfortunate that no such endorsed statement appears in the recent Report and Summary of Proceedings of the Conference (London: H.M.S.O. 1s. net). The Administrative Commission which considered the proposed chain of research stations, bureaux for the interchange of information, and the recruitment, training, and interchange of workers, contented itself with making a number of recommendations regarding the machinery which should be put into operation to effect the objects in view, and with very vague and non-committal suggestions as to the methods by which funds might be raised. Some of the various sub-committees dealing with specialist subjects, for example, veterinary science, animal nutrition, animal genetics, soils and fertilisers, plant breeding, backed their proposals for the encouragement of research with estimates of their cost, but while the conference agreed with their proposed schemes of work, it was not in a position to recommend the allocation of funds for putting them into effect.

Lord Bledisloe, who occupied the chair throughout the proceedings, rightly said that the conference was noteworthy for its comprehensively representative character—albeit more reality would have been lent to it if the proportion of overseas research workers to administrative agricultural officers had been larger—that it served the useful purpose of bringing together a large number of persons for the interchange of views on the impact of scientific research upon Empire development, that it was able to reach a considerable measure of agreement upon the nature, the place, and the character of the machinery necessary for the development of the research services, and that it afforded research workers the opportunity of seeing something

of the research workers and stations in Great Britain and Northern Ireland, which in itself is a useful precursor to a fuller measure of co-operation. Nevertheless, it is permissible to ask why, apart from the actual fact of its meeting, the direct and tangible results of the conference should have been left in the air until such time as further reference could be made to the home and the overseas governments. There is surely something radically wrong with the machinery for imperial co-operation if the accredited representatives of the constituent parts of the Empire, the local governments of which have been notified of the object of a conference at least twelve months in advance, can be empowered to agree upon policy but cannot be given the necessary authority to commit their governments to any expenditure for carrying a policy into effect.

Admittedly, on the basis of the various recommendations passed by the delegates to the Agricultural Research Conference, the home government could, out of the funds at the disposal of the Empire Marketing Board, establish a chain of research stations, create bureaux for the interchange of information regarding soil science, animal nutrition, animal pathology, animal and plant genetics, and so on, and launch an energetic campaign for the training and recruitment of agricultural research workers. Doubtless it would need additional funds for these purposes, but they should be forthcoming, for the home authorities are quite aware of the value of scientific research applied to agriculture, whether in Great Britain or overseas. As Sir Daniel Hall pertinently remarked in the closing session of the conference, if the ultimate goal is to make the British Empire self-supporting in the fundamental and all-important matter of food, we must effect an extension of the area under crops and cattle by means of research. The results already achieved in this direction by means of research in Canada, the Punjab, South Africa, and the tropical colonies, amply justify an ambitious programme of research.

The ideal before the conference was, however, the organisation of co-operative research throughout the British Empire in which each constituent part of the Empire shall play its part, and unless each of the overseas governments makes a contribution to a common fund for the furtherance of this object, there is a very real danger that the delegates to the next conference, which is to be held in Australia in 1932, will find that they are as far removed from its attainment as they were in the autumn of 1927. If governments share financial responsibility for any undertaking, they will keep a critical eye on the activities of the departments or persons on whose behalf expenditure has been incurred. If the whole responsibility is borne by the home government, it will be difficult to arouse and impossible to maintain any interest of the overseas governments in the schemes recommended by their respective delegates.

Were the promotion of agricultural research a contentious issue like fiscal policy, the reluctance of governments to delegate authority to their representatives to commit them to a limited expenditure could be understood. If the scientific workers of Great Britain had no contributions to make to the progress of science as applied to agriculture in the dominions and colonies, if our agricultural research and teaching institutions were lacking vitality, or compared unfavourably with those in other parts of the Empire, there might be justification for the extreme caution displayed. Furthermore, if the overseas governments were still unconvinced that they are losing a large percentage of their agricultural produce yearly through plant and animal diseases, and are not realising to fullest extent the known potentialities of the soil, largely due to the inadequacy of their research services, their attitude could be understood. Judging, however, from the utterances of the statesmen of the dominions and India at the Imperial Conference in 1926, and those of the representatives of the non-self-governing dependencies at the Colonial Office Conference in May 1927, the Empire as a whole is completely convinced of the need for more and still more scientific investigation of the problems facing it, most of which are related to the foremost industry of the Empire, agriculture. Apparently they are also convinced of the need for co-operation in research as in other matters affecting the welfare of the peoples whom they represent. They are represented, directly or indirectly, on the Empire Marketing Board. It can only be suggested to them, that as unanimous agreement has been reached on detailed schemes for co-operation, they will use every endeavour to place the necessary funds at the disposal of their representatives on that Board without further delay.

Since the appearance of the Report and Summary of Proceedings, a memorandum has been issued by the secretariat of the conference outlining the action which has been taken on the recommendations made; nothing in it leads us to modify the views expressed above. Regarding the chain of research stations, the memorandum states that the North Queensland Station "is at the moment the subject of correspondence between the Commonwealth Council for Scientific and

Industrial Research and the Empire Marketing Board"; the Empire Marketing Board "are consulting the Government of the Union of South Africa on the proposals that the facilities of the Ouderstepoort Station should be increased to enable it to undertake the functions of a central research station in animal diseases"; the recommendation that an irrigation research station should be set up "has been forwarded to the Committee of Civil Research. That committee has formed a Sub-Committee to deal with the recommendation." The question of research stations in the Colonial Empire has been considered by a Colonial Office committee under Lord Lovat's chairmanship, and this committee recommends that until the Amani Research Institute in East Africa is thoroughly re-established no other links be forged in the chain. The recommendations relating to the creation of more central research bureaux and clearing-houses of information for the Empire have been accepted by the governing bodies of the institutions to which it is recommended they should be attached, but the British Treasury has only just "been approached in regard to the acceptance of the principle of a United Kingdom contribution towards the cost. When the question of the home contribution is determined the countries of the Empire will be asked, as a first step, to nominate representatives on the financial supervisory body."

The same note runs all through this last memorandum. Everything is to wait until the home departments or committees concerned have reconsidered the recommendations with which they are concerned, after which presumably they will have to be referred to the corresponding authorities overseas and to the British Treasury. The delay involved in this procedure is illustrated by the time taken—three years—before the recommendation of the East Africa Parliamentary Commission regarding the resuscitation of the Amani Institute was put into effect, and in the meantime the Institute was falling further into desuetude. We can only express the hope that more energetic steps will be taken to achieve some positive results before the next meeting of the conference in Australia. At the same time, we should like to suggest that the best means for ensuring that no time will be lost between passing schemes for co-operative research and putting them into effect would be to create immediately a central fund, based upon contributions of each constituent part of the Empire, and large enough to permit of immediate action being taken by an Empire Research Council upon which the Dominions, India, and the Colonies are properly represented.

The Languages of India.

Linguistic Survey of India. By Sir George Abraham Grierson. Vol. 1, Part 1: Introductory. Pp. xviii + 517. (Calcutta: Government of India Central Publication Branch; London: High Commissioner for India, 1927.) 11.12 rupees; 19*s*.

THIS year there have been completed two very notable works in the field of linguistic science: one is the "New English Dictionary," finished after seventy years of labour; the other is the great "Linguistic Survey of India," of which the last volume to be published is now before us. No scholar can work at any problem connected with the history of English without constant appeal to the Dictionary, and no scholar can work at any problem connected with the languages of India without constant appeal to the Survey. Indeed, we can scarcely recall during the last fifteen years an article or book on the history of any of these languages (and shortly it will be seen how numerous and diverse they are) in which reference has not been made to the facts set forth in the Survey, often for the first time.

The only linguistic work which can be compared with the Survey is the "Atlas linguistique de France." But the intention, the scope, and therefore the method of the Atlas are different: in it a certain number of isolated linguistic phenomena (particular words, grammatical forms, and the like) were studied in as many of the local patois of France as possible: it does not pretend in any way to provide a description of any given dialect or even of its most salient features. The author of the Survey, on the other hand, set himself the task of describing, as fully as materials or space allowed, every language and every dialect spoken over vast areas of the Indian Empire by some 300 million people.

The New English Dictionary provides us with an unrivalled history of one language; the "Atlas linguistique" supplies invaluable information concerning the distribution of linguistic phenomena over a whole dialect-area. But the Survey has given us descriptions, not of one language only, not even of the different dialects of one language, nor even of a group of connected languages (as, for example, the Romance in Meyer-Lübke's "Romanisches etymologisches Wörterbuch"), but of four separate and distinct families of languages—the Austro-Asiatic, the Sino-Tibetan, the Dravidian, and the Aryan—excluding two languages as yet unclassified; and these families are represented in India alone (or rather in that part of India with which the Survey deals) by 179 separate languages

(of which the test is mutual unintelligibility) and 544 dialects.

It may at first seem strange that so many different languages should be spoken in a country which geography and politics incline us to look upon as one. Briefly, the linguistic history of India has been this. In the prehistoric period there were spoken over northern India, probably from the mouths of the Ganges to what is now the North-West Frontier Province, languages belonging to the Austro-Asiatic family: to this belong also languages still spoken in parts of Burma and the Malay Peninsula, and by considerable populations in Indo-China. Pater W. Schmidt makes the Austro-Asiatic a part of a wider whole, the Austric, which includes Indonesian, Melanesian, and Polynesian, spoken from Madagascar in the west to Easter Island in the east, and from Hawaii in the north to New Zealand in the south. However that may be, the Austro-Asiatic branch was at one time strongly represented in India, for even to-day in widely separated districts the descendants of these languages still survive—in the Khassi and Jaintia Hills of Assam (Khāsī); in the jungle country of the Central Provinces south of the Narbada; in scattered islets along the southern face of the Himalaya as far north as the Simla Hill States (Kanāwarī). But their greatest mass is in Orissa, where the best known of the many dialects are Santālī and Muṇḍārī. This opens the way to an interesting speculation. The name for an aboriginal inhabitant of Orissa is *ōṛa*, which derives regularly from *ōḍra-*, itself recorded early in the history of India as the name of an outcaste tribe. The same word survives in many other modern languages as the designation of a caste or occupation: in Gujarat *ōḍ* is the name of a caste that dig and carry earth and build mud-houses; in the Panjab the *ōḍ* are a tribe that clear out watercourses and build houses; in Sindh *ōḍru* is a caste that build mud-walls; in Nepal, where stone has largely taken the place of mud for building, *ōṛ* has become a stonemason.

Attention has recently been directed to the discovery of the cities of the past in the valley of the Indus, the ruins of Mohenjo-daro and Harappa with their great brick buildings. Who the builders were, we do not know; nor have we as yet any clue as to their language. But that it was Austro-Asiatic is possible, or even probable. Were they the *ōḍras*, makers of mud-bricks, whose name eventually passed into the languages of the Aryan conquerors as that of a caste of mud-workers, who dug out irrigation channels and built mud-houses? It is, at least, not impossible. For J. Przyluski has recently shown that several culture words of ancient and modern India—such as those designating cloth, cotton, the bow for carding cotton or for shooting with, the plough, the peacock, the elephant, and so on—are of Austro-Asiatic origin, borrowed from the aborigines by subsequent invaders. But whatever their extent and importance in India in the prehistoric period, Austro-Asiatic languages are to-day spoken by only a few jungle tribes, small in numbers (the census of 1921 counts them as 4½ millions only) and doomed to disappear eventually before more dominant languages.

Also in prehistoric times there was in India another family of languages, the Dravidian. Whether these preceded the Austro-Asiatic or themselves entered from the north-west and pushed back the Austro-Asiatic, we cannot say. At the present day their chief mass is found in the south of the peninsula, but at one time they certainly stretched farther north. As in the case of the Austro-Asiatic languages, isolated dialects are found in the jungle country of the Central Provinces and of Bihar and Orissa, where the most northerly (Malto) actually reaches the Ganges. Most interestingly situated of all is Brāhūī, a Dravidian language spoken in Baluchistan and separated by nearly a thousand miles, and all the deserts of Sindh and Rajputana, from its nearest relative, Gōndī on the Narbada. Unfortunately, however, its position can be interpreted in two ways, for, as Sir George Grierson points out, Brāhūī may be either the rear-guard of a Dravidian invasion from the north-west or the vanguard of a movement from the south. These isolated Dravidian dialects, again like the Austro-Asiatic, are giving way before the languages of subsequent invaders; but in the south their compact mass and, in particular, their use for literature and administration have enabled them to resist the attack of their northern neighbours. Telugu, Tamil, Kanarese, and Malayalam all have literatures of considerable antiquity. For all Dravidian speakers the census of 1921 gives the number of some 64 millions.

North and east of India lies the huge mass of the Sino-Tibetan family of languages. These are divided into two sub-families, the Siamese-Chinese and the Tibeto-Burman. Of these the former have penetrated Siam, driving before them the Austro-Asiatic languages; but, except for two small dialects, Khāmtī and one of Shān, they have not come within the area of the Survey. But the other sub-family, the Tibeto-Burman, has many representatives within India proper. Throughout almost

the whole of the historical period they have been spilling over the barrier of the Himalaya or round its ends. In the east they have occupied almost the whole of Burma, and have formed or left many colonies in the valley of the Brahmaputra; while along the whole southern face of the Himalaya are spoken Tibeto-Burman dialects, extending to the extreme north-west beyond Ladakh. But they are without literature, and they do not serve as languages of administration. They are yielding, therefore, to the languages south of them, which serve both purposes—to Kashmiri, Panjabi, Hindustani, Nepali, Bengali.

Here first we meet the names of some of the Aryan languages, which are spoken by more than 230 millions in India itself. At some time during the second millennium B.C. there appeared on the north-west frontiers of India tribes who spoke a language akin to our own, and to Latin and Greek and Keltic and Slavonic, that is to say, one of the so-called Indo-European languages. Behind them were the Iranians, speaking closely related dialects. Indeed, they must at a recent period have formed a single linguistic community. This is termed Aryan or Indo-Iranian. Those that pushed on into India are called Indo-Aryan. The earliest documents that we have of their language are the hymns of the Rigveda, some of which were composed about the time of their entry into India, some perhaps earlier, some later. These, though mainly religious and sacrificial in substance, give hints of the fights that took place between the invaders and the aborigines and between different Aryan tribes. The conquest, however, proceeded steadily, and the ever-increasing extension of Aryan power was followed by an extension of Aryan speech, as it was learnt by the conquered aborigines. The language of the Vedic hymns, becoming the language of religion and of a priesthood—the Brahmans—ever increasing in authority, and with various modifications affecting its vocabulary and grammar rather than its sounds, was stereotyped eventually as the chief language of literature, named Sanskrit, 'the perfected.' But the spoken language did not, of course, stand still in this way: it changed continually from generation to generation in sounds, in grammar, in vocabulary; and, with the widening of the area over which it was spoken and the diversity of the aborigines who learnt it, greater and greater differences began to appear in the way it developed in various parts of the Indo-Aryan domain. Hence arose those forms of speech which are classified in the Survey as 38 separate languages with 492 dialects.

Lastly, on the north-west the Iranian languages have somewhat advanced their boundaries, and some, such as Pashtu and Baluchi, are spoken actually within the borders of British India.

It is, then, this huge mass of differing languages and innumerable dialects which the 18 volumes of the Survey have analysed, classified, described. The task would seem to be beyond the power of one man. Yet in Sir George Grierson was found one equal to it. The reader, lost in astonishment at this achievement, does not know which to admire the most, the depth and breadth of the author's scholarship and his vast stores of knowledge, the acuteness of his analytical power, or the application and force of will which have carried this colossal undertaking to so complete and so brilliant a conclusion. For some years Sir George Grierson had the help of another distinguished Indianist, Prof. Sten Konow, now of Oslo, from whose pen come some five or six of the volumes. But the plan and the direction and some twelve complete volumes, including this the Introduction, are Sir George's. It is an achievement without parallel in the annals of philology.

R. L. TURNER.

Scientific Fact and Fancy.

Possible Worlds, and other Essays. By J. B. S. Haldane. Pp. viii + 312. (London: Chatto and Windus, 1927.) 7*s*. 6*d*. net.

THESE essays, covering a wide range of subjects —including, for example, "The Last Judgment," "Vitamins," "Cancer Research," "What Use is Astronomy"—have mostly been published before, some in popular scientific journals, others in the daily and weekly press. Those dealing with physiology, where Mr. Haldane is on his own ground, well bear re-publication, but it seems unfortunate that some articles of merely ephemeral value should have been included. At any rate, a clue to the original date of appearance would have been helpful as a reminder of the events which originally inspired them. On the other hand, some of the articles, particularly those on research, could have been enlarged with advantage.

The last ten years have seen a great increase in public interest in questions immediately affecting the welfare of children and the improvement of health in nations weakened by four years of war conditions. Among educated persons, even the least serious discuss vitamins, cures for tuberculosis and cancer, food-bacteria, and so on; and authoritative articles on such subjects published in the daily press, and reaching all classes of people,

can be of great use. But the time has come when the non-expert, more interested and better educated in science than his and her predecessor of twenty-five years ago, would like to hear more, and would be capable of understanding and profiting by more than can be covered in two or three octavo pages. This applies particularly to "Immunity," "Cancer Research," "The Fight with Tuberculosis," and "Vitamins," which could all with advantage have been enlarged from their original form and contained more detail.

The best part of the book is that devoted to various aspects of research: "Scientific Research for Amateurs," "The Future of Biology," "On Being One's own Rabbit." In the last paper the author describes how he and a colleague, in desiring to discover "what happens to a man when we make him more or less alkaline," attempted to get further than the merely preliminary work which can be done on animals. "It is difficult to be sure how a rabbit feels at any time, and indeed, many rabbits refuse to collaborate with one," so they began experiments on one another; the author in this essay traces the varying methods by which acidity and alkalinity were arrived at and the resulting symptoms. It is interesting to note that many of the latter were the symptoms of well-known diseases, and he goes on to suggest that it would be well for patients to have some understanding of their own symptoms when relating them to a medical man, and to realise, for example, that a pain near the heart is more often indigestion than heart disease. "Finally," he concludes, "since the public has begun to pay for medical research, it has a perfect right to know how its money is spent. During the last year, about one part in four million of the national revenue was employed during some weeks in keeping me awake during attacks of tetany, and in analysing blood samples drawn from me in the course of them. It has been the object of this article to suggest that one four millionth of the nation's money was well spent" (p. 119).

On the question of research for amateurs, Mr. Haldane writes:

"Until the last century, scientific research was almost entirely the work of men who earned their living by some other method or possessed private means. Until fifty years ago there was no such thing as training for research, and every researcher began his work as an amateur" (p. 162). Natural history, fallen into disrepute towards the end of last century, is coming into its own again. But while the field is narrowed, and there is less to be discovered in a broad sense, there is now even greater scope for detailed accurate observation; though research in chemistry, physics, human anatomy and so on is impossible to any but trained scientific workers, there remains an infinity of unexplored ground along the lines of animal and plant inheritance, habitat and distribution, and in meteorological and astronomical investigations, which will repay study by the amateur. All this can be done without special training and without expensive apparatus. Much valuable suggestion is given for carrying out such work.

The essays on speculative matters, particularly those dealing with religion, are probably of more interest to Mr. Haldane as a setting in order of his own thoughts on these subjects than they can be to other people. Of these, "Possible Worlds" is the most suggestive, dealing as it does with the possibility of regarding the world other than from the present human point of view, of imagining, for example, a 'dog' or 'smell' world, or a world in which our perceptions and senses are enhanced and increased.

"Meroz," a tract against the clergy in relation to the War, seems scarcely in good taste in 1928. The book as a whole, will, however, be of great value in spreading an interest in, and appreciation of, scientific research and the scientific point of view.

Leonhard Euler.

Léonard Euler et ses amis. Par Prof. L.-Gustave Du Pasquier. Pp. ix + 125. (Paris: J. Hermann, 1927.) 22 francs.

THIS is a short sketch of the life and work of Euler. In little more than 100 pages it gives us an interesting account of his early life, his first sojourn at St. Petersburg (1727–1741), his call to Berlin by Frederick the Great, when, soon after his accession, that monarch planned the formation of a new Prussian Academy and was collecting about him the men who were to set it going, among them Wolff, Maupertuis, Algarotti and Euler ("le grand algébriste," as Frederick called him in his letter to Suhm of June 14, 1740); his part in the formation and working of the Nouvelle Société Littéraire, afterwards combined with the Société des Sciences founded by Leibniz into L'Académie Royale des Sciences et Belles-Lettres de Prusse; the years of his co-operation, as director of the mathematical class, member of the directorate, and member of the literary committee, with Maupertuis the director of the Academy, and of his sole direc-

tion of the Academy while Maupertuis was in France recruiting his health; his relations with Frederick, and the circumstances in which, after the accession of Catherine the Great to the throne of Russia, he overcame the resistance of Frederick and returned (in May 1766) to the directorship of the Académie des Sciences de St-Pétersbourg, with which he had all along maintained his connexion; and lastly, his second stay at St. Petersburg, including the period of his total blindness from 1772 until he died of apoplexy on Sept. 7, 1783, while still in full possession of his intellectual powers and in the midst of labours never interrupted (he is said, between 1773 and 1782, to have written no fewer than 355 memoirs).

Applying the new methods due to Newton and Leibniz, Euler indelibly impressed his personality on the whole of mathematics; he left no branch untouched, and "he touched nothing that he did not adorn." He made great advances not only in algebra, geometry, analysis, theory of numbers and pure mathematics in general, but also in acoustics, optics, mechanics, hydrodynamics, engineering science from the theory of turbines to gunnery and the science of navigation, astronomy, the theory of the planets and comets, lunar theory, to say nothing of the calculus of probabilities and its applications to life insurance, statistics and games of chance, mathematical recreations, magic squares, etc.

Euler won the prize offered by the Académie des Sciences de Paris no fewer than fourteen times (the first time at the age of twenty). The mere bulk of his writings must, we suppose, be unapproached by any other scientific writer. Diogenes Laertius says that the output of the philosopher Epicurus was unprecedented, running to about 300 "rolls." What would he have said of Euler's, which in the collected edition (of which 23 volumes have appeared) will fill 69 volumes with about 600 large quarto pages in each?

Euler's powers of work were extraordinary, and he had the advantage of a prodigious memory. He could recite by heart the whole of the Æneid from one end to the other; and at the age of seventy he could still remember what particular lines began and ended each page of the edition from which he learnt it in his youth. Suffering from insomnia, he calculated in his head one night the first six powers of all the integral numbers up to 100; he remembered the numerical table so obtained and reeled it off several days afterwards to the great surprise of his entourage.

In Chapter iii. ("Léonard Euler à Berlin") we may read again the story of Frederick the Great's attitude towards Euler. Frederick admired him but had no sympathy for his subject. So we find Frederick writing to Voltaire about "un gros cyclope de géomètre," and, at the end, congratulating himself on "having exchanged a one-eyed geometer for one with two eyes" (Lagrange). Again we find Frederick writing: "Quoique je n'aye pas appris à calculer des courbes, je sais pourtant, mon cher Euler, que 16,000 réisdallers sont plus que 13,000," and (in letters to D'Alembert): "Un certain géomètre qui a perdu un œil en calculant, s'avisa de composer un menuet par *a* plus *b*," and "M. Euler, qui aime à la folie la Grande et la Petite Ourse, s'est approché du nord pour les observations plus à son aise. Un vaisseau qui portait ses *xz* et son *kk* a fait naufrage; tout a été perdu, et c'est dommage, parce qu'il y aurait eu de quoi remplir six volumes in folio de mémoires chiffrés d'un bout à l'autre; et l'Europe sera vraisemblement privée de l'agréable amusement que cette lecture lui aurait donné." T. L. H.

Our Bookshelf.

The Yearbook of the Universities of the Empire, 1928. Published for the Universities Bureau of the British Empire. Pp. xiii + 866. (London: G. Bell and Sons, Ltd., 1928.) 7*s*. 6*d*. net.

WE live in a busy age, and a perception and appreciation of the necessity for economy of time has, whether we like it or not, penetrated even the serenity of the academic world. Each university publishes its own calendar, and sets out, either briefly or at length, particulars concerning its personnel, organisation, regulations, and activities. But all those separate calendars form a library of some 50,000 pages; and, as the universities come more and more to interest and influence a wider circle than their own professors and students, the "Yearbook," with its admirable condensation and presentation of essential information, satisfies more and more a very real need.

It would, however, be a mistake to imagine that the book succeeds merely in condensing and presenting uninteresting (if necessary) regulations, and tiresome strings of names and qualifications. Indeed it goes far to show how fascinating a 'yearbook' can be made. There are, for example, a few pages summarising the history of the universities which, read in conjunction with the appendices dealing with professions and careers for which university studies are a fitting preparation, form a study in evolution not to be missed by anyone who desires evidence of how university life adapts itself slowly but surely to the changing needs of civilisation.

Since each university undertakes some form of specialised work in addition to the courses common to all, the section on professional schools, specialist

studies, and post-graduation courses, has an outstanding value. There is also a list of centres of research outside the university institutions; and, in both these connexions, there is information concerning inter-university scholarships, grants for research, etc.

The 1928 edition of the "Yearbook" maintains the high standard of its predecessor (which we noticed in these columns a year ago): it would not be easy to pay it a higher compliment.

Plants of the Past: a Popular Account of Fossil Plants. By Dr. Frank Hall Knowlton. Pp. xix + 275. (Princeton: Princeton University Press; London: Oxford University Press, 1927.) 16*s*. net.

THIS book is written for readers with no special knowledge of either botany or geology, but is intended to arouse interest as well as to impart a fair amount of information. It should be successful, for it has many good points, and in any case it covers a field which no other book attempts to cover.

The first chapters are introductory; most of the remainder of the book describes the floras of the different formations from the Cambro-Silurian to the Pleistocene, one chapter being devoted to each formation. The result is that while the treatment is proportionate from a geological point of view, chapters which lack important material are loaded with detail. The British reader will find the chapters on the Tertiary especially troublesome, because they are full of the names of many unfamiliar American plants. The book ends with chapters on evolution, on the influence of man on plants, and on the formation of coal.

The author deals with a wide subject proportionately, accepts his data cautiously, and writes clearly. The general reader will find the book easy to follow, though sometimes dull. Students, on the other hand, are likely to be somewhat disappointed, because the author, in endeavouring to be simple, misses much of the interesting speculation on the evolution of plant structure, and on the changes of past climates, their place being taken by straightforward description.

The Collection and Preparation of Herbarium and Timber Specimens. By J. Burtt Davy and L. Chalk. Pp. 28. (Oxford: The Imperial Forestry Institute, 1927.)

THIS handbook is intended primarily for the use of forest officers, and should prove of value to those district forest officers and their subordinates who can give the time, amidst their multifarious duties, to the collection of specimens for local forest herbaria.

Some forest officers, as the past has shown, have neither the gift nor the temperament of the collector; but for those possessing these attributes, the preparation of this handbook should prove of great service. Not only are the lines upon which the collection of individual specimens clearly laid down, but also the inadequate resources which face the forest officer whilst on tour in the forests are borne in mind. For example, under "Drying the Specimens," after detailing the methods of placing the material in the press, the practical suggestion is made: "In very humid localities or during rainy weather, the press may be suspended endwise over a small camp fire or a portable paraffin stove, surrounded by an improvised tent of branches, grass, etc., with a hole at the top. The hot air penetrates the bundle by way of the corrugated cardboard."

The handbook may be recommended to all those who wish to collect botanical specimens which shall be serviceable for the herbarium, whilst at the same time ensuring that the results of the arduous work often entailed shall not be lost owing to subsequent bad packing and consequent irremediable damage during transit.

The Locomotive-God. By W. E. Leonard. Pp. v + 434. (London: Chapman and Hall, Ltd., 1928.) 18*s*. net.

THIS is not a cheerful book, but it will be read with zest by psychologists. The author, a man of literary and academic distinction in America, in early middle life became the victim of distressing and disabling, yet quite groundless, terrors. He could not walk more than a few hundred paces from home without panic; and he suffered besides from attacks of acute melancholia. Believing that the causes must somehow be infantile, he resolved to reach them. "I knew indeed there was something *down below*. What was it? I estimate by careful computation that my efforts to answer this question have been, up to date, equivalent to four semesters of laboratory research."

University colleagues assisted Mr. Leonard, and in the end it appeared that the first trauma had been caused by a shock received at the age of two years and four months when, straying near the metals, he had nearly been caught by a locomotive (hence the title of the book). Other distressing experiences, one in particular at the age of ten, were also unearthed, and the whole record takes the form of an autobiography, the details of which had in some cases long passed out of conscious memory. The book is far more personal than the mere medical record of a distressing case of distancephobia, and is therefore more widely interesting. It is pervaded by a spirit of indomitable stoicism, for the suffering endured has been incredible. On this account, if for no other, the book makes invigorating reading. J. C. H.

Elektrostatische Versuche mit Anwendung des Universalelektroskops. Von Theodor Wolff. Pp. viii + 85. (Berlin und Bonn: Ferd. Dümmlers Verlag, 1928.) 2·85 gold marks.

IN this volume the author describes his universal electroscope, and gives descriptions of numerous experiments, ranging from elementary experiments in electrostatics to measurements of ionisation currents of various types, and of atmospheric potentials. The experiments described are ingenious and well thought out, and teachers wishing to arrange a course of practical instruction in electrostatics will find some useful hints.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Light-Year *versus* Parsec.

THERE comes a time in every science when merit is acquired by the introduction of a new unit of measurement, and all will admit the occasional necessity of such in a world of expanding physical sciences. Does astronomical science need another unit of stellar distance?

It would seem that, in general, any new unit should satisfy some or all of the following conditions:

(1) It should be urgently needed, to express a magnitude of an order not adequately represented in the existing system of units.

(2) It should be a logical unit, in that it follows customary formation for units of its type; it should depend directly upon other units or dimensions of fundamental nature.

(3) So far as possible, it should be easy of comprehension by men of science who are not specialists in its particular province.

(4) Where it is suggested as a replacement for a unit sanctioned by long usage, it must be in every way a better and more convenient unit. Age does not imply sanctity; it does, however, demand an improvement.

Does the word 'parsec' meet the requirements outlined above? From the viewpoint of the purist, nothing could well be worse than this hybrid, but the nomenclature of science includes a few other verbal monstrosities, and this, in itself, is no argument against the term.

(1) The 'parsec' is equal to 3·26 times the customary unit known as the light-year; it does not indicate a magnitude of an order different from the older unit.

(2) The light-year is a highly logical unit. In mechanics, our best definition of a length is still given by $s = vt$; that is, a length equals a certain velocity multiplied by the time. This is precisely the construction of the unit known as the light-year, and it rests upon two other units, the velocity of light, and the length of the year, which are regarded as highly fundamental.

(3) The light-year is a unit the significance of which is instantly grasped by the layman, or by the man of science in unallied fields. Which is the easier (and the more logical)? Is it the concept of a star at such a distance that light needs 159 years to make the journey therefrom, or the concept of a star at such a distance that, as seen from the star, the semi-major axis of the earth's orbit subtends the 48·7th part of the 1,296,000th of a circumference?

(4) While long usage does not necessarily give authority, the fact that the concept of visualising stellar distances by the time of light travel goes back at least to the year 1740, deserves thoughtful consideration. The actual term, light-year, is not nearly so old.

Aside from its ease of comprehension and its logical structure, we lose historical 'side-lights' of great interest and value by abandoning the light-year. The fact that a distant Milky Way, apparently a replica of our own stars in its integrated light, is to us as it actually was three million years ago, adds a genetic datum which is utterly lost in the distance of one million 'parsecs.'

But the term 'parsec.' was introduced to make computations easier. The skilled computer will smile at this; he cares little whether he has to take a reciprocal, or to add in any one constant log. as against any other. In fairly representative computations involving parallax and distant spiral nebulæ data, I have never yet had to use the 'parsec' unit.

The trigonometric method of determining star distances has given undue prominence to the angle subtended by the semi-major axis of the earth's orbit, an importance which will inevitably be greatly diminished by the further application of the methods of spectroscopic and dynamical parallax determination. Such probable progress will further diminish the excuse for a unit like the 'parsec.' Why use it at all?

HEBER D. CURTIS.

Allegheny Observatory,
Pittsburgh, Pa.,
April 18.

Base Exchange and the Formation of Coal.

IN an article entitled "Base Exchange and the Formation of Coal" (NATURE, Sept. 24, 1927) I discussed the probable influence of base exchange between the roofs of coal seams and sodium chloride solutions on the formation of bituminous coal. I suggested that base exchange might form the connecting link between the coal seams of various geological formations. Since writing the article, I have had an opportunity of examining the roofs of bituminous coal seams of Jurassic, Cretaceous, and Tertiary ages, and they agree with those of the Carboniferous age in showing evidence of base exchange and hydrolysis. It appears, therefore, that bituminous coal always occurs under a roof which has undergone base exchange and which contains sodium as the main replaceable base. The final stage in coal formation appears to have been the bacterial decomposition of the accumulated plant material under alkaline anaerobic conditions.

The base exchange theory of coal formation affords a method by which the 'drift' and 'in situ' theories may be reconciled. If drifted material accumulated in the sea, the characteristic roof constituent would be sodium-clay. If the material accumulated by drift in fresh water and the roof were deposited in fresh water, base exchange could take place by submergence in the sea. If the material accumulated 'in situ' on land or in fresh water, a slight alteration in land level, such as geologists maintain occurred at intervals during the coal-forming periods, could result in base exchange taking place with capillary solutions of sodium chloride raised from subsoil water containing this salt. It follows, therefore, that whether the material accumulated by 'drift' or 'in situ,' the same final roof conditions have been present.

Base exchange appears also to have a bearing on the formation of petroleum. Petroleum-bearing strata are usually overlaid by shales. The fossil evidence indicates that the material from which the shales have been formed was deposited in salt water. Base exchange between the material covering the petroleum-bearing strata and solutions of sodium chloride must therefore have taken place. The subsequent hydrolysis of the sodium-clay would provide alkaline anaerobic conditions for the bacterial decomposition of organic matter.

An investigation of the bacterial decomposition of fats under a roof which has undergone base exchange and hydrolysis is now in progress. The result of such a decomposition is shown in Fig. 1.

The fat was distributed through a sand layer at

the bottom of a beaker and the sand layer moistened and inoculated with a soil suspension. A roof containing hydrolysing sodium-clay was deposited on the sand and a layer of water maintained on top of the roof. The beaker was then incubated at 30° C. The development and accumulation of gas under pressure is shown. The decomposition of triacetin results in the formation of methane alone. The decomposition of tributyrin results in the formation of a mixture of gaseous paraffins. Decompositions of other pure fats and naturally occurring mixtures of fats are in progress. The appearance of these decompositions is similar to that in the figure. Gycerol on decomposition under alkaline anaerobic conditions is converted

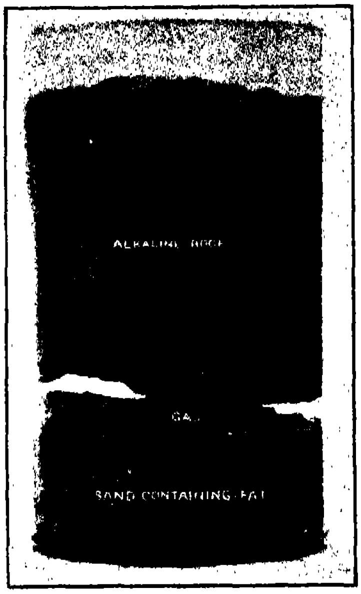

FIG. 1.

into methane, the oxygen being probably eliminated as carbon dioxide and absorbed by the alkaline roof.

From the results so far obtained, it appears that the fat is hydrolysed, the resulting glycerol being converted into methane, and the fatty acid being reduced to a corresponding paraffin. As petroleum occurs under deposits which appear to have undergone base exchange, the investigation now being carried out suggests that it may have resulted from the bacterial decomposition of animal or vegetable fats under alkaline anaerobic conditions. The close relationship that is supposed to exist between the formation of coal and the formation of petroleum lends support to the suggestion, as under the conditions indicated both would be formed by similar types of bacterial action in similar circumstances.

E. McKENZIE TAYLOR.

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Cambridge.

Temperatures of Stars in Planetary Nebulæ.

DURING the past summer, when working at the Dominion Astrophysical Observatory in Victoria, I secured some quantitative data as regards the luminosity of planetary nebulæ. I did not have occasion to elaborate the material until this winter, which I spent in Pasadena, on my leave of absence from the University of Washington at Seattle.[1] The method consists of taking a slitless spectrogram of the nebula with its central star, and impressing on the same film on which this spectrum is taken a series of comparison spectra of varying intensities and of the same time of exposure as the nebula. The comparison spectra are obtained from a sensitometer having the daylight sky as a source, a real image of the sensitometer patches being formed at the slit of the spectrograph. The photographs yield the total intensity of each monochromatic picture of the nebular envelope in terms of the intensity per frequency unit of the adjoining star spectrum of approximately the same wave-length.

In working out our data we have taken a somewhat idealised view which leads to different independent determinations of the temperature of the central star, assumed to be a black body.

1. *Mechanism of ionisation and recombination.*—For a certain type of atom or ion, it is assumed that all the ultra-violet star light beyond the head of the series is completely absorbed, causing ionisation of the atoms or ions in the nebula. From the intensity data of the spectrum, which is assumed to be produced by the subsequent recombination, the approximate temperature of the star is derived. This method may be applied to the data for H, He, and He^+, giving independent determinations for each type. This mechanism was first applied by me to hydrogen in diffuse nebulæ (*Astrophys. Jour.*, **65**, 50 ; 1927).

2. *Bowen's secondary mechanism of electron excitation.*—It is assumed that the so-called nebulium lines are excited by the photo-electrons freed according to the first mechanism, and that the excess of energy absorbed by an atom or ion above its ionisation energy is completely given out as energy in the observed resonance nebulium lines; in other words, that a photo-electron freed from any atom or ion is only recaptured after its energy as a free electron has been completely exhausted in producing the nebulium lines. Hence the data on the nebulium lines provide another independent temperature determination which, of course, may give somewhat low values. This mechanism was put forward by Bowen (*Astrophys. Jour.*, **67**, 1 ; 1928) in order to account for the abnormal intensity of those lines which, according to his well-known identification, originate in many cases from metastable states of known ions. The images of the hydrogen lines and of the green nebulium lines are nearly coincident, apart from the somewhat larger size of the latter and, for the lower temperature nebulæ at any rate, it is likely that the photo-electrons originating from the hydrogen atoms are the main agents in exciting the nebulium lines. In the present temperature determinations the approximation has therefore been introduced that the hydrogen absorbs all the ultra-violet energy of the star beyond the head of the Lyman series, and that the electrons thus freed lose their energy completely in exciting the nebulium lines. For the lower temperatures this approximation is justified, but the higher temperatures derived from nebulium may thus come out somewhat low, so that, for example, a temperature of 70,000° derived from nebulium might be 20,000° or 30,000° low, and that from about 100,000° on, the figures obtained have only significance as lower limits.

For the three nebulæ investigated provisional results have been obtained which are as follows :—

Method.	N.G.C. 6543.	N.G.C. 6572.	N.G.C. 7009.
H	38,000°	39,000°	
He		34,000° to 41,000°	
He^+			70,000°
Nebulium	36,000°	37,000°	

In the first two nebulæ the results of different

[1] A complete account of the work will appear in the *Publications of the Dominion Astrophysical Observatory*.

methods are in very good agreement. Of the third nebula, N.G.C. 7009, the pictures are hard to measure on account of the small intensity of the star and the fact that there is a strong moonlight background which has to be corrected for. The given value of 70,000° from He^+ is fairly trustworthy on account of the sensitivity of the method in this case. The hydrogen and nebulium give values which are decidedly lower, less by roughly 20,000°, but the determinations are not accurate. This means that the He^+ is abnormally strong, as compared with nebulium and hydrogen, which, as Mr. Bowen pointed out to me, is also borne out in the abnormal place this nebula occupies in the sequence of his Table II. However, as they stand, the data show already that the assumption that the star is a black body and the luminosity caused by known physical mechanisms appears to be a fair interpretation of the facts.

The temperature determination based on the strength of the nebulium lines by Bowen's secondary mechanism may be extended so as to include a great number of cases for which data are already available. Taking into account that the photographic brightness of the central star may be assumed to vary approximately as the intensity of the wave-length 4250 A. (Brill), and that the visual brightness of the nebula is mainly due to the green nebulium lines, a table can be made relating the difference d between those quantities expressed in magnitudes with the temperature T expressed in thousands of degrees. The result is

T	35	40	50	60	80	100	150	200
d	2·4	3·3	4·4	5·3	6·6	7·5	9·0	10·1

The scale has been fixed using the results for the temperature determination due to nebulium for N.G.C. 6543 and 6572. Photographic magnitudes of the star have been determined by Curtis and total visual magnitudes of the nebula by Holetschek; these are subject to corrections according to Hubble or Hopmann, and the error in d may probably go so high as one magnitude. Values of the stellar temperature for eighteen nebulæ, including the three original, have thus been obtained. Examples are: N.G.C. 7009, 51,000°; N.G.C. 6720, 68,000°; N.G.C. 6826, 35,000°; N.G.C. 6210, 40,000°; N.G.C. 7662, 48,000°; N.G.C. 6818, 72,000°.

The first nebula is that already discussed. The second is the ring nebula in Lyra; and the others, besides the three original ones, are those common to Bowen's and the present investigation. Among the eighteen nebulæ treated there are only two that yield a temperature so high as 100,000° by this method. They are N.G.C. 6445, 134,000°, and N.G.C. 1952, 100,000°.

In the case of N.G.C. 6445, there is much obscuring matter in neighbouring regions, as Dr. Hubble informed me. The high difference in magnitude may therefore be due to partial obscuration of the star, and the high temperature should be regarded with suspicion, if not entirely discarded. Dr. Hubble informed me also that there is strong evidence that the second case, N.G.C. 1952, the Crab nebula, is an old nova, and hence that there is good reason to expect an abnormally high temperature. An error of one magnitude might make the stellar temperature for this nebula about 20,000° lower, but on the other hand, the underlying assumptions in the present work are such as to make the higher temperatures come out rather low, so that for N.G.C. 1952 it is very likely that a temperature of 100,000° is reached.

Though in planetary nebulæ such high temperatures occur, as has also been stated by Bowen, it must be remarked that the lower temperatures are of the same order as those known for ordinary O stars, and that the present treatment appears to give the much desired continuity of the temperature scale.

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The Blubber of Whales.

THE blubber of whales does not appear to have received the attention it deserves; some writers pass it over in silence, others regard it as the mere counterpart of hair and assign to it only a non-conducting function.

Unlike the blubber of seals, which is thick at one season and thin at another, that of whales undergoes no changes in thickness except those which are incidental to age and growth. A tissue so constantly present, and subject to so little change, must be an essential one and must fulfil a very important purpose.

That the blubber has other functions besides a non-conducting one is shown by the fact that its thickness in different species is not related to the temperature of the water inhabited; for example, in the Greenland whale it is many times thicker than in the Narwhale, although both inhabit the same seas, and in the same whale it may be many times thicker than in the Saddle-back and Bladder-nose seals which also inhabit the Greenland Sea, and which, moreover, are obliged at times to go on the ice and expose themselves to a temperature below freezing point and sometimes to one below zero.

The blubber is merely the skin modified to enable its possessor to lead an aquatic life. As Bennet, the author of a whaling voyage round the globe in 1833–36, says, its most important function is doubtless a hydrostatic one; its lightness doubtless diminishing the whale's specific gravity and helping it to float, and its elasticity perhaps helping it to withstand the pressure of the water at great depths.

Whales—at any rate some of them—can rest at the surface without effort, with a small part of their bodies above water, and when extended in this manner, as Scoresby states, can sink downwards in a few seconds beyond the reach of their human enemies. These feats the whale doubtless performs with the aid of its lungs; when resting at the surface it keeps them distended, when it wants to 'settle' or sink it either expels air from them or compresses them by muscular effort, as Delage suggests. The blubber is, therefore, thick enough to buoy up the whale's body with, but not without, the aid of the lungs.

With the exception of the lungs, when in a distended condition the blubber is the only tissue of the whale that is lighter than water, and the only one that can be used at all times to diminish the specific gravity of the body. Whales probably differ but slightly from one another as regards the relative weight of their internal parts, but obviously do so as regards their external ones—their 'whale-bone,' their fins, and the outer layers of their skin. Consequently, the blubber is thickest in species in which these parts are large and heavy, and the reverse in whales in which the opposite obtains.

In the Greenland whale the parts to be buoyed up appear to reach a maximum size and weight, and the blubber which has to sustain them a maximum thickness.

In a large Greenland whale killed in the Greenland Sea in 1887, the marketable whale-bone cleaned and

dried alone weighed 25 cwt., a single plate (the longest one) weighing 9 lb. 5 oz. How much the other parts weighed is uncertain, but the following are their dimensions; namely, pectoral fin, length externally, 8 feet 2 inches; breadth, 5 feet 1 inch; caudal or tail fin, breadth from tip to tip about 24 feet; epidermis, thickness, $\frac{3}{4}$ of an inch; while the thickness of the blubber that buoyed up these parts and made it possible for the lungs to bring the body into equilibrium with the water displaced, was 15-18 inches (on the body or over the muscular parts) and yielded 25 *tons* of oil.

In the young Greenland whale the epidermis is even thicker than in the adult, and the blubber relatively thicker as well. In a calf examined by Scoresby the epidermis was $1\frac{3}{4}$ inches thick: "It was so extremely fat," says this trustworthy witness, "that we obtained a quantity of blubber from it calculated to yield six *tuns* of oil, a produce equal to that of a 'size fish' of six or seven feet bone . . . and the body when stripped of the fat, that is, the blubber, was so small as to be quite within the power of our tackles (to heave up). In another 'sucker' or 'calf,' 19 feet in length, the blubber on an average was 5 inches in thickness, the largest of the whale-bone measured only 12 inches, of which about one-half was imbedded in the gum."

During adolescence, and until the adult stage is reached, the epidermis and blubber (and consequently the yield of oil) both diminish in thickness; the first absolutely, the second only relatively.

Seven young animals captured in the Greenland Sea in 1886, with the 'sample' or longest plate of whale-bone averaging 6 feet in length, yielded only 36 tons, or on an average about the same as Scoresby's calf; and in another killed in 1888—42 feet in length, with the longest plate of whale-bone 7 feet 6 inches in length—the thickness of the epidermis was less than an inch, that of the blubber being 8 inches.

Except in early life, the weight of oil yielded by the blubber is definitely related to the length of the longest or sample plate of whale-bone and to the total weight of the marketable whale-bone—in other words, the thickness of the blubber is in proportion to the size of the animal.

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Exmouth, Mar. 24.

Photochemical Clustering.

IN a paper describing experiments on the photochemical decomposition of nitrous oxide (*J. Chem. Soc.*, 1; 1928) Dr. James Younger Macdonald finds among other things that four molecules of N_2O decompose for each quantum of energy absorbed. The striking agreement between this value of $M/h\nu$ and the value obtained for M/N in the α-ray reaction suggests, according to Lind (*J. Phys. Chem.*, **32**, 575; 1928), a similarity in the mechanism of decomposition, namely, *clustering* about an excited N_2O molecule on one hand and about an ionised one on the other. This suggestion deserves consideration, especially in view of the failure of mechanism proposed by Macdonald, namely,

$$\begin{aligned}&(1)\ N_2O + h\nu = N_2O'\\&(2)\ N_2O' + N_2O = O_2 + N_2 + 2N\\&(3)\ 2(N + N_2O = NO + N_2).\end{aligned}$$

The second step, according to the best data, requires at least 80,000 calories more energy than is available. In view of this, Dr. Macdonald, who originally used a minimum value for the energy of dissociation of nitrogen, has now abandoned the special mechanism which he put forward (private communication). The clustering, however, of three molecules about an active one leading to decomposition as

$$4N_2O = 3N_2 + O_2 + 2NO$$

is very possible thermodynamically.

With Dr. Macdonald's permission to publish the contents of his letter, it may be said that other mechanisms proposed therein are pure speculations, as he himself realises. The best of them admits of differences between oxygen atoms in their effects on N_2O. Furthermore, he proposes to add H_2 to the decomposing N_2O. In the event that O atoms are formed he expects water would result from

$$H_2 + O = H_2O.$$

It is doubtful whether this reaction would go in spite of its exothermic nature to the extent of about 140,000 calories, since H_2 can be considered a pseudo-atom with a helium-like structure. Furthermore, unless radiation is emitted and the water molecule occupies a definite quantised state, the principle of conservation of energy and momentum is violated, except in the almost zero probability case, in which the relative kinetic energy of the colliding systems plus the energy of combination corresponds exactly to a quantised state of the water molecule. Therefore a third body would have to intervene in order to remove the energy. Such triple collisions would be rare in view of the atomic pressure. If the life period of the activated N_2O is of the same order of magnitude as that of other systems involving roughly similar electron jumps, then it is possible to distinguish between the *clustering* theory and Macdonald's idea of a binary collision as the first step, by working at low pressures, using a method employed by the writer in his work on hydrogen iodide (*Proc. Nat. Acad. Sci.*, **13**, 720; 1927; *J. Phys. Chem.*, **32**, 270; 1928).

One hesitates to put forward any definite and general theory regarding clustering in photochemical reactions. The examples in which agreement is found between the photochemical and α-ray yields are exceedingly few (see Lind, "Chemical Effects of Alpha Particles," second edition, p. 144, 1928). In one of these at least (photochemical decomposition of hydrogen iodide or bromide), the experimental work of the writer (*loc. cit.*) indicates that clustering is out of the question. The others involve either reaction between two different systems or else yields of less than unity. Even in the decomposition of N_2O, it is difficult to understand the survival of two impacting molecules having more than sufficient energy to decompose, since it has been shown that two N_2O molecules undergo thermal decomposition when the energy increment is only 58,000 calories (Hinshelwood, "Kinetics of Chemical Change in Gaseous Systems"). Such survival would imply electronic stability of the excited molecule until sufficient 'clustering' impacts had been undergone.

Still, cases involving survival of an excited molecule after collision are not lacking. On the other hand, much can be said for the idea of photochemical clustering in reactions involving association or polymerisation. It is important that examples of association be found for comparing the photochemical and α-ray yields; Lind ("Chemical Effects of Alpha Particles," p. 145) has studied the ionic clustering of certain unsaturated hydrocarbons. For acetylene he finds a value for $M/N = 20$. Interest is therefore attached to the yield in the photochemical polymerisation which is reported to take place (Berthelot and Gaudechon, *Compt. rend.*, **150**, 1169; 1910; Bates and Taylor, *J. Am. Chem. Soc.*, **49**, 2444; 1927).

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Negrito Racial Strain in India.

THE presence of a negrito strain in the aboriginal population of India has been suspected for a long time, but any definite evidence as to its existence has been lacking so far. Thus in the opinion of the Sarasin Brothers "no one has yet succeeded in finding pure woolly hair in India" (*Ergebnisse naturwissenschaftlichen Forschungen auf Ceylon*, **3**, 355; 1893), a view which has also received the support of Turner (*Transactions of the Royal Society of Edinburgh*, **40**, 114; 1905), Lapicque (*Revue Scientifique*, **6**, July 1906), Thurston ("Tribes and Castes of Southern India," vol. 1, Introduction, 1909), and Risley ("The Peoples of India," p. 15, 1915).

During a recent visit to the Kerala country I measured a large number (seventy) of Kadars living in the Cochin Hills (Fig. 1). The majority of this

FIG. 1.—Two Kadar men from the Cochin Hills.

people are not unlike the other jungle tribes of southern India, having a head of hair varying from wavy to curly, but in the extreme interior of the hills I was fortunate enough to find five men and one woman with undoubtedly spirally curved hair, one of whom was pure woolly with short spirals, and the rest were of the frizzy type, similar to that seen among the Melanesians. Besides their spirally curved hair, the Kadars are short (average stature, 1516 mm.), of very dark complexion (the skin colour varying from 29 to 33 in von Luschan's scale), prognathic, and have not infrequently receding foreheads. I was informed by Mr. K. Govinda Menon, Conservator of Forests of the Cochin State, and one who has known the Kadars very intimately for the last quarter of a century, that in the early years of his service he noticed at least a dozen men and women with woolly and frizzy hair, but who must have died out since.

The head measurements of the Kadars do not show them to be brachycephalic, the average cephalic index of the five men (with spirally curved hair) measured by me being only 75·06. Of these five men, however, two are mesocephalic, with 79·29 and 77·34 as their respective cephalic indexes, while the rest are in the lower grades of dolichocephaly. It is not improbable that the negrito element among the Kadars was originally brachy-, or at least mesocephalic, but in its admixture with the long-headed Vedda-like race, which forms the dominant element among the Kadars to-day, the head has become considerably elongated.

It would not be safe to assume anything more until further investigations take place, but it is just possible that the detailed analysis of the measurements to be published later may throw some light on the question. In this connexion it is interesting to note that the designs on the bamboo combs worn by Kadar women ("Die Zauberbilder Schriften der Negrito in Malakka," by K. T. Preuss, *Globus*, 1899) are strikingly similar to those of the Semangs—a negrito tribe of the Malay Peninsula with short stature, dark complexion, and medium head (Av. C.I. 79), who are not unlike the Kadars in general appearance.

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New Regularities in the Band Spectrum of Helium.

BY the work of Curtis and Fowler, the structure of the band spectrum of helium has become well known. More recently, Weizel and Füchtbauer (*Zeit. f. Phys.*, **44**, 431; 1927) added considerably to our knowledge of the spectrum by detecting a number of new bands which they could ascribe to transitions between terms with the oscillational quantum number one. Nevertheless, there appear to be in the spectrum still many lines which have not yet been arranged into bands. As the helium band spectrum is of considerable theoretical interest, we have analysed those parts not yet studied by previous investigators.

As these parts are very rich in lines, it was necessary to use high dispersion. With a suitably constructed powerful discharge tube it was possible to photograph the spectrum with sufficient intensity in the first, second, and third orders of a 15 ft. concave grating. We were able to find more than twenty new bands, and a number of parts of other bands which we hope to be able to complete in the near future. Most of the new bands have the $2p$ state as final state. The initial states have, however, a structure different from that of the terms discovered by Curtis as they cannot be represented in first approximation by a quadratic formula. This and the fact that they combine in a different way with the $2p$ terms causes the appearance of the new bands to be much different from that of the other helium bands, and bands of a similar structure do not seem to have been found either in other band spectra.

The band $2p - 3z$, for example (we designate provisionally the new terms by the last letters of the alphabet), has only a P- and a Q-branch, the R-branch being absent. The band $2p - 3x$ has a strong P- and R-branch; the Q-branch is absent or very weak. The band $2p - 3y$ has three branches which have the appearance of a Q-branch, a P-branch and a branch in which the *effective* rotational quantum number decreases by two units. Whereas many bands overlap in the more refrangible side of the spectrum and make its structure there extremely complicated, the arrangement of bands is quite open in the region between 5700 A. and 6700 A. There we have, except the bands $2p - 3d$ and $2p - 3s$ discovered by Curtis, the bands $2p - 3x$, $2p - 3y$, $2p - 3z$, and the *five* analogous bands for par-helium, which have exactly the same structure but are much fainter than the ortho-bands. The absolute values of the $3x$, $3y$, and $3z$ terms lie between those of the $3s$ and $3d$ terms. We have not yet succeeded in unravelling the structure of par-helium $2P - 3D$, but only locate its position.

Besides bands in which terms of a new type are

involved, we found new bands originating from the combination of Curtis's terms with the vibrational quantum number one and two, and could thus extend the results of Weizel and Füchtbauer. For the transition $2s - 3p$, *e.g.*, the following bands are now known $0 \rightarrow 0$ ($\lambda 465\ m\mu$); $0 \rightarrow 1$ (505); $1 \rightarrow 1$ (467); $1 \rightarrow 0$ (432); $1 \rightarrow 2$ (505); $2 \rightarrow 2$ (468). Of these, 465 is the main band analysed by Curtis, 505 and half of 467 were found by Weizel and Füchtbauer. Evidence was found that the discrepancy between the zero lines of the $p - R$ and the Q-branches found by Curtis is due to the slightly different vibrational frequencies of the p_a and p_b terms (especially well marked in the $2p - 3d$, $1 \rightarrow 1$ band for the $3d_a$ and $3d_b$ terms). If it can be postulated—as theoretical considerations and the results obtained from other band spectra make probable—that the a- and b-states are exactly coincident for the vibration- and rotationless molecule, this discrepancy can be regarded as another experimental proof for the half-integer values of the vibrational quantum number.

In another note we hope to discuss the theoretical significance of the new levels. Details about the work can be found in a series of forthcoming articles in the *Zeit. f. Physik* and the Scientific Papers of the Institute of Physical and Chemical Research, Tokyo.

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New Type of Discharge in Neon Tubes.

IT was found some years ago by one of us (J. W. R.) that if a condenser of the order of a microfarad capacity was discharged through a tube containing neon at a pressure of about 10 mm. with an adjustable resistance in series, then when the resistance was reduced below a certain value there was a marked change in the character of the discharge, distinguishing clearly the new type of discharge from others obtainable in such tubes.

Further study now makes possible a brief statement of the general properties of discharges of this type.

The appearance of the tube during the passage of the heavy current discharge is quite different from that for the normal neon glow discharge, which in the tubes used amounted to a few milliamperes only. The heavy current was marked by a small bright spot or scintillation of bluish light at a single point on the surface of the cathode. In this neighbourhood the nickel spectrum could be seen. The spot was almost always either on the weld between the cathode disc and its supporting wire or on the square-cut edge of the disc. When the discharge passed a sharp click could usually be heard. Occasionally, instead of the bright spot, there was a violet flash between the electrodes, and the current recorded was about one-half the expected value. Conspicuous fluorescence of the glass usually occurred.

That some special conditions at the electrodes are necessary is shown by the fact that in some tubes when one of the two apparently similar electrodes is made cathode heavy currents are obtained, whereas with the other as cathode they are not.

It was found that the value of the current depends chiefly on the circuit conditions external to the tube, particularly the resistance and the condenser voltage. Currents of various magnitudes between 100 amp. and 1·6 amp. were measured and were found to repeat fairly well for successive discharges under any given set of conditions.

A point of clear distinction between this and the glow discharge is that a change in the area of the electrodes (over a range of at least 10 to 1) did not affect the value of the current.

The voltage across the tube at the moment of maximum current falls to a low value, about 20 volts for the smallest currents, rising to a constant value of 60 volts for all currents above 20 amperes.

After the discharge is over, the condenser is usually found to have some charge still remaining, the voltages varying from zero up to about 90 v.; with a normal neon glow discharge this voltage would be about 130 v. Where there is no resistance in circuit the final voltage is sometimes of the opposite sign to that of the original charging, indicating that the discharge was oscillatory. For this to occur in the circuit used, the effective resistance of the discharge could not have exceeded one or two ohms.

A further characteristic property of the discharge should be mentioned. If the capacity of the condenser or alternatively the charging voltage is sufficiently low, a heavy current is not obtained every time the condenser is discharged; indeed, there is a regular relation between the value of the capacity and the probability of a heavy current discharge.

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Disappearance and Reversal of the Kerr Effect.

A BEAUTIFUL confirmation of recent theories of the electric birefringence in liquids (C. V. Raman and K. S. Krishnan, *Phil. Mag.*, April 1927) is furnished by observations of the phenomenon in electric fields oscillating with radio-frequency such as may readily be obtained with thermionic valves. The Kerr effect arises from the orienting action of the field on the molecules, and the time taken by the latter to adjust themselves to a state of statistical equilibrium has naturally to be taken into account. It may be pointed out here that the orienting couple acting on the *permanent* electric moment of the molecule (assumed to be chemically polar) stands on a different footing from the couple acting on the oscillating *induced* moment in it. The couple acting on the permanent moment is purely periodic, and its effect must tend to disappear at sufficiently high frequencies. The couple on the induced moment, on the other hand, has a quasi-static part and tends to persist even at optical frequencies.

The Kerr effect expressly due to the polarity of the molecule must thus disappear at high frequencies, while the non-polar part will continue. In certain polar liquids, for example, chloroform or the higher alcohols, the Kerr effect is negative and may be considered as the resultant of a *negative polar*, and a *positive non-polar* Kerr effect. In all such cases we should expect the Kerr effect *to diminish and vanish as the frequency is increased*, and then to *reappear* at still higher frequencies.

Observations with octyl alcohol made by us confirm this remarkable prediction, the Kerr effect disappearing at 32 metres frequency and reappearing at still shorter wave-lengths. Cooling the liquid with a freezing mixture shifts the frequency of disappearance and reversal to longer wave-lengths, as might be expected.

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The *Discovery* Expedition.

By Dr. Stanley Kemp.

In a previous issue of Nature (Oct. 30, 1926, p. 628) an account was given of the work of the *Discovery* Expedition up to the end of June 1926: the investigations since that date, to the conclusion of the commission on Sept. 29, 1927, form the subject of the present article.

The work at whaling stations during this period has been continued mainly under the direction of Mr. N. A. Mackintosh, and a note by him on this side of the investigations is given below. This shore work has now been in progress for two and a half seasons at South Georgia and for one season in South Africa, and the whales examined, nearly all Blue and Fin, have reached a total of 1685: never before has so large a number been the subject of scientific investigation. The task of working up the data has only just begun, but already there are indications that results of great economic importance will be gained.

Among other work at the South Georgia station reference may be made to investigations on the elephant seal and on birds by Mr. L. H. Matthews: it is hoped that papers embodying his results will be published at an early date.

As noted previously, the *Discovery* reached Cape Town after her first season's work on June 29, 1926, and she proceeded almost immediately to the Admiralty Dockyard at Simonstown for refit. Hitherto the excessive rolling of the ship had been a serious hindrance to the work, and to minimise this defect sister-keels were fitted. The keels proved very effective in reducing the extent of the roll, but they unfortunately interfered with reception from the echo-sounding apparatus, and in consequence the deep water gear could not be used. On completion of the refit, the *Discovery* left for a short cruise on the south-west coast of Africa before returning to South Georgia for the next season's

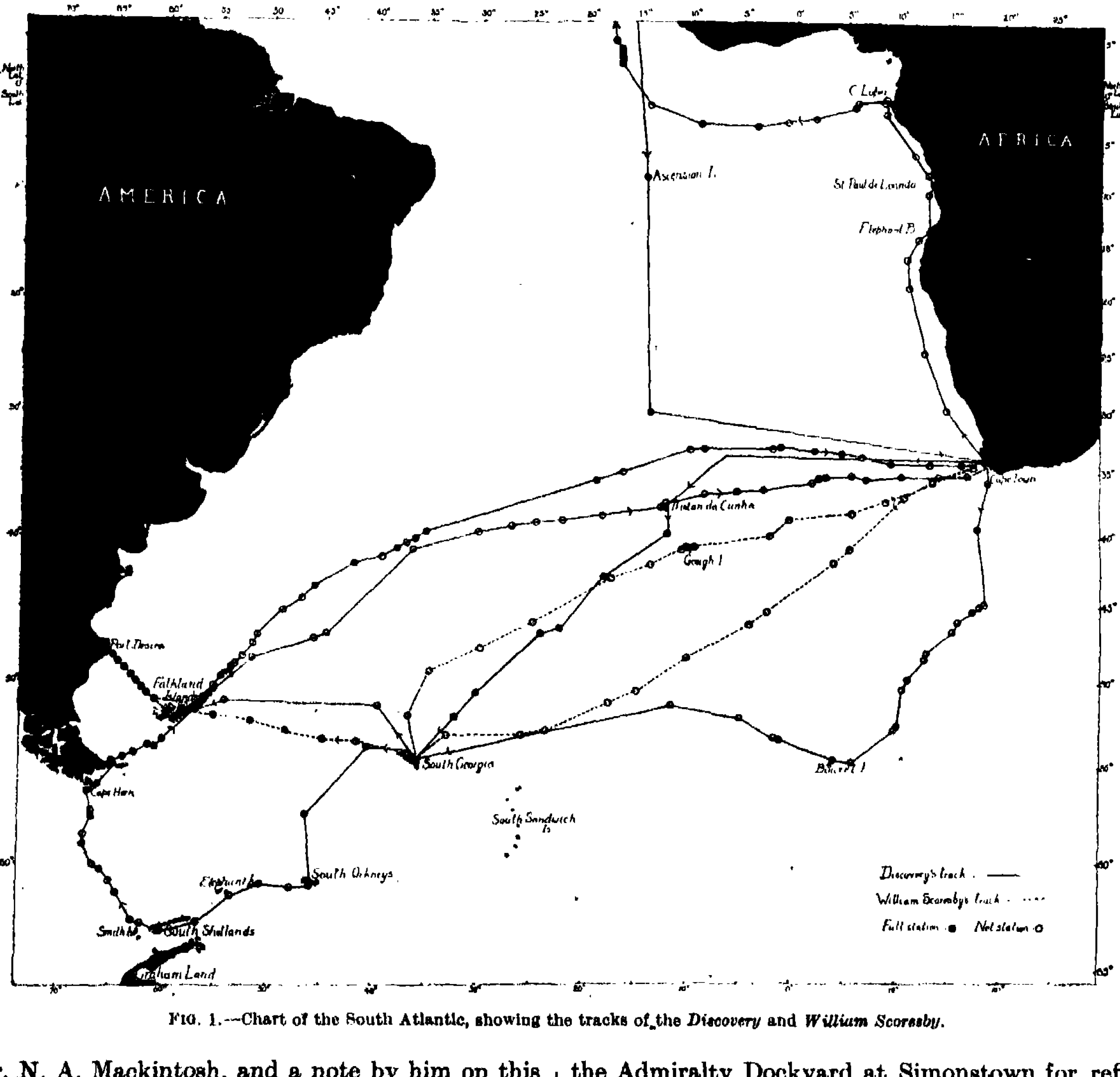

Fig. 1.—Chart of the South Atlantic, showing the tracks of the *Discovery* and *William Scoresby*.

work. Off Saldanha Bay, where two whaling stations are located, a line of planktonic and hydrographic stations was taken and a series of hauls with large closing nets was made in deep water. In order if possible to obtain some knowledge of the diurnal movements of the plankton on the whaling grounds, hauls with closing nets, towed horizontally, were made every four hours during a 24-hour period.

In the meantime the second vessel of the expedition, the *William Scoresby*, had arrived from England, and in October both ships left for South Georgia. The tracks of the two ships are shown in Fig. 1. The *William Scoresby*, with Mr. J. E. Hamilton in charge of the scientific work and Capt. G. M. Mercer in command of the ship, took a direct course, making a series of observations on the plankton during the passage. The *Discovery* attempted a more southerly route with the object of testing the theory that the entire fringe of the Antarctic continent is potential feeding ground for whales. It was our aim to proceed due south past Bouvet Island and to work to the west in high latitudes where easterly winds might be expected to prevail; but abnormal ice conditions frustrated this hope. Near Bouvet Island, which we approached within a short distance, dense pack-ice was encountered, through which it was impossible to make headway, and we were obliged to turn west while still in the track of the westerly winds.

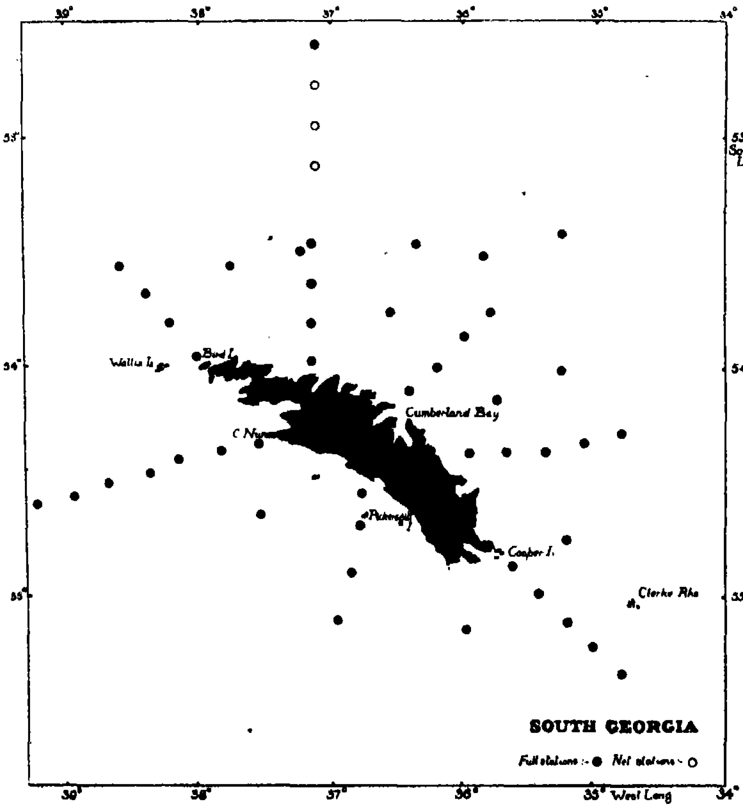

FIG. 2.—Chart illustrating work carried out off South Georgia during December 1926 and January 1927.

With shortage of coal the passage proved one of exceptional difficulty, and we counted ourselves fortunate when we reached Cumberland Bay on Dec. 5.

The *William Scoresby* had arrived earlier, and before long the two ships set about an intensive study of the conditions on the South Georgian whaling grounds. Mr. A. C. Hardy, in charge of the work on the *William Scoresby*, was in wireless touch with me throughout, and, thanks largely to the great enthusiasm of everyone concerned, the full programme, as illustrated in Fig. 2, was completed. At each of the stations a series of vertical hauls was made with closing plankton nets, covering in standardised sections a column of water from bottom to surface, and two flights of nets towed horizontally, one of coarser and one of finer mesh, were taken in the upper layers between the surface and a depth of about 150 m. The hydrographic observations include full serial readings of temperature, salinity, and phosphate at each of the stations, oxygen determinations at every alternate station, and hydrogen ion concentration values over a considerable area on the north-east side of the island. As a result of this work, we possess material and data from which a precise picture can be drawn of the organic and physical conditions on the whaling grounds at this period. Much can be learnt from a study of these data, and if the observations can be repeated in subsequent years the conditions in different seasons can be compared.

At the conclusion of this survey the *William Scoresby*, with Mr. N. A. Mackintosh in charge, left for Port Stanley, taking a line of hydrographic and plankton stations on the passage, and then began a trawling survey of the continental shelf between the Falkland Islands and South America. The trawl was used at thirty separate positions, and a line of hydrographic stations taken between West Falkland Island and Port Desire in Patagonia. The trawling survey is being continued during the present season, and an account of the results obtained cannot usefully be given until it is completed.

The *Discovery*, after dredging and trawling for a short time on the South Georgian coast, left for the South Orkneys, arriving after a slow and very rough passage, during which only two stations could be taken. At the South Orkneys great numbers of icebergs were encountered, and on the further passage to the South Shetlands one was found which was 35 miles long; another, reported by the whaling community, was said to have exceeded 100 miles in length. All these bergs appear to have come from the Weddell Sea.

We reached Deception Island, the centre of the South Shetland whaling industry, on Feb. 26, and after a few days steamed south to Melchior Harbour in Schollært Channel and to Port Lockroy in Wiencke Island—both in the Palmer Archipelago. We passed through Bismarck Strait and made plankton observations at a station situated in latitude 64° 58′ S., but were unable owing to bad weather to undertake any hydrographic work. Some trawling and dredging was done in the sheltered channels among the islands, where the fauna was found to be one of very great richness. A large species of *Umbellula* was abundant, together with another remarkable alcyonarian probably belonging to the family Xeniidæ. Elasipod and other peculiar holothurians were plentiful, and, among cephalopods, a very large purple *Cirroteuthis* was taken: amphipods and pycnogons occurred in great quantity. Several species of *Cephalodiscus* were found, and with them what appear to be some early developmental stages. On the return passage to Deception Island a line of stations was taken in Gerlache Strait. Work in this area ended with two lines of full plankton and hydrographic stations across Bransfield Strait (not shown in Fig. 1), in the course of which we took immense numbers of larvæ of *Euphausia superba*, the euphausian which in these waters and on the evidence obtained constitutes the sole food of Blue and Fin whales.

The return passage to the Falkland Islands was taken by way of Cape Horn, and owing in no small degree to a spell of particularly favourable weather, good series of observations were made across Drake Strait. Results of considerable interest were obtained in both plankton and hydrography, the most significant feature being the presence of a warm mid-water layer of water on the southern side of the Strait. After a few days at St. Martin's Cove in Hermite Island, close to Cape Horn, the passage to the Falklands was continued, a series of further observations being made on the way. We arrived at Port Stanley on May 6 and found the *William Scoresby* awaiting us after completion of her trawling programme.

Shortly afterwards both vessels left for Cape Town. The *William Scoresby*, with Mr. A. C. Hardy in scientific command, first went to South Georgia, where, with the view of ascertaining the conditions at the close of the whaling season, she repeated a line of stations on the north-east side of the island. Her subsequent course to Cape Town was made via Gough Island, where a party landed, and throughout the passage systematic observations were made on the plankton. The *Discovery* took a direct course via Tristan da Cunha —a second visit to the islanders proving impossible by reason of weather conditions—and made a similar series of plankton investigations on the way.

Soon after her arrival in Cape Town, the *William Scoresby* sailed for England, while the *Discovery*, after a brief period in dock, cruised up the west coast of Africa. The line of stations off Saldanha Bay was repeated, and throughout the passage until arrival at St. Vincent plankton observations were continued. The plankton throughout this passage was of very considerable interest. Among cœlenterates, siphonophores of great beauty were taken, some belonging to the genus *Crystallodes*, and a mysterious form, which defied the zoological knowledge on board but has since been identified as 'Semper's larva.' At some positions cymbuliid pteropods were found in astonishing numbers, and a small fresh-water prawn (*Atya*) was caught in the open sea many miles off the mouth of the Congo river. Fish and crustaceans, often provided with great numbers of luminous organs, were abundant. One night a remarkable luminescent effect was observed, due to a ctenophore of the genus *Deiopea*. Most surface forms which are capable of producing light luminesce only when some mechanical stimulus is provided, such as contact with the ship, the movement of the propeller, or a rough sea. The *Deiopea*, however, on a perfectly calm night, and over an area which extended as far as could be seen in every direction, were emitting momentary but most vivid flashes. Owing to the numbers present in the water, the effect produced was one of the most remarkable seen during the voyage.

We touched at Elephant Bay and St. Paul de Loanda in Angola, and at Port Gentil in French Congo, with the object of visiting whaling stations, and also landed on Annobon Island in Spanish Guinea. Whaling has unfortunately proved unprofitable on this part of the coast, and the stations visited were found to have ceased operations. The *William Scoresby* reached England on Aug. 14 and the *Discovery* on Sept. 29.

One or two points remain to be noticed. It may be remembered that when the *William Scoresby* was commissioned, it was hoped that she would be able to undertake the marking of whales with the view of tracing their migrations. In this work we have so far had little success, for it was found in practice that owing to certain structural defects in the vessel, the operation of marking was unexpectedly difficult. The necessary alterations were made, however, while the ship was in England, and we hope for better results in the future. The experience we have had indicates that the marking of whales is a practicable method of research.

In the brief outline of the work of the two ships it will be noticed that plankton observations have been made at a great number of points covering a very considerable part of the South Atlantic. This work has been done to a carefully standardised programme and in working up results the hauls may be regarded as strictly comparable if the assumption is made that the plankton is uniform over comparatively large areas. To ascertain the truth of this theory was one of the objects for which the 'continuous plankton recorder' was invented by Mr. Hardy (see NATURE, Oct. 30, 1926), and with this instrument records of plankton extending over nearly 2400 miles of our course have been taken. We have also on several occasions made continuous hauls over long distances with surface nets. Both methods show an almost startling lack of uniformity in the plankton, and teach us that it

is only by working on broad lines that results of real value can be obtained.

Opportunities for survey work were limited, but Lieut.-Commdr. J. M. Chaplin made the utmost use of all that came his way. Harbours in South Georgia and the South Shetlands were surveyed, and numerous corrections made in our charts of these little-known regions.

It will be seen that in the second season's work we have been more successful than in the first—a result due in no small measure to the efficient help given by the *William Scoresby*. We have made a detailed survey of the conditions on the whaling grounds of South Georgia, with some work on the same lines in Bransfield Strait and off Saldanha Bay in South Africa. We also have a considerable number of observations on plankton and hydrography in the region bounded by Cape Horn, the Falkland Islands, South Georgia, and the South Shetlands, and plankton material obtained on a system of comparable hauls over a much more extensive area.

My thanks are due to Commdr. J. R. Stenhouse, Capt. Mercer, and to all officers and men for their continuous efforts to carry on the work, often in the face of very considerable difficulty, and to the scientific staff, both on the ships and at the shore station, for their enthusiastic support in every programme that was attempted.

In the course of the work a great number of hydrographic observations have been made, and very large zoological collections obtained, and this material is being studied, with particular reference to its economic value, by those of the scientific staff who are now in England. The systematic treatment of some of the zoological collections is being undertaken by specialists, and the publication of results will shortly begin.

The *William Scoresby*, with Mr. D. D. John and Capt. H. de G. Lamotte respectively in scientific and executive command, is again at work in South Georgia, and the shore station, with Mr. F. C. Fraser in charge, has been reopened. It is expected that most of the scientific staff at present in England will leave for further work in the south towards the end of this year.

WORK AT THE WHALING STATIONS.

By N. A. MACKINTOSH.

The previous description of the work of the marine station at Grytviken (included in the article in NATURE, Oct. 30, 1926) dealt mainly with the observations made there at the whaling station from February 1925 until March 1926. Since that period a further 455 whales were examined at Saldanha Bay, Cape Colony, from June to October 1926, after which work was resumed at South Georgia, where 490 whales were examined between November 1926 and April 1927. The material and data obtained are now being studied in England.

As was previously explained, it was desirable that work should be continued in South Africa during the southern winter in order that observations should extend over the whole year. Records of the lengths of fœtuses obtained at South Georgia clearly indicate that both pairing and parturition take place for the most part during the southern winter, and it was therefore hoped that the work at Saldanha Bay would lead to a more accurate knowledge of the breeding of whales. Observations on the adult females taken there were very instructive, but it was not possible to examine nearly as many as was desirable, since the vast majority of whales taken in this locality are immature. Evidence of œstrus taking place at this time of year was, however, found, and several very small fœtuses were collected. Three of these measured 20 mm. to 30 mm., and one, a Sei whale embryo, measured 2 mm. to 3 mm.

As at South Georgia, the catches at Saldanha Bay consisted almost entirely of Blue and Fin whales, other species being practically negligible. Between 80 and 90 per cent of the Blue and Fin whales we examined were, however, immature, and both the abundance of whales and the proportion of adults remained roughly constant during the period we were there. During the final season's work at South Georgia, whales were caught throughout in large numbers, Blue whales being specially abundant.

An interesting comparison can now be made between the whale 'populations' of South Georgia and the south-west African coast. At the latter locality we have two classes of whales—the small immature whales which are abundant, and the large and fully mature whales which are comparatively scarce. The number of intermediate sized whales is very small. At South Georgia the whale community is quite different and much more complex. The population is more representative, but undergoes important changes during the season through the arrival and departure of different 'sets' or herds of whales which may differ in respect of sex, age, condition, etc. The constitution of the whale community may also differ from season to season. In view of these fluctuations, it is necessary to exercise caution in drawing conclusions from such estimations as the percentage of immature whales caught, the ratios of pregnant and lactating females, etc., as one cannot assume that the catches are representative samples of the whole stock.

A further study of the lengths of fœtuses which have been examined indicates that the period of gestation is about 10 months. The uncertainty regarding the rate of growth in the earliest stages of gestation, however, is the principal difficulty in making a precise estimation of the length of this period.

It appears that birth mostly takes place early in the southern winter, and a study of the lengths of young calves occurring in different months suggests that the nursing period lasts for five or six months, mostly in the winter. The young Blue whale appears to be weaned at a length of about 15 or 16 metres, and the young Fin whale at a somewhat shorter length. Growth is thus very rapid during the nursing period, but there are indica-

tions that it slows down very considerably after weaning.

It may be mentioned that external parasites which are rare on Blue and Fin whales at South Georgia, are abundant on those taken at the Cape, *Pennella* being particularly plentiful. Many of the whales examined at Saldanha Bay were also notable for the numerous and peculiar scars which are found on the body, mostly towards the tail. These are in the form of clean, cup-shaped holes in the blubber, and in the majority of whales they are found in all stages of healing. Old scars are quite common in this position on whales at South Georgia, but the unhealed pits are very rare.

The Problem of Artificial Production of Diamonds.

THE relations between the allotropic forms of carbon constitute one of the most baffling problems in chemistry. The hardness and incompressibility of the diamond point to its structure as being an exceedingly stable one, and the examination by X-rays proves it to have the tetrahedral lattice which accords with the known chemical properties of the carbon atom. On the other hand, graphite has its atoms arranged in sheets made up of hexagons, the carbon atoms in that plane being actually closer than in the diamond (1·42 instead of 1·53 Angstrom units), but the sheets are widely separated, their distance being 3·41 A., so that the structure is a loose one, corresponding with the easy cleavage. Graphite is readily produced from diamond at high temperatures, but the converse change has presented the greatest difficulties, graphite having shown itself under all conditions to be the more stable modification. It has been supposed that the atoms of carbon in the two substances differ in their electronic structure, the atom in diamond having four 2_1 orbits, and that in graphite only three 2_1 orbits and one of the 2_2 form, an arrangement which is consistent with the two space lattices and also with the great difference in electrical conductivity between the two modifications. It is doubtful whether specimens of graphite have ever been obtained quite free from other elements, and Prof. H. E. Armstrong has maintained that it always contains hydrogen, which is the cause of its open structure.

The diamond is found in Nature under conditions which afford little clue as to its genesis, but as it is converted into graphite by heat in the laboratory, it has seemed probable that it has been formed under a high pressure, and most attempts at its artificial production have started from this assumption. Of these, the most famous were those of Prof. Henri Moissan. Moissan's most successful experiments were made by melting pure iron with sugar charcoal in an arc furnace, and plunging the crucible containing the molten mass into cold water. The pressure produced by the rapid chilling of the outer crust was relied on to bring about the conversion of the carbon, so that it would crystallise from its solution in iron as diamond, and not, as usual, as graphite. The iron was successively treated with nitric and hydrochloric acids, with oxidising mixtures, and with fused potassium hydrogen fluoride to remove all minerals except diamond, and after the operation minute crystals were found, some of which had the optical properties of diamond and yielded carbon dioxide on combustion. Molten silver was also used as a solvent, with similar results. Sir William Crookes, working with the residues found in a bomb in which cordite had been exploded, the pressure being calculated to reach 8000 atmospheres, obtained similar crystals after the same chemical treatment. Crookes arrived at the conclusion that carbon, if sufficiently heated under a pressure of 2350 atmospheres, would be liquefied, behaving in this respect like arsenic, and should then crystallise on cooling.

Sir Charles Parsons carried out extensive experiments on this subject, the results of which were communicated in his Bakerian Lecture of the Royal Society for 1918. The main conclusions were:

1. That carbon, if melted or vapourised under a pressure of 15,000 atmospheres does not crystallise, as predicted by Moissan and Crookes.
2. That Moissan's supposition that great pressure was produced by quenching molten cast iron is erroneous.
3. That if the crucible, instead of being quenched, were subjected to a pressure of 100 tons per in.^{2} in a steel die under a press, less crystal residue was obtained.
4. That impurities in the iron, such as silicon, aluminium, magnesium, and chromium, greatly increase the amount of crystalline residue, whilst commercially pure iron melted and carburised with graphite yielded practically no residue.

All attempts to produce diamond by the rapid compression and adiabatic heating of acetylene and other substances (as by firing rifle bullets into cavities which they fitted closely), without the use of iron as a solvent, failed to give a crystalline residue.

The method of analysis adopted was that used by Prof. Moissan. Great uncertainties are involved, as there are no chemical reagents which can be relied on to dissolve every crystalline substance formed at such high temperatures other than diamond. Some of the minerals are extremely resistant to acids, even after prolonged boiling, whilst fusion with alkalies cannot be used, as it destroys diamond. The only certain test is that of combustion, microscopical examination being uncertain in view of the hardness and transparency of some of the spinels and carbides. When the crystals are very minute, all that can be done is to place them in a silica boat and heat in a current

of oxygen, watching for a luminous flash when combustion occurs.

According to Prof. Le Chatelier, Moissan's supposed discovery has not been generally accepted in France, but at the time of the Bakerian Lecture his authority was such that Sir Charles Parsons accepted the statement that diamonds had been obtained, although he found it necessary to correct a number of details in the original account. Crookes also, speaking with high authority, confirmed the statements of Moissan, and described crystals which he regarded as being undoubtedly diamonds. He found one crystal, in particular, to show octahedral planes with dark boundaries due to a high index of refraction. He was able to distinguish such crystals with ease from those of carborundum, which are doubly refracting, but optical appearance alone would not serve to distinguish them from minerals of the spinel group. Unfortunately, although Moissan states in his book on the electric furnace that he prepared many artificial diamonds, no microscopical slides containing them are known to exist. The sketches reproduced by Crookes in his little book on diamonds only indicate that the crystals are of octahedral form and of high refractive index.

In view of the doubts which have been expressed as to Moissan's results, Mr. H. M. Duncan, who was associated with Sir Charles Parsons in his experiments, has repeated very carefully the various analytical processes, and his observations have been placed at our disposal by Sir Charles Parsons. It is found that spinels formed at a high temperature from magnesia and alumina, for example, are exceedingly resistant to repeated treatment with concentrated hydrofluoric and boiling sulphuric acids, and being colourless and crystallising in the regular system, they may readily be mistaken for diamonds. When a residue containing crystals of this kind is placed in a platinum boat and heated in a stream of oxygen in a tube of transparent silica, flashes are often observed, but the crystals of spinel are found to be unchanged. The flashes are to be attributed to carbon dust, which is often present in the air to such an extent that when an apparently clean boat is placed in the tube, many flashes are still seen.

Whenever Moissan's experiments with cast iron have been repeated, although many particles resembling diamond in appearance have been obtained, they have never withstood the combustion test. In order to prove that the methods adopted for removing foreign substances are not too severe, five very small fragments of boart have been placed in a platinum dish, and their size and appearance under the microscope noted, after which they were mixed with 15 gm. of iron filings and about a gram of graphite. The mixture was then subjected to chemical treatment until the whole of the iron and graphite had been removed. Microscopical examination showed that the particles of boart had not been destroyed, so that had similar particles been present in any of the residues from cast iron fusions they would not have been lost.

When repeating the experiments, the most characteristic residues were selected for combustion, and a blue pencil used to mark the position of each small crystal in the silica boat under the microscope, before placing it in the combustion tube. After heating at 900° in oxygen, which had been previously filtered through cotton wool, the boat could be again placed under the microscope. In one of these tests, five very characteristic crystals, photographs of which had been exhibited by Sir Charles Parsons at the Royal Society soirée in 1918, were tested in this way, and were found to be unburnt.

It is possible that Moissan's residues had become contaminated during the long period of their preparation. It is stated that in order to obtain sufficient material for a quantitative combustion test, no less than 80 ingots were made and dissolved. As the extraction with successive reagents is a most tedious process, there was ample opportunity for accidental contamination with carbon in the course of the operations.

Sir Charles Parsons and Mr. Duncan have also repeated the experiments of other workers who have claimed to have produced diamonds by artificial processes, but in every case the results have been negative. The conclusion seems inevitable that diamonds have not yet been produced in the laboratory, and that investigators have been misled into regarding as diamonds various transparent, singly-refracting minerals which happen to be very resistant to chemical reagents.

When graphite is heated to very high temperatures under pressures as great as 15,000 atmospheres, it remains perfectly soft, and there is no indication of the production of a new phase. This was confirmed by the experiments of Sir Richard Threlfall, published in 1908. The pressure produced in quenching molten cast iron in water or lead is not remarkably high, being limited by the yielding of the iron shell under stress, and the supporters of Moissan's views have therefore supposed that the action was not one of pressure, but of crystallisation from a solvent, which might be expected to give the less stable phase, whilst prolonged heating would convert it into the more stable graphite. Success had been claimed by Friedlander for experiments in which fused olivine was used as the solvent, but a repetition of the fusions, described in the Bakerian Lecture, gave negative results, and with such a solvent the chance of producing crystals which might be mistaken for diamond on a casual inspection is evidently great. Inconclusive experiments were made by O. Ruff in 1917, which showed that minute diamonds introduced into heated hydrocarbons under high pressure did not increase in size, but minute crystals which might have been diamonds were obtained from carbon in metallic solvents. The sources of error in all such observations having been detected, it must be admitted that the origin of the diamond in Nature remains an unsolved problem.

C. H. D.

Obituary.

DR. W. B. BLAIKIE.

WALTER BIGGAR BLAIKIE, LL.D., who died on May 3, was an extremely well-known figure in Edinburgh circles. Born in 1847, the son of a remarkable mother, his death severs a link with a past period. Educated at Edinburgh Academy, and the Universities of Edinburgh and Brussels, he began life as a railway engineer in the Public Works Department in India. He returned to Edinburgh after his marriage and joined the firm of T. and A. Constable, printers, with whom he remained associated until his retirement a few years ago.

In each of these very different professional tasks Blaikie showed the same remarkable vitality and intellectual energy. In particular he raised the productions of Constable's to a very high stage of artistic excellence. He was also warmly interested in the infirmary and other good works in Edinburgh. But besides, his activity overflowed into two channels in special, Scottish history and astronomy. In matters of history he was a recognised authority on special points and local history; in particular his "Itinerary of Prince Charles Edward" shows infinite pains in verifying details. In astronomy his interest was direct and original, especially in what he could himself create, preferably with his own hands. He devised numerous ingenious methods of prosecuting 'astronomy without a telescope.' He used to draw, print, and issue annually to his friends a book of monthly star maps, showing the position of the moon and planets, with tabular particulars. These issues were supplemented in different years by appendices on such subjects as the names of the stars, the fables of the constellations, etc., the product of a considerable amount of accurate, original work.

Perhaps the best of all Blaikie's devices was a graphical method of solving many common cases of spherical triangles, by means of two circular discs, engraved on celluloid, with two nests of coaxial circles, and rotatable about a common centre. By means of this, for example, the hour angle of a known star can be read at once from the usual observed data of a theodolite without engaging in any calculations. Blaikie preserved all his life a singularly boyish activity, so that, though actually he died at an advanced age, he never seemed to his many friends an old man. R. A. S.

PROF. WILHELM VON BRANCA.

THE eminent geologist and palæontologist, Prof. Wilhelm von Branca, died in Munich on Mar. 12, aged eighty-three years. Descended from an old Lombardy family, he was born in Potsdam on Sept. 9, 1844, and graduated as Ph.D. at Heidelberg in 1876. He began his academic career as *docent* in the University of Berlin in 1881, and his first professorship of geology and palæontology was in Königsberg in 1887. He succeeded Quenstedt in Tübingen in 1890, and was next for a short time at the Agricultural High School at Hohenheim. Finally, he succeeded Dames in Berlin in 1899, and remained there until his retirement in 1917.

Branca's earliest researches were in vulcanology, and he continued to be actively interested in the study of extinct volcanoes until 1894, when he published his well-known account of 125 'volcano-embryos' in Würtemberg. In stratigraphical geology, he added much to our knowledge of the Jurassic formations. In palæontology, he will be remembered for his researches on the initial chamber and the development of the suture lines in cephalopod shells, and for his memoirs on the ganoid fish Lepidotus and various other extinct vertebrates. As director of the geological-palæontological institute in the University of Berlin, he encouraged the systematic collection of fossils, and he was largely responsible for organising the expedition to German East Africa (now Tanganyika Territory) which made so many important discoveries of Dinosauria.

Branca was also an inspiring teacher, beloved by his numerous pupils, and throughout his career he exerted an important influence on the promotion of geological science in Germany.

WE regret to announce the following deaths:

Henri Bosmans, of the Jesuit College of Saint-Michel, at Brussels, author of many papers relating mainly to fifteenth, sixteenth, and seventeenth century mathematicians, whose works are not generally accessible, on Feb. 3, aged seventy-six years.

Dr. C. G. Cumston, president in 1925 of the International Congress of the History of Medicine and author of "An Introduction to the History of Medicine," on April 14, aged fifty-nine years.

Prof. Julius Hirschwald, who occupied the chair of mineralogy at the Technische Hochschule in Berlin from 1877 until 1921, aged eighty-three years.

Dr. John P. Munson, head of the department of biology at the Washington State Teachers' College, distinguished for his work in comparative cytology, on Feb. 27, aged sixty-eight years.

Mrs. Flora Wambaugh Patterson, formerly mycologist in charge of the pathological collections, U.S. Bureau of Plant Industry, on Feb. 5, aged eighty years.

Prof. W. W. Payne, of the observatory of the National Watch Company, Elgin, Ill., and founder of *Popular Astronomy*, on Jan. 29, aged ninety years.

Dr. E. C. Schroeder, superintendent of the Experiment Station of the Bureau of Animal Industry, United States Department of Agriculture, who had made important contributions to our knowledge of animal diseases, on Jan. 24, aged sixty-two years.

Mr. W. C. Tait, of Oporto, Portugal, author of "The Birds of Portugal" and a pioneer in the introduction of the eucalyptus tree in Portugal, aged eighty-three years.

Dr. Willard P. Ward, of Savannah, Georgia, known for his work on the metallurgy of manganese, on Jan. 17, aged eighty-two years.

Dr. Theodor Zincke, professor of chemistry in the University of Marburg from 1875 until 1913, author of a large number of publications, particularly in the field of aromatic chemistry, on Mar. 17, aged eighty-four years.

News and Views.

THE British Association has issued the preliminary programme of its meeting to be held in Glasgow on Sept. 5-12, under the presidency of Sir William Bragg, who in his address will deal with modern developments of the physical sciences and their relation to national problems. The subjects of the presidential addresses and discussions in the various sections include the reflection of electrons by matter, the photography and measurement of radiation, ancient geography in modern education (by Prof. J. L. Myres), the nature of skill (by Prof. T. H. Pear), the influence of engineering on civilisation (by Sir William Ellis), the archæology of Scotland (by Sir George Macdonald), and increasing returns and economic progress (by Prof. Allyn Young). Dr. Cyril Norwood will give the presidential address in the education section, which also will hold a discussion on broadcasting in the service of education, opened by Sir John Reith. One of the customary evening discourses will be given by Prof. E. A. Westermarck, on the study of popular sayings ; this will be the Frazer Lecture in social anthropology, which is due for delivery in Glasgow, and to which members of the Association will, by the courtesy of the University authorities, be admitted. The other evening discourse will be given by Prof. F. G. Donnan under the title of "The Mystery of Life," the subject being considered from the viewpoint of physical chemistry. The delegates of corresponding societies, under the presidency of Dr. Vaughan Cornish, will discuss the preservation of scenic beauty in town and country. All the meetings, except those in the evening, will be held in the University, an unusually convenient arrangement. The Lord Provost and Corporation of Glasgow will give a reception and dance in the City Chambers, and the local committee a reception in Kelvingrove Art Galleries. Ample opportunity will be provided for visits to places of scientific interest in the country around Glasgow, and for studying the manifold economic interests of the city and the Clyde area, with their many outstanding examples of the value of applied science in industry and social conditions.

THE Royal College of Physicians has been celebrating this week the tercentenary of the publication of William Harvey's "De Motu Cordis," which was referred to in these columns on Mar. 31 (p. 507). In his Lumleian lectures before the Royal College of Physicians delivered in the spring of 1616, Harvey had explained his discovery of the circulation of the blood, but his views met with so much criticism that he was deterred from publishing an account of his work until 1628, when his little book, in Latin, was published from the press of William Fitzer, of Frankfort. This event marked the veritable birthday of modern physiology and scientific medicine. In honour of Harvey's memory, delegates from all parts of the world have gathered in London. H.M. the King received the company on Monday morning, May 14, and, in reply to the address by Sir John Rose Bradford, president of the Royal College of Physicians, remarked that we honour Harvey not as the author of a fundamental discovery alone, but as one who "discerned and taught that the true method of scientific progress is by observation and experiment." On Monday afternoon the delegates were formally welcomed at the Royal College of Physicians, addresses were presented on behalf of universities and scientific bodies, and the president conferred honorary fellowships of the College on Lord Balfour, Sir Ernest Rutherford, Prof. I. P. Pavlov (of Leningrad), and Prof. K. F. Wenckebach (of Vienna). This distinction has only been conferred in the past by the College very occasionally. After this ceremony, addresses on Harvey and his work were delivered by Sir Charles Sherrington, Prof. A. Chauffard (of Paris), and Prof. F. Keibel (of Berlin). The celebrations during the week included visits to University College, London, where demonstrations of Harvey's work were arranged. We hope to give a fuller account of the proceedings in a later issue.

THE recent celebrations commemorating the two-hundredth anniversary of the birth of John Hunter recall that his brother, Dr. William Hunter, F.R.S., was born on May 23, 1718, having thus a seniority of ten years. William was born at Long Calderwood, Lanarkshire, and after studying at Glasgow and Edinburgh he entered at St. George's Hospital, London. Thereafter his career was one of distinction and authority, though marked by conflict with his distinguished younger brother, with whom at one time he was a co-lecturer on anatomy at the Great Windmill Street School. In 1747, William had become a member of the Corporation of Surgeons, but, applying in 1756 to the Court of Assistants to be disfranchised, his request was granted, subject to the payment of forty guineas. He did not pay the fee, and shortly afterwards, when admitted a licentiate of the College of Physicians, he was ordered by the Court to pay a fine of twenty guineas for joining the College of Physicians without the consent of the Court. Hunter became physician extraordinary to Queen Charlotte in 1764, and, in 1768, first professor of anatomy to the Royal Academy. He was elected a fellow of the Royal Society in 1767 (also the year of his brother's election), and he contributed papers to that body. There is a three-quarter length portrait of Hunter, by Zoffani, in the apartments of the Royal College of Surgeons, but none in the National Portrait Gallery.

IN the early part of 1780, William Hunter, in a communication to the Royal Society, claimed the credit for an anatomical discovery made by his brother John twenty-five years previously. The latter dealt with the assertion in a caustic manner, avowing that his silence might be misinterpreted into an acknowledgment that he had intentionally claimed what was not his due. "I am as tenacious as he is of anatomical discovery," he wrote to Sir Joseph Banks, "and I flatter myself as tenacious also of truth." He then recounts the mode and incidents of the discovery, recording that "Dr. Mackenzie had injected the

subject, and being unable as I conceived to explain an Appearance which he had found in dissecting it, sent for me. I came to him and having examined it further, explained the appearance in question then for the first time to my own satisfaction and that of Dr. Mackenzie; on the evening of the same day, full of my discovery, I came to Dr. [William] Hunter, and brought him with me to Dr. Mackenzie's to see and judge of the Explanation which I had given, and Dr. Mackenzie agreed to. This is my state of the fact upon which I grounded my belief of myself being the author of this anatomical discovery." William Hunter died on Mar. 30, 1783.

SIR JAMES WALKER, who delivered the Arrhenius memorial lecture before the Chemical Society on May 10, instead of speaking with the historian's detachment of one who, although so human and genial a personality, was an outstanding figure in contemporary science, chose to present a delightfully intimate sketch of the life and work of a close friend and one-time fellow student. Arrhenius was of course a pioneer of modern physical and biological chemistry. In selecting the conducting power of solutions for early investigation, he was doubtless influenced by the contemporary researches of Van 't Hoff, Raoult, Kohlrausch, and Ostwald, and by the theories of Grotthus, Clausius, Hittorf, and Helmholtz, but his choice was primarily due to a recognition of the potential value of a method for determining the molecular weight of substances which are not volatile without decomposition. His first measurements of electrolytic conductivity were directed to this end, but he soon recognised that the state of the conducting salt is a matter of primary importance. In his memoir, the record of experimental results was followed by an exposition of the germ of the later theory of electrolytic dissociation, although a precise account of the nature of the active (electrolytic) and inactive (non-electrolytic) portions was not then given. The important statement was made, however, that the active portion increases with dilution. In correlating theoretical considerations with experimental data, Arrhenius's next step was to show that "the molecular conductivity of the active part of an acid (in dilute solution) is constant and independent of the nature of the acid," and hence "the better the solution conducts electricity, the greater is its active part." Final formulation of the theory of electrolytic dissociation followed during the period 1886–1890, while Arrhenius was working with Ostwald in Riga or Leipzig, with Kohlrausch in Würzburg, with Boltzmann in Graz, or with Van 't Hoff in Amsterdam.

ARRHENIUS was indebted to Van 't Hoff for the nucleus which determined the crystallisation of his theory, for the application of the equation $PV = iRT$ to dissolved substances led to experimental values of i which for aqueous salt solutions were greater than unity. Arrhenius immediately realised that the value of i reflected the number of ions produced by the salts, and in a letter to Van 't Hoff in March 1887 he was able to state positively that the 'active molecules' are the dissociated molecules, and that (in opposition to Clausius's view) at extreme dilutions all salt molecules are completely dissociated. Arrhenius's work on other physico-chemical subjects, however, also merits recognition. He investigated, for example, the viscosity of pure liquids and solutions, the phenomena of conduction in hot gases and flames and of diffusion in aqueous solution, and studied also the velocity of hydrolysis of esters and the inversion of sugars. Although offered the chair of chemistry at Giessen in 1891, Arrhenius preferred to remain in his native country, and was appointed chief of the laboratory of physics at the Högskola at Stockholm, being designated professor in 1895; again refusing a foreign post, he became, in 1905, the director of the new Nobel Institute for Physical Chemistry. The stormy period of his career was now over, and until his death on Oct. 2, 1927, he was in Sweden a scientific oracle. His interest extended even to cosmic and meteorological problems, and in the beginning of the present century he directed his attention to serum therapy, contributing to the foundations of the new study of immunochemistry. Sir James Walker remarked that the character of much of Arrhenius's work is explained by his union of an aptitude for scientific speculation with an extraordinary facility for dealing with figures. Sweden can, he said, boast of many eminent names in science, of which two—Linnæus and Berzelius—are of the first magnitude; since the death of Berzelius she has had none to rank with these save that of Arrhenius.

THE subject of the discourse by Prof. Doris MacKinnon, delivered at the Royal Institution on Friday, May 11, was the intimate association of living organisms of different kinds for mutual benefit, especially those associations in which at least one of the partners is an animal. The phenomenon of luminescence [in certain marine animals] has recently been discovered to depend on the presence within the animal's body of captive bacteria having the power to emit light. In the colonial ascidian, *Pyrosoma*, these bacteria are intra-cellular, whereas in the cuttle-fishes they live in the cavity of the so-called accessory nidamental glands. In both these animals there are elaborate devices for ensuring that the developing young receive their bacterial supply from the parent. The majority of the other known associations have probably to do with food capture and with its digestion: and the very different methods in which green plants, fungi, bacteria, and animals feed, have to be borne carefully in mind. The green marine worm *Convoluta* is a good example of the more intimate sort of symbiosis associated with nutrition. Here the obligate partner is a minute green plant living in the worm's tissues and supplying it throughout most of its life with carbohydrates and fat in return for shelter and carbon dioxide. Many insects living on plant-juices or on blood are provided with pockets in the gut which contain yeasts or bacteria. Since here again precautions are taken to insure the infection of the next generation, it seems possible that these micro-organisms are not

'parasites,' but helpful symbiotes that somehow assist in the preparation of food for digestion. In one case, the wood-eating termites, that constantly harbour enormous numbers of tricho-nymphid flagellates in their guts, it has been shown experimentally that the host cannot get on without its guests.

In an address on currency and credit delivered at the Royal Institution of Great Britain on May 4, the Right Hon. Reginald McKenna, chairman of the Midland Bank, referred to controversies relating to the proper constitution and functions of a central bank. He showed that the quantity of money in circulation varies with gold movements into and out of the country. The effect of these movements, however, can be counteracted or intensified by the buying or selling of securities on the part of the Bank of England, and indeed the Bank may go further and increase or diminish the amount of money on its own initiative. To give the Bank greater freedom in the exercise of these powers, proposals have been made to modify its constitution. This is a debatable question, as on one hand the Bank has behind it since 1844 a fine record of disinterested and public-spirited work, but on the other hand, with the present constitution of the Bank, important movements in gold supplies, wholly unconnected with monetary conditions in Great Britain, may react on trade and employment through their effects on currency and the price level. It might be argued that trade considerations should be taken into account in determining Bank policy, though Mr. McKenna admitted that a policy of leaving well alone has a great deal to recommend it, in view of the esteem in which the Bank is justly held. These questions, he pointed out, have a direct bearing on national prosperity, and are more worth public inquiry than some of the subjects which at one time or another have engaged the attention of Royal Commissions.

Further particulars of the arrangements which have been made by the Society of Chemical Industry, in association with the Institution of Chemical Engineers, for the visit to Canada and the United States of America, and for the annual general meeting of the Society to be held in New York, are now available. Sailing from London on Aug. 10 in the s.s. *Megantic*, the visitors will reach Quebec nine days later, and full use will be made of facilities for night travelling to visit and inspect some of the most important and interesting cities and industrial plants. Thus, Aug. 20 will be spent at Shawinigan Falls; on the following day, a glimpse of Montreal and Ottawa will be afforded, and Aug. 22 will be devoted to the gold mines at Kirkland Lake. On Aug. 23 the International Nickel Company's refineries at Port Colborne will be visited, followed by a three days' stay at Niagara Falls, an important electro-chemical and electro-metallurgical centre. Monday, Aug. 27, is reserved for a visit to Akron, Ohio, a great rubber manufacturing centre, and the next day for an inspection of a modern glass factory, the U.S. Bureau of Mines laboratories, and the Mellon Institute of Industrial Research at Pittsburgh. Thereafter follow visits to the E. I. du Pont de Nemours Company's dye works at Wilmington, Del., and to the famous Edgewood arsenal. During a three days' stay at Washington, D.C., visits will be paid to various U.S. Government scientific departments and laboratories, New York being reached in the evening of Sunday, Sept. 2.

The annual meeting of the Society of Chemical Industry begins on the following day, Sept. 3, with informal and social meetings, and continues in business and technical session—with due provision for pleasurable social intercourse—on Sept. 4 and 6; Sept. 5 is entirely devoted to an industrial trip by boat, and to the Messel Medal award and address by Dr. R. A. Millikan, whilst on Sept. 7 there will be an excursion up the Hudson River, details of which are not yet available. By leaving New York on Sept. 8 by the s.s. *Celtic*, England is reached on Sept. 16. The total cost of the trip, excluding expenses incidental to the stay in New York, but covering tourist class steamship accommodation in both directions, single berths on trains, all meals and hotel accommodation up to arrival in New York, is £77, 2*s*., with corresponding additions should superior arrangements be desired. Some members may prefer to visit only New York for the meetings; the cost of travel (tourist cabin) with hotel and other expenses for Sept. 2-8 will be about £60 in that case.

In a recent speech at Birmingham, Sir Samuel Hoare dealt with air tragedies, and in particular with those that have arisen from high-speed and trans-Atlantic flights. After directing attention to the tremendous progress that has been achieved in aviation since an independent Air Force was created ten years ago, he stressed the cost that must be paid in human life for these advances and dealt with the question whether it *is* worth while. "Does the pursuit of speed," he asked in reference to Lieut. Kinkead's death, "justify the sacrifice?" If it were only the pursuit of speed, no world's record would be worth it, he said, but just as many of the improvements in the motor-car are directly attributable to motor racing, so a definite advance in aeroplane design and in engine improvement results from high-speed flying. While paying tribute to the daring spirits that undertake trans-Atlantic flights, however, he denied that the effort is a wise one or that it serves a sufficiently useful purpose. On grounds of practicability, he does not consider it desirable to attempt either to prohibit these flights directly, or on grounds of expediency to impose such restrictions as will make them possible.

Nine new members were elected to the National Academy of Sciences of the United States at the meeting held on April 25, and Science Service of Washington, D.C., has issued some particulars of them: Dr. John August Anderson, astronomer at the Mt. Wilson Observatory in California, is known specially for his invention of a new type of earthquake recorder, in collaboration with his colleague, Dr. Harry O. Wood. Prof. William Mansfield Clark, of the Johns Hopkins University Medical School, has been largely responsible for the development of hydrogen ion concentration determination in the United States; he worked on the chemistry of cheese while in the

bureau of dairy chemistry of the U.S. Department of Agriculture and later he was with the U.S. Hygienic Laboratory. Mr. Arthur Keith, of the U.S. Geological Survey, is an authority on the geology of the Appalachian Mountains. Mr. Charles Franklin Kettering, a vice-president and director of the General Motors Corporation, and head of the General Motors research laboratory, perfected and put on the market the 'Delco' lighting system; he developed the tetra ethyl anti-knock fuel for motor-cars and also perfected the 'Delco' ignition system. Dr. Alfred L. Kroeber, professor of anthropology at the University of California, is one of the leading authorities on the languages of the American Indian. Dr. Rudolph Ruedemann, State palæontologist for New York, is distinguished for his work on the fossils and geology of the Ordovician and Silurian of New York, and on pre-Cambrian continents. Prof. Philip A. Shaffer, professor of biochemistry at the Washington University Medical School, St. Louis, has carried out important investigations on human metabolism. Dr. George Malcolm Stratton, professor of psychology in the University of California at Berkeley, has investigated the psychology of vision and related subjects. Dr. Lewis Madison Terman, professor of psychology at Stanford University, California, is the author of the Stanford Revision of the Binet-Simon tests, and has done important work on intelligence measurement in children and others. Dr. Joseph S. Ames, provost of the Johns Hopkins University, was elected treasurer of the Academy, while Dr. W. B. Cannon, of the Harvard University Medical School, and Mr. Gano Dunn, a distinguished engineer of New York, were elected members of council. Dr. George K. Burgess, director of the U.S. Bureau of Standards, was elected chairman of the National Research Council, succeeding Mr. Gano Dunn.

MR. WILLIAM H. WRIGHT, astronomer of the Lick Observatory, Mount Hamilton, California, has been awarded the Henry Draper medal of the National Academy of Sciences. It will be remembered that Mr. Wright is to give the George Darwin Lecture of the Royal Astronomical Society on June 8 on the photography of planets.

RECENT appointments to scientific and technical departments made by the Secretary of State for the Colonies include two agricultural chemists, Mr. D. Manlove and Mr. W. A. Watson. Both are appointed to the Agricultural Department, Nigeria, chiefly for work on the products of the oil palm. The expansion of the inspection staff of the Nigerian Agricultural Department is continued, and six new produce inspectors are appointed: Messrs. J. R. Brown, D. W. P. Irons, L. J. Jackson, J. K. Peile, F. S. Philip, and N. W. Hardwick.

THE following have been elected foreign members of the Linnean Society of London: Thore Gustafsson Halle, chief of the Palæobotanical Department, Naturhistorika Riksmuseum, Stockholm; Robert Almer Harper, professor of botany, Columbia University, New York; Axel Johan Einar Lönnberg, Chief of the Vertebrate Department, Naturhistoriska Riksmuseum, Stockholm; Thomas Wayland Vaughan, director of the Scripps Institution of Oceanography, La Jolla, California; and Friedrich Zschokke, professor of zoology, University of Basle.

THE Council of the Royal Geographical Society has received a radio message from Captain Wilkins at Green Harbour, Spitsbergen, thanking the Society for the award of the Patron's Medal, and offering for the Museum of the Society the small British flag which he has carried through more than 15,000 miles of Arctic flying. The Council has gratefully accepted this gift, which will be placed beside the Union Jack flown by Sir Edward Parry on his sledge journey to Lat. 82° 45′ North a century before. Captain Wilkins will receive his medal at the anniversary meeting to be held on June 18; it is expected that both he and Lieutenant Eielson will be guests of the Society at the anniversary dinner on the same evening.

THE Empire Cotton Growing Corporation, Millbank House, 2 Wood Street, Millbank, S.W.1, announces its intention to award in June next not more than twelve studentships as follow: (a) research studentships to enable graduates with a leaning towards research to receive training in research under leaders in their subject, and (b) advanced study studentships to enable those holding them to receive specialised instruction in equipment for agricultural posts in cotton-growing countries. Both classes of studentship are of two kinds, namely, senior and junior. Each studentship will be tenable for one year, and of the value of £250, plus a further sum for travelling and other expenses. Forms of application can be had upon application to the Secretary of the Corporation. The latest date for their return is June 5.

A PUBLICATION grant of £2500 is receivable by the Royal Society from H.M. Government during the current year. The grant is available for assisting the publications of other scientific societies, as well as for assisting the separate publication of books, memoirs, etc., of a scientific nature. Applications for grants will be adjudged by the Council of the Royal Society at its meeting early in July, but should be received before the council meeting of June 14. Applications from societies will be received by the secretaries of the Royal Society; those from individuals must be brought forward by members of Council.

THE British Empire Cancer Campaign announces that an International Conference on Cancer has been convened to be held on July 16-20 in London at the house of the Royal Society of Medicine. Doctors, surgeons, pathologists, and radiologists from all parts of the world whose work has been closely associated with inquiry into the causes and cure of cancer will attend, whilst the Royal Society and the principal universities, medical schools, and scientific bodies of Great Britain are sending delegates. Sir John Bland-Sutton, Bart., past president of the Royal College of Surgeons and a vice-chairman of the Grand Council of the British Empire Cancer Campaign, will preside, and Sir Richard Garton, chairman of the Finance Committee, has been elected honorary

secretary of the International Conference. H.R.H. the Duke of York, president of the British Empire Cancer Campaign, and H.R.H. the Duchess of York will receive the delegates and their wives at a reception to be held at Lancaster House (London Museum), which has been lent by the trustees for this purpose, on July 18.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in the Department of Navigation of the Cardiff Technical College—The Principal, Technical College, Cardiff (May 26). Two physicists with electrical engineering experience for research work under the Safety in Mines Research Board—The Under Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (May 29). An assistant to the Leeds City Analyst—The Town Clerk, 26 Great George Street, Leeds (June 6). A lecturer in electrical engineering in the University of British Columbia—H. Vickers, 54 High Street, Connah's Quay, Chester (June 8). A head of the department of pure and applied physics, a lecturer in municipal and sanitary engineering, and an assistant lecturer in municipal and sanitary engineering, each at the Manchester Municipal College of Technology—The Registrar, College of Technology, Manchester (June 9). A lecturer in electrical engineering at Loughborough College — The Principal, Loughborough College, Leicestershire (June 18). A part-time professor of dietetics at St. Thomas's Hospital Medical School—The Academic Registrar, University of London, South Kensington, S.W.7 (June 22). An assistant lecturer in the zoological department, the University, Birmingham—The Secretary, University, Birmingham (June 30). An assistant lecturer in metallurgy in the University of Birmingham—The Secretary, University, Birmingham (June 30). The George Henry Lewes studentship of the University of Cambridge—Prof. Barcroft, Physiology School, Cambridge (July 10). A junior assistant under the directorate of metallurgical research, Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18. A chief lecturer in building at the Huddersfield Technical College — The Director of Education, Education Offices, Huddersfield. A geography master at St. Dunstan's College, S.E.6 — The Headmaster, St. Dunstan's College, Catford, S.E.6. An assistant lecturer in education in the Department for the Training of Teachers, of the University of Reading—The Registrar, The University, Reading. A woman teacher of physiology at the Chelsea Polytechnic—The Secretary, Chelsea Polytechnic, Manresa Road, S.W.3. Civilian education officers in the R.A.F. Educational Service for teaching engineering subjects—The Secretary, Air Ministry, Gwydyr House, Whitehall, S.W.1.

Our Astronomical Column.

NOVA PICTORIS.—A photograph of this star, taken at Johannesburg, was shown at the meeting of the Royal Astronomical Society on May 11. Dr. Jackson noted that from examination of the plate, the Greenwich observers considered it probable that the rings round the star were not objective, but arose from the fact that the star, being probably red (as is the rule with novæ on their decline), did not give a sharp image on the plate, being somewhat out of focus. In fact, similar rings were seen round the images of red stars on the Franklin Adams plates. However, the Johannesburg observers stated that the rings were expanding at the rate of a second a day, which, if confirmed, would be evidence of their reality. Dr. Wood was evidently alive to the possibility of optical rings, since he stated that he examined other images on the plates of the Nova without finding similar rings.

RECENT SOLAR ACTIVITY.—Since the beginning of May the sun's disc has offered a number of spots for observation. Of these, the most interesting has been a very long stream of spots nearest the centre of the disc on May 8. The stream originated when on the invisible hemisphere, but its maximum development evidently occurred when turned earthwards. The longitudinal distance between the centres of the leading and following spots reached a maximum of 16°, or more than 100,000 miles. About this time the aggregate area of the stream exceeded 1500 millions of square miles. A single spot of this size would have been easily seen with the naked eye, but as the stream was drawn out into a number of component spots, it was a difficult object for naked-eye vision. This is the largest group of spots seen since February (NATURE, Mar. 3, p. 335).

In the interim, a few other fairly large spots have appeared, but were not of special interest. The largest of these were nearest the centre of the disc on Mar. 18 (lat. 14° N.), Mar. 19 (lat. 8° N.), and April 19 (lat. 16° S.) respectively. Particulars are appended of the recent large group.

No.	Date on Disc.	Central Meridian Passage.	Latitude.	Maximum Area.
2	May 2-14	May 8·4	14° S.	1/650 of hemisphere.

At the meeting of the Royal Astronomical Society on May 11, Mr. Evershed showed photographs illustrating the violent disruption of a large solar prominence of the type not usually subject to sudden changes. This prominence was photographed by Mr. Evershed at his observatory at Pitch Hill on May 8 and 9, the disruption and subsequent disappearance of the prominence taking place on the morning of May 9 at the sun's east limb.

COMETS.—Dr. Carrasco obtained a photograph of Giacobini's comet on Mar. 26·8472 U.T., from which he derived the position R.A. (1928·0) $6^h\ 5^m\ 2^s$, N. Decl. 14° 50′ 24″ (*I.A.U. Circ.*, No. 203). Dr. A. C. D. Crommelin has obtained the following parabolic elements from the observations of Mar. 17, 26, 28:

T	1928 Mar. 27·4335 U.T.
ω	345° 27·11′
Ω	196 20·45
i	2 49·71
log q	9·99769

Dr. Carrasco obtained similar elements, but the above give a better representation of the middle place.

Ephemeris for 0^h:

	R.A.	S.Decl.	log r.	log Δ.
May 20	$16^h\ 58^m\ 6^s$	14°33′	0·1269	9·5316
28	16 53 32	14 53	0·1544	9·6219
June 5	16 49 40	15 15	0·1814	9·7047
13	16 47 0	15 40	0·2074	9·7812
21	16 45 50	16 6	0·2325	9·8530

The small inclination suggests possible periodicity. However, the observations are satisfied better by a parabola than by an ellipse.

Research Items.

NORTH AMERICAN INDIAN STATISTICS.—A study of the population of America north of Mexico, which was begun by the late Mr. James Mooney as a contribution to the "Handbook of American Indians," but grew beyond limits suitable for that publication, has been published as No. 7, vol. 80, of the *Smithsonian Miscellaneous Collections*. It was still incomplete at the time of the author's death in 1921, but was sufficiently advanced to warrant publication. The territory is divided into fourteen areas. The figures show the relative strength of the tribes and an approximate estimate of losses and gains, with notes on the causes, epidemics and other, responsible for the decline. In the North Atlantic States, including New York, New England, New Jersey, and Pennsylvania, as well as part of Quebec, at the time of first colonisation, about 1600, the Indians probably numbered about 55,000. They are now reduced to about 22,000, of which number about 18,000 are Iroquois. In the South Atlantic States—Delaware, Maryland, Virginia, and the Carolinas—leaving out the Cherokee territory, there are not to-day twenty full-bloods keeping their own language, though there are about 1000 mixed bloods. It is estimated that in the early seventeenth century they numbered 52,000. Decline was noted so early as 1607. In the Gulf States the numbers have fallen from 114,000 to 62,700, though this latter figure includes large numbers with white admixture. Of the remaining regions the largest decrease is shown in the southern plains, where the population has fallen from 41,000 to 2861, and in California from 260,000 in 1769 to 18,797 in 1907. The figures for the whole area, including Alaska and Greenland, are: early figure, 1,153,000; latest figures, 406,000. The early figure, it will be noted, includes the first estimate or calculation for each area, but is not composed of synchronous figures, some belonging to the seventeenth century, others to the eighteenth or even early nineteenth centuries.

ANTLERS CARRIED BY FEMALE DEER.—Except in the case of the reindeer, it is the exception for the female of any species of deer to carry antlers. Interest, therefore, attaches to three recent records, collected by Joseph Dixon, of such abnormality in the case of the Rocky Mountain mule deer (*Jour. Mammalogy*, vol. 8, 1927). Other accounts of horned does in this species have been given by woodsmen and hunters, but though heads were occasionally preserved, the authenticity of the statements could not be tested. The present records come from one general region. In each case the antlers were well developed, but although all the deer were shot about the same season of the year, two had clean, hard, regularly forked horns, while in the third the antlers were gnarled and malformed and remained in full velvet. The last was evidently an old individual, and in this case senile degeneration of the ovaries may account for the abnormality, but the others were young individuals, and "there was no evidence noted that would lead one to believe that their reproductive organs were aberrant." It is a pity that opportunity was not taken to settle the questions aroused by the abnormal antler development, by critical examination of the reproductive organs.

NORTH AMERICAN SHORE BIRDS.—The United States National Museum has issued at intervals a series of volumes describing with great thoroughness the life-histories of related groups of wild birds frequenting the sea or inland waters. The seventh and latest of the series, by A. C. Bent, describes the "Life-histories of North American Shore Birds" (*Smiths. Inst., U.S. Nat. Mus., Bull. 142*). Under the head of each species the author has collected all the essential information regarding its migrations, breeding range, courtship, nesting, behaviour, plumages, and so forth, so that to each of the forty-one species of waders described in this first instalment, goes the goodly allotment of an average of some 8½ pages of print. To the British reader the volume is of special interest, since many of the species are migrants familiar on our shores during the winter months, and others nest in Great Britain as well as in North America; moreover, the group dealt with includes some of the most remarkable of migrants, 'globe-spanners,' which range from the Arctic almost to the Antarctic circle.

FISH MORTALITY IN FRESH WATER.—Major R. B. Seymour Sewell, in his "Investigations regarding an Epidemic of Fish Mortality in the tank in the Indian Museum Compound" (*Jour. As. Soc. Bengal*, vol. 22, 1926, Art. 25), gives a general account of the mortality of animal life in the tank on Feb. 16 and 17, 1926. The mortality among the fish is for the most part confined to the members of the carp family, which respire through the gills only. Post-mortem examination of fishes indicated that death was primarily due to asphyxia, either from insufficient oxygen or from excess of carbon dioxide in the water of the tank. A gas analysis of the surface water, taken on the morning of Feb. 17, showed 8·3 c.c. of carbon dioxide, 3·2 c.c. of oxygen, and 13·8 c.c. of nitrogen at N.T.P. per litre. Thus the percentage of carbon dioxide in the deeper layers of the tank must have been very near the lethal concentration of 10 c.c. per litre, especially as there was no wind and an insufficient temperature gradient to create a circulation in the tank. Hence it would appear that the epidemic was due to a rise in the carbon dioxide content, assisted by a reduction in the amount of free oxygen, both changes being brought about by the meteorological conditions. It is suggested that either by periodic introduction of water weeds and green algæ, or by circulating the water by artificial means or by treating the water with lime, such occurrences of mortality in tanks may be prevented. Dr. B. Chopra (*ibid.*, Art. 26) records that the fishes in the Indaw River in Upper Burma die in large numbers three or four times a year. This is said always to follow a heavy fall of rain on the hills, the water of which is collected by the Namtig stream. During the rainy season the Namtig brings down an exceptionally large quantity of water, some of which forces its way up the Indaw. The deadlock caused by the upstream of Namtig water and the downstream from the lake, brings about the fish mortality. Death is probably due to the water being fouled, preventing respiration. In spite of the periodic mortality every year, the stock of fish living in the river does not appear to be affected.

VARIABILITY IN CYCLOPS.—Z. Koźmiński (*Bull. Internat. Acad. Polonaise Sc. et Lettres*, Classe des Sciences Math. et Nat. B, No. Suppl. I., 1927) records in 114 pages and 19 plates detailed observations on the variability of Cyclops of the *strenuus* group. 640 specimens from varied sources were examined, carefully measured, and compared. He concludes that within the group *strenuus-insignis* four species are distinguishable—*scutifer*, *vicinus*, *strenuus*, and *insignis*, for which and for their *formæ* he provides full diagnoses, and adds notes on their ecology, local and seasonal variations, and on their geographical distribution.

THE DIGESTIVE ENZYMES OF A HOLOTHURIAN.—E. Sawano has investigated the digestive enzymes of a holothurian *Caudina chilensis* (*Sci. Reports Tohoku Imp. Univ.*, Sendai, Japan, vol. 3, No. 2, January 1928), and finds evidence of the presence of lipase, butyrase, amylase, invertase, maltase, ereptase, tryptase, and rennet. Examination for cellulase, lactase, pepsinase, and tyrosinase yielded negative results.

ERYTHRÆA SCILLOIDES.—This small but beautiful plant is one of the species selected for descriptive treatment in *Curtis's Botanical Magazine*, vol. 152, Part 2. Its chief interest lies in the fact that it is one of the latest additions to the flora of Great Britain, having been noticed for the first time on the cliffs at New Port Bay, Pembrokeshire, South Wales, in 1918. The nearest other localities in which it is found are in the Cherbourg Peninsula, and in the Monts d'Arré in Brittany. The species, one of the Gentian family, is described very fully and critically, and illustrated by a hand-coloured and lithographed plate.

MILDEW ON COTTON GOODS.—Various species of *Aspergillus* responsible for a large proportion of the cases of mildew on cotton goods have been worked out and identified by George Smith (*Jour. of Textile Institute*, vol. 19, No. 3). The forms have all been isolated in pure cultures in the laboratory, and the morphology and characteristics of each species are described. Species of *Aspergillus* described in this paper are divided into two conventional groups: first, those which have been identified as causal agents in actual cases of mildew damage of yarns and cloths; and secondly, forms which have been found to occur commonly as spore infections on commercial yarns, but have not so far been found growing on cotton goods. It is considered that the presence of living spores of such species on cotton constitutes a probable source of trouble. For each species or group, the variations in dimensions and colonial characteristics recorded are those noted in the actual strains isolated from cotton goods, and are not necessarily so wide as those cited in systematic works on the Aspergilli. In all, seventeen species are described, of which only one, *A. effusus*, has not been otherwise encountered on cotton goods.

THE FOCAL DEPTH AND ORIGIN OF EARTHQUAKES.—As the late Prof. Omori showed, the distance of the origin of an earthquake from a neighbouring station is given by the duration of the preliminary tremor recorded there. If the distance of the epicentre is also known, it is a simple matter to calculate the depth of the focus. Mr. K. Suyehiro, of the Earthquake Research Institute, Tokyo, has recently determined the focal depths of 17 earthquakes, all of them with epicentres less than 100 km. from Tokyo (*Proc. Imp. Acad.*, Tokyo, vol. 4, pp. 41-44; 1928). He finds that the earthquakes fall into two classes, the focal depth ranging in one from 25 km. to about 50 km., and in the other from 55 km. to 95 km. These earthquakes were also recorded by a new form of seismographic analyser recently erected in the laboratory of the Institute. The instrument is strongly damped and its period is adjusted to agree with the usual period of vibration (0·3 sec.) of the ground below. As the instrument after disturbance rapidly comes to rest, it is easy to detect the number of separate shocks in an earthquake. In the first class, each earthquake shows several groups of waves, in one case as many as eleven, while those of deeper origin had only one or two groups. This seems to suggest that, in the upper and more brittle layer, the initial movements start in succession or in different places; while in the lower stratum, a single movement as a rule takes place throughout the focus.

POSITIVE ION KINETICS.—The curious fact that some positive ions suffer very few effective collisions in passing through a gas has been confirmed by G. P. Harnwell in an investigation described in the April number of the *Physical Review*. The experimental tubes used were very similar to cylindrical thermionic valves, but the ordinary filaments were replaced by small troughs containing material which emitted the ions of potassium or of cæsium when it was heated. For speeds corresponding to accelerating potentials of fifteen hundred volts or less, the singly charged atoms of these two elements produced no detectable ionisation of the five gases that were studied. The free paths for transfer of kinetic energy proved to be many times what would be expected from the kinetic theory of gases, when the impinging particles were treated as elastic spheres, and although a closer agreement between theory and experiment could be obtained by an appropriate assumption about the force of attraction between ions and molecules, the similarity of the phenomena to those found with protons of comparable velocities, where the fields are presumably less complex, seems to indicate that there is some fundamental explanation that is valid in both instances. The analogous Ramsauer effect for slow electrons has been already accounted for by the wave mechanics.

THE MEASUREMENT OF CAPACITANCE.—Maxwell's method is the one that has been most commonly used for the absolute measurement of capacitance (capacity). It was first used by J. J. Thomson in 1883, who proved the accurate formula for computing the capacitance. In a valuable paper by H. L. Curtis and C. Moon, of the U.S. Bureau of Standards (No. 564), a very thorough investigation is made of the accuracy of the method, and an appreciative account is given of the work of preceding investigators. In order to determine experimentally the accuracy that can be obtained, two independent Maxwell bridges were set up and used to measure the same capacitance. The bridges were entirely distinct, using different resistances, galvanometers, and batteries. A rotating commutator was used on one bridge and a vibrating commutator on the other. With the former the balance was made by adjusting the speed and determining the frequency of the charge and discharge by means of a chronograph. With the latter the adjustment was made by a resistance and by determining the rate of vibration of the commutator by comparison with a pendulum. The experiments extended over several months, various anomalous results having to be investigated. The final value of the capacitance as found by the first bridge method was 0·249236, and by the second 0·249242. This shows a difference between the results of 2·5 parts in 100,000. The authors conclude that even with excellently designed and carefully adjusted apparatus, there may be an error of 3 parts in 100,000 when measuring a capacitance of 100,000 by Maxwell's method. They recall that Glazebrook showed in 1890 that the method was not suitable for measuring any condenser which had absorption, that Orlich was the first to point out the importance of earthing the bridge, and that Russell showed that ballistic galvanometers when used with a mutual inductance do not always integrate correctly.

THE VOLUMETRIC ESTIMATION OF SULPHURIC ACID.—In the *Chemiker-Zeitung* of April 21, Dr. O. Nydegger directs attention to the fact that the benzidine method of estimating sulphuric acid deserves far more attention than is usually paid to it; he claims that if properly carried out the errors due to the appreciable solubility of benzidine sulphate in water and to its tendency to adsorb benzidine hydrochloride, can be reduced to a maximum of 0·5 per

cent. Investigation has shown that the presence of small quantities of iron, nitric acid, and other substances in the solution have no effect upon the results, so that the method is particularly suitable for the rapid estimation of sulphur in iron pyrites.

THE BUDDE EFECT WITH BROMINE VAPOUR AND AIR.—In 1871, Budde observed that chlorine expands on exposure to light, but later workers have claimed that this effect does not take place with dry chlorine. An investigation of the Budde effect with mixtures of pure bromine vapour and air is described by E. Brown and D. L. Chapman in the *Journal of the Chemical Society* for March. Their results indicate that mere removal of water from such mixtures has no detectable influence upon the increase of volume which occurs on exposure to light. This conclusion is not in agreement with recent work of Ludlam, and also Lewis and Rideal, who state that no Budde effect can be observed with bromine vapour which has been thoroughly dried.

SPECTRUM OF THE GLOW OF PHOSPHORUS.—The spectrum produced by passing a discharge through phosphorus pentoxide vapour was recently investigated by H. J. Emeléus and R. H. Purcell (*Jour. Chem. Soc.*, 788; 1927), who found that it partially corresponded with the ultra-violet band spectrum of the glow of phosphorus. R. C. Johnson has pointed out that these measurements also correspond below 3000 A. with the band spectrum of the singly ionised oxygen molecule, and it therefore appears possible that the ultra-violet emission from glowing phosphorus is due to oxygen. In view of the fact that ozone is produced at the same time, this suggestion is of considerable interest, and the available evidence is discussed by Emeléus and Purcell in the *Journal of the Chemical Society* for March. They conclude that, owing to lack of sufficient knowledge of the spectra concerned, the origin of the spectrum of glowing phosphorus must still be regarded as unsettled.

AN ATTEMPT TO PREPARE TRIATOMIC HYDROGEN.—According to a number of investigators, hydrogen can exist in an active form which is said to be capable of reducing certain elements, such as sulphur and nitrogen, to their hydrides, and, unlike monatomic hydrogen, is not completely destroyed by passage through glass wool. Wendt and Landauer claim that its formation in a closed system is accompanied by a decrease in pressure, and this observation has led to the assumption that this active form is triatomic hydrogen. In the *Journal of the American Chemical Society* for March, H. M. Smallwood and H. C. Urey describe a series of experiments to produce this substance. The methods employed include the combustion of oxygen in hydrogen, the passage of hydrogen over heated metals, and the effect of corona and vacuum discharges on hydrogen. The latter method was investigated in great detail, but it was found to be impossible to obtain a product which would definitely reduce sulphur to an appreciable extent. The experiments all gave negative results, and it is suggested that previous workers have failed to carry out adequate blank tests. Smallwood and Urey conclude that the existence of triatomic hydrogen has not yet been established, and that if it does exist its preparation is very difficult.

GASES IN BRASS INGOTS.—The work described in a paper, read at the spring meeting of the Institute of Metals by G. L. Bailey, on "The Influence of Gases on the Soundness of Brass Ingots," consisted in the production of ingots of brass and bronze which were treated, prior to pouring, with nitrogen, hydrogen, and sulphur dioxide and were then allowed to solidify over a fairly wide range of time. It was shown that a bronze containing 5 per cent of tin was very nearly sound after treatment with nitrogen, except in the case of the ingot poured in the warm, dry, sand mould. With more rapid chilling the rate of solidification played no very important part. Ingots of the bronze through which hydrogen had been bubbled were slightly less sound than those which were treated with the nitrogen, except in the case of the most slowly cooled ingot, which contained again about 10 per cent of cavities. Brass containing 30 per cent of zinc proved to be practically completely sound after both the nitrogen and hydrogen treatment, except, again, in the case of the slowest cooling in dry sand. Sulphur dioxide rendered the casts only very slightly more porous. It is concluded that whatever be the conditions of casting, 70:30 brass is not liable to unsoundness due to gases. The spherical cavities, of varying size and unequal distribution, frequently found in brass ingots, are attributed not to the evolution of dissolved gas, but to the mechanical entrapping of gases within the mould during pouring. This view is supported by the fact that the use of low casting temperatures is followed by an increase in the number of spherical cavities, and that with very low casting temperatures large cavities of entrapped air can be produced. The results suggest that molten brass has very little solubility for gases. Even, however, if such gases are occluded, it appears that they will remain in solution after solidification. Very slow rates of solidification, however, cause the casting to be unsound, but probably for other reasons connected with the dressing of the mould.

THE ACTION OF FUSES.—It is well known to electricians that if the current through a carbon arc is increased, the length of the arc being kept constant, then, at a certain value of the current, the arc suddenly begins to hiss and there is a sharp drop in the voltage and a sudden rise in the current. If a graph of the voltage and the current is drawn, there is a discontinuity in the curve. For values of the current between definite limits it is impossible to maintain an arc of a given length. In a paper by P. D. Morgan, read to the Institution of Electrical Engineers on Mar. 22, on the rating of fuses, a somewhat analogous phenomenon was described in connexion with the melting of fusible wires. For example, in one of the experiments tinned copper wires No. 19 S.W.G. of given length were fixed in succession between two terminals, and the times taken for them to melt with given currents were observed. It was noticed that when the current was greater than 70 amperes, the wire always melted in less than 30 seconds; but when the current was not greater than 69·3 amperes, the wire always took at least five minutes to 'blow.' For currents lying between these somewhat narrow values there appear to be two times of operation, the short time being less than 30 seconds and the long time never being less than four minutes. For smaller values of the current the curve connecting the 'blowing' current and the time of operation is a perfectly definite 'smooth' curve. Similar discontinuities were noticed over the whole range of wires tested. The phenomenon is due apparently to the oxidation of the wires. Above a certain temperature, oxides form quickly on the surface. These have a better emissivity than the bright wire, and the improvement is so appreciable that the temperature of the wire actually falls. This fall in temperature is accompanied by a change in brightness which is clearly visible to the eye. There is a decreased resistance, and since the current is maintained constant, a consequent fall of potential across the ends of the wire. Suggestions are made for improving the methods in use for rating fuses.

Problems in the Physiology of the Cerebral Hemispheres.[1]

THE function of the nervous system is to maintain dynamic equilibrium within the organism and between the organism and its environment. In the latter case the equilibrium is, in the higher animals, extremely complex and is achieved mainly by means of the hemispheres. These continuously analyse and synthesise events occurring in the environment, and in correspondence with its changes establish temporary connexions between events, whether simple or complex, and various activities of the organism, in particular those of the skeleto-muscular system, which is preponderantly concerned in reacting to environmental changes and is likewise itself highly differential and integrative in its response.

At present the physiology of the hemispheres exists only in outline—as a framework consisting of a limited number of known factors, such as excitation and inhibition, their two-directional movement in the form of irradiation and concentration, and their mutual induction. The working out of the innumerable details of their intimate mechanism is a colossal problem of the future. A few of the latest investigations carried out by the author and his co-workers (*i.e.* subsequent to the publication of the author's book, "Conditioned Reflexes") are here summarised.

(1) The development of new temporary connexions between external agencies and definite reactions of the organism (development of conditional reflexes) depends on the coincidence in time of the action of these agencies upon the receptor mechanisms of the organism, with the various activities of the organism evoked either by external stimuli effective since birth, or by external stimuli which have become established as such after birth, or finally by changes in the internal condition of the organism (automatic stimuli). The formation of the connexion is then a physiological law.

In order to become a firmly established, powerful, conditioned stimulus the external stimulus *must* begin to act slightly before the particular activity of the organism, and *may* even cease a few seconds before the beginning of the activity. If, on the other hand, the given activity constantly begins before the stimulus, either no connexion is established, or if any is established it is weak, and survives only for a short time, and the specialised excitatory effect of the stimulus is invariably replaced by general inhibition. The biological significance of this fact is not yet clear. Where the stimulus begins to act before the given activity of the organism and continues during that activity, the reflex tends to increase in strength and stability. The mechanism underlying these phenomena cannot yet be expressed in terms of the general properties of the cortical tissue.

(2) The analysing activity of the nervous system is founded in the first instance on the peripheral receptor organs, which constitute not only a receptive mechanism but also an analysing apparatus of the organism. To the peripheral points of the analyser separate points correspond in the cortex (the primary and simplest cortical mosaic). A good proof of this is that by applying definite external stimuli belonging to the same analyser, for example, different auditory stimuli, it is possible to produce various disturbances or fatigue at different strictly localised cortical points. In this manner a very delicate method is opened up for investigating the construction of the cortical parts of the analysers, and it is possible to distinguish special areas in the cortex corresponding to the different analysers (visual, auditory, etc.) from certain other cortical elements of those analysers, which are dispersed probably over the whole mass of the cortex of the hemispheres. Not only are these dispersed elements incapable of performing any higher synthesis and analysis, but they have a very low degree of vitality, as evidenced by the rapidity of their transition into an inhibitory state under the influence of external stimuli.

(3) The conditions determining the characteristics and the magnitude of the excitatory and the inhibitory effects of conditional stimuli are bewilderingly complex and are only gradually being classified.

It is obvious that the magnitude of the positive effect is directly related to the amount of energy applied to the receptor organ. The phenomenon of summation of weak stimuli comes out clearly. The limit of normal excitability and the optimum strength of stimulation are also definite. In the case of very strong stimuli and of the summation of medium stimuli, the excitatory process rapidly changes into an inhibitory one. Of course the strength of stimulus is a relative quantity, varying greatly with individual differences of nervous system.

Since most probably the points between which the new connexions are established are in the cortex, it follows that the variations in the effect of conditioned stimuli will be dependent on the mutual relation between the different cortical points corresponding to the different conditioned stimuli, and also between the different points of those areas of the hemispheres which are affected by the unconditioned stimulus. For example, the conditioned stimuli based on food and acid respectively, both become connected with the chemical analyser of the hemispheres, and therefore, if in the experiments both sets of conditioned stimuli are used, their effect will be determined not only by the interrelation of the points corresponding to the stimuli, but also by the relation existing between the alimentary and 'acid' points of the chemical analyser.

(4) The accumulation of observations upon the normal and pathological activities of the hemispheres gives grounds for distinguishing various types of nervous system. There is the excitable type, which always displays partial or complete failure when confronted by difficult relations between the excitatory and inhibitory processes, and if the experiments are continued, ends by developing an abnormal and extremely protracted weakening of the inhibitory activity, attended by an exaggerated general excitation. At the other extreme stands the inhibitable type, which very easily becomes subjected to inhibition by stimuli either unusual or slightly stronger than usual, and, when confronted by comparatively difficult relations between the excitatory and inhibitory processes, passes into a state of complete inhibition for prolonged periods of time.

In between can be placed the well-balanced type which, successfully and without any signs of abnormality, establishes in all cases a balance between the opposed nervous processes. This type comprises two varieties of animal, differing greatly from one another in external appearance—the stolid animal, always quiet, and the animal which is lively under ordinary conditions, but becomes drowsy with surprising rapidity under monotonous conditions. The latter variety has some difficulty in obtaining a balance between the two processes. This grouping of the types of nervous system corresponds closely to the ancient classification of temperaments; the excitable type—choleric temperament; the inhibitable type—melancholic; the quiet, balanced type—phlegmatic; the lively balanced type—sanguine.

[1] Abstract of the Croonian Lecture delivered before the Royal Society on May 10, by Prof. I. P. Pavlov, For. Mem. R.S.

The University of Liverpool.

THE University of Liverpool has just been celebrating its twenty-fifth anniversary, and in the city were gathered representatives from all branches of civic life and from many universities to take part in the rejoicings and to bring messages of goodwill and encouragement. A service of thanksgiving and of dedication was held in Liverpool Cathedral on the afternoon of Thursday, May 10, and was conducted by Dr. David, Bishop of Liverpool. In the evening the University Association entertained the delegates from the universities, the representatives of civic authorities, and those who on the following day were to receive honorary degrees. In a publication issued for the occasion, a brief record was given of the work and progress of the University of Liverpool from its foundation in 1907.

On the afternoon of May 11, Lord Derby, Chancellor of the University, presided over a large gathering in St. George's Hall, and conferred honorary degrees on twelve people of eminence in academic and civic life. Representatives of every department of the university and civic life of Lancashire and Cheshire attended, accompanied by delegates from the American University Union, the University Colleges of Exeter, Southampton, and Nottingham, King's College, London, and the Universities of Reading, Bristol, Queen's University, Belfast, Leeds, Birmingham, Wales, Manchester, London, Durham, Trinity College, Dublin, Edinburgh, Aberdeen, Glasgow, St. Andrews, Cambridge, and Oxford. Having welcomed the visiting representatives, Lord Derby paid high tributes to the late Sir Alfred Dale and Dr. Adami, former vice-chancellors of the University, and to the many benefactors whose munificence has made the University a growing reality. The Vice-Chancellor (Dr. Hetherington), speaking of the faith of those who laid the foundations of the University, welcomed the presence of some who saw and some few who shared in that endeavour, expressed the indebtedness of the University to these teachers who have won for it recognition in the world of scholarship and letters, and to those who have served it in the care of its affairs. Above all others, he recalled in faithful remembrance those who gave themselves in battle that the foundations of the University might not be moved.

Prof. Campagnac, as Public Orator of the University, presented the following recipients of honorary degrees to the Chancellor, and in each case delivered a brief eulogy of their work :—

Doctor of Letters.—The Earl of Crawford and Balcarres (Chancellor of the University of Manchester), Emeritus Prof. Oliver Elton (University of Liverpool), Prof. T. Percy Nunn (Principal of London Day Training College, and professor of education in the University of London).

Doctor of Science.—Prof. John E. Littlewood (professor of mathematics in the University of Cambridge), Prof. Robert Robinson (professor of organic chemistry, University College, London).

Doctor of Laws.—Vice-Chancellor William MacBride Childs (The University of Reading), The Right Hon. H. A. L. Fisher (Warden of New College, Oxford, and formerly Minister of Education), Prof. John W. Gregory (professor of geology in the University of Glasgow), Miss Emma G. Holt (founder of the Liverpool University Hall), Sir Edwin L. Lutyens (in recognition of his services to British architecture), Sir Archibald Salvidge (leader of the City Council of Liverpool).

Doctor of Engineering.—Emeritus Prof. John A. Fleming (for forty-two years professor of electrical engineering in University College, London).

Speaking of them individually, Prof. Campagnac said that the Earl of Crawford had directed his disciplined taste and lent his strong advocacy to preserving what Nature and human effort had produced of fair and lovely in our land. For twenty-five years Prof. Elton, as head of the Department of English Literature, had been to many generations of students, guide, philosopher, and friend, the pattern of exact scholarship, the model of just criticism, and the unbending champion of University liberty. By nature and vocation a teacher of teachers, Prof. Nunn had astounded all by the variety of his learning, in letters, philosophy, mathematics, and music, and by his supreme perfection in administration. The researches in which Prof. Littlewood delights fill the uninitiated with wonder and dread, and provoke, in his peers, reverence and admiration. The learned revel in Prof. Robinson's synthesis of flower pigments and have admired the fertility of his genius. Of the Vice-Chancellor of the University of Reading, he said that in the development of that institution he had acted with courage and wisdom, and had satisfied modern needs by freely interpreting a venerable tradition. As scholar, teacher, historian, and philosopher, the Right Honourable H. A. L. Fisher had shone, but above all he had been the champion of youth, resolute to ensure their inheritance in liberty and discipline. In presenting Miss Emma G. Holt, Prof. Campagnac said that the establishment of colleges in which piety and learning might be sought in cloistered leisure was of old the beneficent labour of royal and generous ladies. Miss Holt had taken up and embellished this tradition by providing in Liverpool a hall which, in beauty and fitness for its purpose, challenges the glory ot these houses. As a traveller, Prof. J. W. Gregory had fared far east and west, north and south, over the world and in the realms of thought. His scientific instinct had had the nature of prophecy, and his anticipations boldly made in many fields of inquiry had been fulfilled in as many regions of knowledge ascertained by his labours. In East Africa and Australia, in Chinese Tibet and along the Himalayan system, he had conducted explorations, the results of which are of great social and political importance. He has illuminated some of the most difficult social and racial problems. To the success of Sir Edwin Lutyens in planning a new capital city in India was added the fact that to him Britons had turned when at the heart of their Empire a memorial of the men who had fought and died for home was needed. In presenting Sir Archibald Salvidge, Prof. Campagnac spoke of the encouragement and generous support which the University had received from the City of Liverpool, and of the University's pride in a man for whose heart its prosperity is a passion, and by whose courage, enterprise, and unremitting labour the city has been promoted and advanced. As in great measure responsible for the introduction to this country of the telephone, the incandescent electric lamp, and radio telegraphy and telephony, and as the inventor of such cunning instruments as the thermionic valve, the University sought to honour Emeritus Prof. J. A. Fleming.

In the evening the University, the civic representatives, the honorary graduates, and the University delegates were the guests of the Lord Mayor of Liverpool (Miss Margaret Beavan) at a reception at the Town Hall.

The celebrations ended on the afternoon of Saturday, May 12, with a garden party at the University Sports Grounds at Allerton, at which the Christie Sports were also held.

University and Educational Intelligence.

CAMBRIDGE.—The honorary degree of LL.D. is to be conferred upon the Right Honourable Sir John Simon, P.C., M.P.

W. H. McCrea, Trinity College, has been elected to the Sheepshanks exhibition in astronomy.

The General Board of Studies has issued a report giving details of the scheme for carrying out the statute passed by the recent Statutory Commission, which gives University teaching officers a right to be excused from teaching duties during one term in seven. There are financial difficulties in granting this leave generally with full stipend, but the Board hopes that it will be possible to grant two terms' leave of absence with stipend once in every period of seven years. *A significant development in University teaching is indicated in the transfer of Mr. W. S. Farren's lectureship from the Department of Engineering to that of Aeronautics.*

A syndicate, consisting of the Vice-Chancellor, Sir Henry Miers, Sir William Pope, Sir Ernest Rutherford, Sir William Bragg, Dr. Thomas, Dr. Spencer, Dr. Rastall, Mr. Thirkill, Dr. Harker, Mr. Nicholas, and Dr. Rideal, has been appointed to consider the position of mineralogy in the studies of the University. A second syndicate has been appointed to consider plans for the new University Library.

Mr. L. E. S. Eastham, lecturer in advanced and economic entomology; has been appointed to represent the University at the International Congress of Entomology to be held at Ithaca, New York, next August.

Messrs. J. S. Fry and Sons, Ltd., Bristol, offer a post-graduate studentship of £300 a year for two years, tenable at Peterhouse, for research in moral science, law, history, modern languages, economics, and English. The studentship is open to members of any university in Great Britain or Ireland.

MANCHESTER.—The Edmund Mills Harwood Memorial Scholarship, value £50 per annum for three years, is being offered by the Municipal College of Technology. It will be tenable in one of the university engineering courses in the College. Information concerning the scholarship and forms of application are obtainable from the Registrar of the College until June 15.

OXFORD.—On May 8, two rival schemes for the extension of the Bodleian Library came before Congregation. The first scheme, which contemplated the building of a large new library at a distance of not more than three-quarters of a mile from the present Bodleian Library, was advocated by Sir Michael Sadler, Master of University College, and Mr. E. L. Woodward. The second plan, which proposed an addition to the Library by building on the site owned by the University on the north side of Broad Street, was supported by Prof. H. W. C. Davis and Dr. A. E. Cowley, Bodley's Librarian. After a speech by Mr. Falconer Madan, a former Bodley's Librarian, who opposed both projects, the two schemes were rejected, the former by a large majority. There is little doubt that a paper put out by the late Warden of Wadham and the Provost of Worcester, urging that Congregation should declare its mind on the general policy of the future of the Bodleian before descending to points of detail, contributed largely to this result.

On June 16, Convocation will proceed to the election of a Chancellor of the University in succession to the late Viscount Cave. It is understood that there will be no official opposition to the nomination of Lord Grey of Fallodon to the vacant office, but nominations will be received at the University Registry up to June 7.

A LIMITED number of grants-in-aid are being offered by the Salters' Institute of Applied Chemistry to young men and women employed in chemical works in or near London who desire to extend their education for a career in chemical industry. The latest date for the receipt of applications by the Director of the Institute, Salters' Hall, St. Swithin's Lane, E.C.4, is June 9.

THE Board of Education is again prepared to receive applications for full-time studentships from teachers desiring financial assistance in order to attend approved full-time courses of advanced instruction or research at universities or other institutions at home or abroad. The amount of grant cannot exceed £100 for an academic year. The Board is prepared to consider proposals for carrying out research involving travel or the practical study of industrial conditions connected with the teaching of technical subjects. Teachers must have had not less than five years teaching experience and may be serving in any type of a school or institution recognised by the Board. Applications for the year 1928–29 should be made as soon as possible, and in any event not later than June 30. *Further information and application forms can be obtained from the Board of Education,* Whitehall, London, S.W.1.

THE report of the Principal of the University of London (Dr. Franklin Sibly), read on Presentation Day (May 9), records 9119 admissions to the University in 1927–28, compared with 3852 in the last year before the War. Of these, 6545 entered through the ordinary matriculation examination and 426 as graduates of other universities. In 1927 there were 3325 candidates for first degrees and 529 for higher degrees, these figures showing slight decreases compared with the previous year. Of the candidates for degrees, 2283 were internal and 1571 were external, contrasting with 900 and 907 respectively for the last year before the War. The roll of internal students now comprises 9556 names. The outstanding event of the past year was the completion of the purchase of the Bloomsbury site for the new University buildings. New scientific developments include the institution of a chair of dietetics, at present a part-time appointment; and a chair of highway engineering. The Vice-Chancellor (Sir William Beveridge), in an eloquent address on the same occasion, referred to the reconstitution of the University now in progress, which, he expected, would be completed in a year's time. "On the old examining university," he said, "had been successfully grafted a new teaching and researching university." The new constitution will give to the Colleges of the University for the first time an organic place in its structure and government. Development of the Bloomsbury site awaits only the passing of the Bill now before Parliament for closing the streets and making the site "a self-contained plot," and he promised that the new buildings would be worthy of the greatest city in the world—the University dared not build anything "mean or cramped or ugly." That enclosure of great courts and green spaces and great libraries and halls of learning in a market-place of nations would be a thing of beauty to which the thoughts of all its children of all races from all lands would turn continually, a visible sign to all men of the academic faith—of the learning that knew no frontiers, of the contemplation that alone gave eyes to action, of the calm that should be the centre of man's being.

Calendar of Customs and Festivals.

May 20.

THE DIVINE SACRIFICE IN MEXICO.—On the first day of the fifth Aztec month, a date of which the exact incidence is uncertain, though it has been fixed conjecturally at various times between Easter and May 20 by different authorities, the festival of Toxcatl, the most important of the Mexican year, took place. The great god Tezcatlipoca was sacrificed in the person of his human representative, a man who had been feasted and worshipped during the whole of the preceding year, and was now succeeded by another who enjoyed divinity for a like period and was then sacrificed in his turn. Twenty days before the god was to die, his costume was changed and four brides were given him. On the last day he embarked with his retinue in a canoe, was ferried across the lake and slain by a priest on a stone altar on the summit of the pyramidal temple. His heart was cut out and offered to the sun. This was said to be a sacrifice for rain, but the names of his brides, for example, "The Goddess of Flowers," "The Goddess of the Young Maize," suggest a general renewal of fertility.

This was one only of a number of occasions on which a man was sacrificed, after living as a god. A human representative of Huitzilopochtli was sacrificed in May after leading dances in which the maidens were decked with maize ears. At Cholula, in February, the merchants sacrificed a slave who was the god Quetzalcoatl, after a ceremonial lasting forty days. The victims of human sacrifice were not men only. Women were also made to personate a female deity and were then sacrificed; for example, the Goddess of Salt, Huixtocihuatl, the sister of the Rain Gods, was personated for ten days by a woman who wore her clothes and led the dancers, until on the last night she danced to the point of exhaustion and was sacrificed in the morning in the same manner as the men by having her heart cut out.

May 21.

ST. BARIND (sixth century), patron of Kilbarron, Co. Donegal, is said to have been the first European to discover America. He gave St. Brendan an account of his adventures on the Western Ocean before the latter set out on his seven years' voyage in search of the Land of Promise. References to a legendary country lying to the west of Ireland are frequent in early Irish tradition.

The story of the voyage of Brendan, extremely popular in the Middle Ages, includes many marvels—visits to an Island of Birds, an Island of Sheep, and an Island of Fruits, an encounter with a sea monster so huge as to be mistaken for an island, fire-drakes, and the like. The parallels to be found in the voyages of Sindbad and other early travellers are obvious. It has therefore been suggested that incidents of an oriental origin have been grafted on to an Irish version of the Land of the Blessed. The description of the Island of Fruits suggests that the West Indies may have been reached, and the story of the island of which the inhabitants cast molten iron at the voyagers might well be an account of a violent volcanic eruption in that area.

May 26.

ST. AUGUSTINE (A.D. 605).—After the conversion of the Saxons to Christianity by St. Augustine, bitter racial quarrels broke out between Saxon and Briton, of which the occasion was the divergence between the ancient British and the Roman churches in the date of celebrating Easter. One incident is said to have given rise to the medieval legend current on the Continent that Englishmen had tails. Fisher folk of Dorset attacked St. Augustine and his followers and drove them from their territory, fastening fish-tails to their robes. Another version attributed tails to the men of Kent only, because they had cut off the tail of Becket's horse.

ST. BECAN (sixth century).—A native of Munster of great sanctity, who was the object of a cult in the parish of Killardry, Co. Tipperary, where, near the church of Kilpeacon, is Peacawn's Well. It is surrounded by a ring of stones, and nearby are a few stones known as 'the Altar,' with an associated legend. This well was much visited by pilgrims until 1830.

MAY MARRIAGES.—The popular belief that May marriages are unlucky is widespread, being found in most European countries. It was also the view of the Romans, who extended the period of ill-luck to the first half of June. The aversion is sometimes explained as due to the connexion of the month with the Virgin Mary; but this must be regarded as an attempt to justify the retention of a pagan observance. Other periods have also been regarded as unlucky or as forbidden; for example, Lent, and the period between the Rogation Days and the first Sunday in Trinity; August in Sicily and France, and July in Sardinia; between Passover and Pentecost among Jews. Marriage in the month of Moharram in Morocco and Egypt might entail death or madness.

Certain days were also to be avoided. Marriage on the Sabbath was forbidden among the Jews, on Friday in the Mohammedan world; while in popular belief certain days of the week were to be avoided; among others, Thursday in England because of its connexion with Thor, Tuesday and Friday in Italy because curses are peculiarly efficacious on those days. Yet among Teutonic peoples Tuesdays and Thursdays were favourite days for weddings, because they were connected with the deities Ziu and Donar. The Romans did not marry on Kalends, Ides, and Nones, or on the *Dies Parentales* (Feb. 13-21).

Friday is almost universally regarded as unlucky in Christian countries. The avoidance in the north of Scotland of a waning moon, which will lead to a barren marriage, or a falling tide, is due to an obvious association of ideas; while the Irish disinclination to marry in harvest, as the time of binding, points to the widespread popular belief in the efficacy of the knot in the magical prevention of consummation.

Among people of lower culture, marriage is regarded as a time of peculiar danger, and it is a widespread practice to secure by means of consultation of omens that it shall take place at an auspicious time. On the other hand, the occasions on which marriage is regularly avoided are those which are regarded as especially critical, that is, when the powers of evil are peculiarly potent. The Moslem's belief that an evil spirit may enter into the body of the woman at consummation serves to indicate how such an idea becomes operative. Witches, too, may interfere by the knotting of a string, causing impotence, or otherwise. For this reason marriage is avoided in Macedonia between Christmas and Epiphany. The month of May, although the month of fertility and growth, is also the month of the witch. It is the time when the powers of evil are peculiarly active, and the fire festivals of Beltane are called into operation to neutralise and drive them away. At such critical seasons primitive wisdom counselled continence.

Societies and Academies.

LONDON.

Physical Society, April 27.—**Will C. Baker**: Experiments with mercury jets and the phenomena exhibited at their impact with steel and glass. As a light sphere is retained in a vertical jet of fluid in virtue of the change of momentum of the fluid produced by its adhesion to the sphere, it was thought that a steel sphere would not be retained in a vertical mercury jet, as there is no 'wetting' of the steel by that fluid. Experiment showed that a given bicycle ball might or might not be retained by such a jet, as the speed of the jet (at a given angle of incidence) rose above or fell below a critical value for that ball. Conditions were simplified by the use of cylindrical and of plane surfaces of steel, and an approximately constant time of adhesion between mercury and steel was found for various speeds of impact. This led to the explanation of the phenomenon in terms of the well-known instability of jets.—**E. P. Perman** and **W. D. Urry**: The elastic constants of glass. The coefficients of compressibility of soda-glass and Jena 16^{III} glass have been determined at six temperatures ranging from 30° C. to 80° C. From experiments on the effect of external pressure only, Poisson's ratio has been determined, and hence the modulus of rigidity and Young's modulus.—**G. Eric Bell**: A valve-maintained high-frequency induction furnace and some notes on the performance of induction furnaces. In Part 1 the electrical design is given of a valve-operated high-frequency induction furnace; in Part 2 a theory of the behaviour of induction furnaces in general is developed.

Society of Public Analysts, May 2.—**A. L. Williams**: Locust kernel gum and oil. Locust kernel gum has recently been used as a thickening agent for sauces. Its reactions with tannin, borax, and Fehling's solution are the most characteristic. So little as 1 per cent. of the gum may be separated from sauce or jam by treatment with tannin. The constants of the kernel oil have been determined (iodine value, 98·4). The oil gave a negative result in the antimony trichloride test for vitamin A.—**W. R. Schoeller** and **E. F. Waterhouse**: Investigations into the analytical chemistry of tantalum, niobium, and their mineral associates. (12) Observations on the pyrosulphate hydrolysis method. The pyrosulphate hydrolysis method does not effect a quantitative separation of the earth acids from zirconia. At best, a decrease in the quantity of zirconia co-precipitated is achieved, at the cost of slightly incomplete earth acid precipitation.—**F. W. Toms** and **C. P. Money**: The separation of lead tetra-ethyl from solution in petroleum spirit. The method depends on the separation of lead ethyl sulphinate on passing sulphur dioxide into 'ethyl petrol,' and conversion of the deposit into lead sulphate.—**B. S. Evans** and **S. G. Clarke**: New precipitation method of determining vanadium and its application to steel analysis. The method is based on the precipitation of vanadium as ferrocyanide and eventual determination of the vanadium present by titration with potassium permanganate. Vanadium ferrocyanide is insoluble in mineral acids of quite high concentration. In applying the process to steel analysis, the iron is quantitatively converted into ferrocyanide by reducing it from the ferric condition in alkaline citrate solution in the presence of cyanide, and the resulting ferrocyanide then acts as the reagent for the vanadium.—**P. Houseman**: The examination of liquorice mass. Stick liquorice adulterated with starch is now extensively sold in England, and a test to detect this adulteration has been devised. Occasionally the added starch is boiled so as to destroy the individuality of the granules, but usually it is possible to discover a few granules that have escaped disintegration.

PARIS.

Academy of Sciences, April 11.—**A. Lacroix**: The composition of the basaltic lavas of Indo-China.—**Charles Nicolle** and **Charles Anderson**: The presence in Morocco of the spirochæte of recurrent Spanish fever. The Spanish and Moroccan varieties of spirochæte must be considered as belonging to the same species: the Moroccan strain is perhaps somewhat more virulent to the guinea-pig than the Spanish.—**R. Coenen**: The mean geodesic curvature.—**G. Vranceanu**: Some tensors in the non-holonome varieties.—**Edward Stenz**: Observations of solar radiation and of atmospheric opacity made at Jokkmokk during the solar eclipse of May 29, 1927.—**Ch. Jacquet**: Experimental researches on the magnetisation of the volcanic rocks of the Department of Puy-de-Dôme.—The coefficients of magnetisation determined varied from 9·2 to less than 3 (magnetite, 92·7). Determinations of the variation of the magnetisation with the temperature showed that all the specimens examined the magnetisation of which was above 4 units, gave a Curie point of 550° C., near that of magnetite. The enclosures gave 580° C., exactly that of magnetite.—**H. Ollivier**: Research on the thermal variation of the magnetic rotatory power, in the case where the magnetisation coefficient is positive and independent of the temperature. For sodium bichromate, the paramagnetism of which is constant, the Verdet constant, referred to the unit of mass, does not vary between 7° and 61° C. by a quantity exceeding the error of experiment.—**A. Boutaric** and **F. Banès**: The immunity of the granule in colloidal solutions. The results of experiments described agree with the views of A. Lumière in that they prove a certain analogy between living cells and colloids in the sol condition, and between flocculated colloids and dead cells.—**Daniel Bodroux**: The condensation of cyclohexene with some aromatic hydrocarbons in the presence of aluminium chloride. Toluene and cyclohexene in presence of aluminium chloride give cyclohexyltoluene. The replacement of the toluene by other aromatic hydrocarbons gives analogous products.—**L. Palfray** and **B. Rothstein**: Some derivatives of quinite. A description of the preparation of acetate and benzoates of quinite.—**R. Morquer**: The systematic value of the genera *Dactylium* and *Diplocladium*, especially *Dactylium macrosporum*.—**A Sartory, R. Sartory,** and **J. Meyer**: The influence of radium on the production of the zygospores in *Mucor spinosus* (*Zygorhynchus spinosus*). Zygospores were produced in cultures under the influence of the radium radiation: in the absence of radium, no zygospores were obtained by cultivation in the same culture medium.—**E. Brumpt**: The study of autofecondation in the aquatic mollusc *Bullinus contortus*.—**J. B. Abelous** and **H. Lassalle**: The humoral origin of the modifications of excitability of the nervous system in the course of the Wallerian degenerescence of a severed nerve.—**Emile F. Terroine** and **Mme. Hélène Sorg-Matter**: The influence of the magnitude of the consumption of thermogenesis on endogenous nitrogen metabolism.—**Georges Lakhovsky**: The action on living beings of oscillating circuits.—**Em. Perrot** and **P. Bourcet**: A new method of estimating crystallised digitalin.

LENINGRAD.

Academy of Sciences (*Comptes rendus*, 1928, A, No. 1).—**V. Ipatiev, N. Orlov,** and **B. Dolgov**: The

preparation of certain α-ω-diphenylparaffins. Diphenylpropane may be obtained by hydrogenating dibenzylketone under pressure in presence of nickel at 210° C., using Ipatiev's high-pressure apparatus. Diphenylbutane may be prepared by hydrogenating unsaturated diphenylparaffins (diphenylacetylene and diphenylbutadiene) under pressure at 210° C. Diphenylpentane can be prepared by hydrogenating dibenzylacetone obtained by distilling calcium salts of phenylacetic and phenylpropionic acids.—**P. P. Sacharov**: The hereditary transmission of the size and weight of flies resulting from inanition. The reduction in size and weight of larvæ, pupæ, and adult house flies resulting from inanition is not hereditary, since the progeny of the smallest flies was larger than that of the normal ones.—**P. Kobeko and I. Kurchatov**: The validity of Faraday's law for currents due to ionisation by collision. It has been shown that in an electrical field exceeding 2×10^6 volts/cm., new charges arise due to collision; it has not been ascertained, however, whether the newly formed charges are ions or electrons. The most direct way to solve the question was to test the application of Faraday's law in such conditions. The results of the experiments by the authors show that Faraday's law holds within the limits of errors, and that consequently the charges liberated by the mechanism of collision are ions and, especially in the case of glass, the most mobile, the sodium ions.—**P. Schmidt**: Three rare cat-fishes of the Magdalena River (South America, Columbia). *Doras crocodili* Humb. et Val. is redescribed fully, and *D. longispinis* Steindachner referred to it as a synonym; measurements of *Trachycorystes magdalenæ* Steind. and *Pimelodina flavipinnis* Steind. are given.—**P. Tartakovskij**: The scattering of electrons in a thin aluminium foil. Scattering of electrons by the surface of a crystal is accompanied by interference of phase waves. A diagram analogous to a röntgenogram is obtained containing several maxima the significance of which has not been discovered.

Official Publications Received.

BRITISH.

Memoirs of the Department of Agriculture in India. Entomological Series, Vol. 10, No. 3: A Contribution to our Knowledge of South Indian Braconidae. Part i: Vipioninae. By Dr. T. V. Ramakrishna Ayyar. Pp. 27-60f+plates 5-14. 14 annas; 1s. 3d. Entomological Series, Vol. 10, No. 5: The Use of Hydrocyanic Acid Gas for the Fumigation of American Cotton on Import into India; Experiments on its Lethal Power for the Mexican Boll-Weevil (*Anthonomus grandis*), and for the Grain-Weevil (*Sitophilus oryzae*); on the Extent to which it is absorbed by Cotton and Jute respectively; and on a Practical Method for Satisfactory Fumigation on a large Scale. By A. James Turner and D. L. Sen. Pp. vi+69-160. 2 rupees; 3s. 9d. (Calcutta: Government of India Central Publication Branch.)

Agricultural Research Institute, Pusa. Bulletin No. 173: Occurrence of Trichomonad Flagellates in the Blood Stream of Fowls. By Hugh Cooper and Amar Nath Gulati. Pp. 9+1 plate. (Calcutta: Government of India Central Publication Branch.) 3 annas; 4d.

Journal of the Indian Institute of Science. Vol. 11A, Part 1: i. Studies on Invertase, Part 1: Preparation and Purification of the Enzyme, by B. N. Sastri and Roland V. Norris; ii. Note on a Simple Method for Concentrating Enzyme Solutions, by B. N. Sastri. Pp. 15. Vol. 11A, Part 2: The Bleaching of Lac. By M. Venugopalan. Pp. 17-22. Vol. 11A, Part 3: Contributions to the Study of Spike-Disease of Sandal (*Santalum album*, Linn.); Part i. Diastatic Activity of the Leaves. By M. Sreenivasaya and B. N. Sastri. Pp. 23-29. Vol. 11A, Part 4: A Micro-method for the Determination of Enzyme Activity. By B. N. Sastri and M. Sreenivasaya. Pp. 31-39. (Bangalore.)

Air Ministry: Meteorological Office. International Meteorological Organization: Commission for the Exploration of the Upper Air. Report of the Meeting in Leipzig, August 29-September 3, 1927. (M.O. 300.) Published by the Authority of the Meteorological Committee. Pp. iv+107. (London: H.M. Stationery Office.) 3s. 6d. net.

Transactions of the Royal Society of Edinburgh. Vol. 55, Part 3, No. 26: Schist Geology; Braemar, Glen Clunie and Glen Shee. By E. B. Bailey. Pp. 737-754+1 plate. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 2s. 6d.

Bishop's Stortford College. Report of the Proceedings of the Natural History Society, 1927. Pp. 20. (Bishop's Stortford.)

A Report on the Public Museums of the British Isles (other than the National Museums). *By Sir Henry Miers to the Carnegie United* Kingdom Trustees. Pp. ii+218+8 plates (Dunfermline: Carnegie United Kingdom Trust.)

A Report on American Museum Work. By Dr. E. E. Lowe. Pp. 50+12 plates. (Dunfermline: Carnegie United Kingdom Trust.)

The Scottish Forestry Journal: being the Transactions of the Royal Scottish Arboricultural Society. Vol. 42, Part 1, March. Pp. 34+27. (Edinburgh.) 7s. 6d.

Journal of the Chemical Society: containing Papers communicated to the Society. April. Pp. iv+749-1060+viii. (London: Gurney and Jackson.)

Research Association of British Paint, Colour and Varnish Manufacturers. Review of Current Literature relating to the Paint, Colour and Varnish Industries. No. 1, Jan.-Feb. Pp. 31. (Teddington: Paint Research Station.)

Experimental Researches and Reports published by the Department of Glass Technology, The University, Sheffield. Vol. 10, 1927. Pp. iii+186. (Sheffield.)

Proceedings of the Cambridge Philosophical Society. Vol. 24, Part 2, April. Pp. 171-356. (Cambridge: At the University Press.) 7s. 6d. net.

Journal of the Marine Biological Association of the United Kingdom. New Series, Vol. 15, No. 2, April. Pp. 365-781. (Plymouth.) 12s. 6d. net.

Colony and Protectorate of Kenya. Agricultural Census: Eighth Annual Report, 1927. Pp. 44. (Nairobi: Department of Agriculture.)

Index to the Quarterly Journal of the Royal Meteorological Society. Vols. 27-51, 1901 to 1925. Pp. 71. (London: Edward Stanford, Ltd.) 2s. 6d.

Indian Journal of Physics, Vol. 2, Part 3, and Proceedings of the Indian Association for the Cultivation of Science, Vol. 11, Part 3. Conducted by Prof. C. V. Raman. Pp. 267-398+plates 6-12. (Calcutta.) 3 rupees; 4s.

General Guide to the Durban Museum. By E. C. Chubb. Third edition. Pp. 72. (Durban.) 6d.

The Mining Institute of Scotland. Jubilee, January 1928. Pp. 26. (Glasgow.)

Union of South Africa. Report of the South African Museum for the Year ended 31st December 1927. Pp. ii+13. (Cape Town.)

Board of Education. Syllabus of the Science Scholarships Examination, 1929. Pp. 23. (London: H.M. Stationery Office.) 3d. net.

Stonyhurst College Observatory. Results of Geophysical and Solar Observations, 1927; with Report and Notes of the Director, Rev. E. D. O'Connor. Pp. xxii+48. (Blackburn.)

County Council of the West Riding of Yorkshire: Education Committee. Summer Vacation Course for Teachers, Bingley Training College, August 1st to August 15th, 1928. Pp. 24. Summer Vacation Courses in Physical Training and Swimming to be held at the Grammar School, Ilkley, 30th July-11th August 1928. Pp. 8. (Wakefield.)

Annual Report of the Council of the Yorkshire Philosophical Society for the Year 1927, presented to the Annual Meeting, February 13th, 1928. Pp. 41+12. (York.)

Society of Chemical Industry: Chemical Engineering Group Proceedings, Vol. 8, 1926. Pp. viii+127. (London.) 10s. 6d.

The Quarterly Journal of the Geological Society. Vol. 84, Part 1, No. 333, April 30th. Pp. xlviii+178+12 plates. (London: Longmans, Green and Co., Ltd.) 7s. 6d.

FOREIGN.

Scientific Papers of the Institute of Physical and Chemical Research. No. 131: Experimental Studies on Form and Structure of Sparks, Part i. By Torahiko Terada and Ukitirô Nakaya. Pp. 19+6 plates. 35 sen. Nos. 132-134: Mehanismo de Sapiĝo de Celulozesteroj de Altaj Fatacidoj, de Iĉiro Sakurada; Sapiĝo de Celulozacetato per Alkalio, de Iĉiro Sakurada; Pri Sapiĝo de Celulozacetato dum la Hidratigado, de Iĉiro Sakurada. Pp. 21-61. 50 sen. No. 135: Experimental Studies on Form and Structure of Sparks, Part ii. By Torahiko Terada and Ukitirô Nakaya. Pp. 63-82+plates 6-8. 30 sen. No. 136: The Reversal of Helium Bands. By Toshio Takamine and Taro Suga. Pp. 83-91+plate 9. 20 sen. No. 137: The Effect of Hydrochloric Acid on the Oxidation of Stannous Chloride by Air. By Susumu Miyamoto. Pp. 93-102. 20 sen. No. 138: Experimental Studies on Form and Structure of Sparks, part iii. By Torahkio Terada and Ukitirô Nakaya. Pp. 103-129+plates 10-14. 40 sen. (Tokyo.)

Nebraska Geological Survey. Bulletin 2, Second Series: The Fusilinidae of the Pennsylvanian System in Nebraska. By Carl O. Dunbar and G. E. Condra. Pp. 130+15 plates. (Lincoln, Nebr.)

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 19, Part 3: Protease and Amylase of *Aspergillus oryzae*. By Kokichi Oshima. Pp. 185-244. Vol. 19, Part 4: Embryological Studies in *Oryza sativa* L. By Shinichi Terada. Pp. 245-260+plates 6-9. Vol. 20, Part 4: Chemismus der kombinierten Tannin-Chrom-Gerbung, von Prof. Dr. G. Grasser und Dr. Hirose; Kleinere Experimental-Untersuchungen aus dem Institute für Gerberei-Wissenschaft, von Prof. Dr. Georg Grasser. Pp. 203-232. (Tokyo: Maruzen Co., Ltd.)

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 32: *Researches on Cellulose Acetate and its Solution.* i. Composition of Cellulose Acetate Lacquer for Aeroplane Dope. By Katsumoto Atsuki and Ryo Shinoda. Pp. 49-69. 0.37 yen. No. 33: Researches on Cellulose Acetate and its Solutions. ii. Stability of Cellulose Acetate. By Katsumoto Atsuki. Pp. 71-89. 0.33 yen. No. 34: Researches on Cellulose Acetate and its Solution. iii. Stabilizer for Cellulose Acetate. By Yoshio Tanaka and Katsumoto Atsuki. Pp. 91-101. 0.23 yen. No. 35: Researches on Cellulose Acetate and its Solution. iv. On the Acetylation of Cellulose. By Katsumoto Atsuki and Ryo Shinoda. Pp. 103-113. 0.28 yen. No. 36: Researches on Cellulose Acetate and its Solution. v. Relation of Temperature and Time of Ripening to the Viscosity of Cellulose Acetate. By Katsumoto Atsuki and Ryo Shinoda. Pp. 115-125. 0.28 yen. (Tôkyô: Kôseikai Publishing House.)

Bulletin of the Earthquake Research Institute, Tokyo Imperial University. Vol. 4. Pp. 234+65 plates. (Tokyo.)

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Second Series (Geology), Vol. 11, No. 2: The Triassic Fauna of Rifu, near Sendai. By Hisakatsu Yabe and Saburô Shimizu. Pp. 101-136+plates 10-14. (Tôkyô and Sendai: Maruzen Co., Ltd.)

Bulletin of the American Museum of Natural History. Vol. 56, Art. 6: Geographical Report of the Crocker Land Expedition, 1913-1917. By Donald B. MacMillan. Pp. 379-435. (New York City.)

University of California Publications in American Archaeology and Ethnology. Vol. 23, No. 7: Notes on the Akwa'ala Indians of Lower California. By E. W. Gifford and R. H. Lowie. Pp. 339-352. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) 25 cents.

Mitteilungen der Naturforschenden Gesellschaft Bern aus dem Jahre 1927. Pp. xlvi+376. (Bern: Paul Haupt.)

Meddelande från Lunds Astronomiska Observatorium. Ser. 1, Nr. 114: On the Influence of the Accidental Errors in the Proper Motions on the Velocity Distribution. By L. Hufnagel. Pp. 31. (Lund.)

The Rockefeller Institute for Medical Research: Organization and Equipment. Pp 25+2 plates. (New York City.)

Comité international des Poids et Mesures. Procès-verbaux des séances. Deuxième série, Tome 12, Session de 1927. Pp. vii+121. (Paris: Gauthier-Villars et Cie.)

Bulletins et mémoires de la Société d'Anthropologie de Paris. Série 7, Tome 8, 1927, Fascicule 1-2-3. Pp. xviii+188. (Paris.)

Ministère de l'Instruction publique et des Beaux-Arts. Enquêtes et documents relatifs à l'enseignement supérieur. 122: Rapports sur les Observatoires astronomiques de Province et les Observatoires et Instituts de Physique du Globe. Année 1926. Pp. 95. (Paris: Imprimerie Nationale.)

CATALOGUES.

Pictorial Perfection in Photography. Pp. 36. (London: Burroughs Wellcome and Co.)

The Photo-electrical Recording Photometer. Second edition. (Mess 469/II.) Pp. 7. (London and Jena: Carl Zeiss.)

Artificial Sunlight Apparatus. (Bulletin No. 94.) Pp. 48. Muller Hot Cathode Tubes. (Bulletin No. 95.) Pp. 16. (London: Watson and Sons (Electro-Medical), Ltd.)

Catalogue of Secondary and Higher Text-Books. Pp. iv+228. (London: G. Bell and Sons, Ltd.)

Advantages, Applications and Technology of Nickel Cast Iron. (Series B, Paper No. 3.) Pp. 8. (London: The Bureau of Information on Nickel, Ltd.)

Diary of Societies.

SATURDAY, MAY 19.

MINING INSTITUTE OF SCOTLAND (jointly with National Association of Colliery Managers (Scottish Branch) and Association of Mining Electrical Engineers (West of Scotland Branch)) (at Royal Technical College, Glasgow), at 3.—W. Maurice: Electric Mine Lamps and Better Mine Lighting.—Discussion on paper by J. A. B. Horsley on Design and Maintenance of Flame-Proof Enclosures, with Special Reference to Coal Face Machinery.

PHYSIOLOGICAL SOCIETY (in Department of Physiology, University, Cambridge), at 3.—L. J. Henderson: The Capillary Circulation in Active Muscle.—U. v. Euler and G. Liljestrand: Effect of Adrenaline, Sympathol, Tyramine, Ephetonine, and Histamine on Gas Exchange and Circulation in Man.—G. Stetla: The Concentration of Inorganic Phosphate in Living Muscle.—H. Dryerre: The Effect of Histamine upon the Cardio-Inhibitory Fibres of the Vagus.—G. P. Crowden and M. G. Pearson: The Effect of Cold on the Adrenaline Content of the Supra-renal Glands. (Preliminary communication.)—B. P. Wiesner: Reactivation and Relative Age.—T. R. Harrison, C. S. Robinson, G. Syllaba, and A. Blalock: The Changes in Oxygen Capacity of Blood during Exercise in Man in Normal and Rare Atmospheres.—Dr. W. Cramer: On Temperature Regulation and the Adrenal Gland.—S. Wright: Further Observations on Depressor Reflexes.—J. and D. M. Needham: Protein Metabolism in the Dogfish Egg.—W. E. Dixon and J. C. Hoyle: The Comparative Action of Adrenaline and Nicotine on the Pulmonary Circulation.—H. Florey and A. N. Drury: Mucus Secretion by the Colon.—Dr. E. K. Rideal and C. G. L. Wolf: Oxidations by Special Charcoals.—Dr. G. V. Anrep and H. Häusler: Effect of Arterial Resistance, Heart Rate, Temperature and Ventricular Fibrillation on the Coronary Circulation.—Dr. G. V. Anrep, W. Pascual, and R. Rössler: Respiratory Variations of the Heart Rate.—Kathleen Culhane and Dr. G. W. F. Underhill: Some Factors affecting the Response of Rabbits towards Insulin.—Dr. A. S. Parkes: The Rôle of the Corpus Luteum in the Maintenance of Pregnancy.—J. A. Campbell: Carbon Dioxide and Oxygen Tensions in the Bladder.—A. Hemingway: The Effect of Carbon Dioxide on the Heart.—G. P. Crowden and M. G. Pearson: The Effect of Morphia on the Adrenaline Content of the Supra-renal Glands.—Demonstrations:—Helicoid Structure of Muscle, O. W. Teiga.—Co-ordination of Movements in Animals with Amputated Limbs, A. Bethe.—The Production of High Blood-Pressure in Dogs, H. D. Rolleston and W. E. Dixon.—The Action of Chloroform on the Central Nervous System, W. E. Dixon.—Oestrus and Pseudopregnancy in the Ferret, J. Hammond and Dr. F. H. A. Marshall.—The Effect of Changes of the Heart Beat on the Coronary Circulation, Dr. G. V. Anrep and H. Häusler.—A Modified Cannula for Coronary Perfusion, R. Rössler.—A Method for Measuring the Oxygen Consumption of the *Tortoise* Heart, W. Pascual.—An Approximate Method of Determining the Total Lung Ventilation of Small Animals, H. Taylor.—Precocious Puberty induced by (a) Oestrin; (b) Anterior Pituitary Extract, Dr. A. S. Parkes and G. F. Marrian.—The Vascular Reaction in Response to Fear of the Denervated Colonic Mucosa in the Dog, H. Florey and A. N. Drury.—Improvements in the Thermal Method for following the Velocity of Rapid Processes, Dr. F. J. W. Roughton.—A Method of Measuring the Oxygen Dissociation Curve of Hæmoglobin applicable both to Dilute and Concentrated Solutions, W. H. Forbes and Dr. F. J. W. Roughton.—(a) A New High Speed Electrical Recording System; (b) The Shape of the Action Potential Wave Accompanying a Single Sensory Impulse, B. H. C. Matthews.—(a) Impulse Discharges in Single Motor Nerve Fibres; (b) Sensory Impulses from the Heart, Dr. E. D. Adrian and D. L. Bronk.—A Schema for Studying the Pulse-Wave, J. C. Bramwell.—Records of the Korotkow Sounds, J. C. Bramwell, G. L. Brown, and R. Ellis.—The Effect of Frequent Bleedings on the Spleen of the Rabbit, T. C. Shen.

MONDAY, MAY 21.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. P. Adams: English Hospital Planning.

ROYAL SOCIETY OF MEDICINE (Odontology Section) (Annual General Meeting) (at Royal College of Surgeons), at 8.—Sir Frank Colyer: The Pathology of the Teeth of Elephants.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Dr. J. C. Shattuck: A Journey in Liberia and the Eastern Congo.

MEDICAL SOCIETY OF LONDON, at 9.—Sir Archibald Garrod: Lessons on Rare Maladies.

TUESDAY, MAY 22.

ILLUMINATING ENGINEERING SOCIETY (Annual Meeting) (at Home Office Museum, Horseferry Road, Westminster), at 6.—D. R. Wilson: Presidential Address.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. A. Chubb: The University of Chicago Epigraphic Expedition, Luxor, Egypt. The Photo-Drawing Process of Recording Ancient Egyptian Scenes and Hieroglyphs.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Prof. J. L. Myres: Ancient Greek Physical Types.

INSTITUTION OF MINING AND METALLURGY (Special Meeting in Cornwall) (continued on May 23 and 24).—Annual Meeting, to be followed by a discussion on The Illuminating Engineering Movement at Home and Abroad.

WEDNESDAY, MAY 23.

ROYAL SOCIETY OF MEDICINE (Comparative Medicine Section) (Annual General Meeting), at 5.—Dr. J. P. McGowan: Aplastic Anæmia.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. P. G. H. Boswell: The Geological Features of the New Mersey Tunnel (Lecture).

FOLK-LORE SOCIETY (at University College), at 8.—Miss Sona R. Burstein: The Harrowing of Hell.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Anthropological Institute), at 8.30.—Prof. B. Malinowski: The Melanesian Medicine-Man and his Patient.

THURSDAY, MAY 24.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (East Midland District Meeting) (at Council Offices, Hinckley), at 11.15 A.M.

FRIDAY, MAY 25.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.

INSTITUTE OF CHEMISTRY AND SOCIETY OF CHEMICAL INDUSTRY (East of Scotland and Glasgow and West of Scotland Sections) (Joint Meeting at St. Andrews), at 6.30.—Principal Sir James C. Irvine (Address).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—A. C. Egerton: Engine Knock and Related Problems.

SATURDAY, MAY 26.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 3.—R. White: The Use of Carbon Monoxide Masks in Mines.

PUBLIC LECTURES.

MONDAY, MAY 21.

UNIVERSITY COLLEGE, at 5.30.—Prof. Ross G. Harrison: Modern Trends in the Study of Animal Development.

THURSDAY, MAY 24.

UNIVERSITY COLLEGE, at 2.30.—Sir Flinders Petrie: Recent Discoveries (also on May 25, at 5.30, and May 26, at 3).

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, at 5.—Prof. R. H. A. Plimmer: Some Recent Researches on Vitamins.

IMPERIAL COLLEGE—ROYAL SCHOOL OF MINES, at 5.15.—Dr. E. M. Kindle: Types of Sedimentation on the Atlantic Coast of N. America. (Succeeding Lectures on May 29 and 31.)

CONGRESSES.

MAY 19 TO 28.

CONGRESS OF RADIOLOGY OF THE UNION OF S.S.R. (at Kiev).—Subjects of Discussion:—The Consequences of the Changes of Elements of Cells under the Influence of Radiation. Classification and Radiodiagnosis of Diseases of Joints. Functional and Anatomical Changes of the Gastro-intestinal Canal after Operative Intervention. X-ray-therapy of Diseases of the Circulatory System. Temporary Sterilisation with X-rays. Radiodiagnosis of Intestinal Diseases.

MAY 25 TO 27.

FRENCH SOCIETIES OF OTO-NEURO-OPHTHALMOLOGY (at Marseilles).

SATURDAY, MAY 26, 1928.

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Broadcasting as an Aid to Scientific Study.

"THE modern world," wrote the author of "Arnold of Rugby" in a more recent work, "with its democratic temper which holds in small esteem the traditions of a learned caste, realises that the society of a university may embrace many groups within the State who possess capacity and energy for the serious pursuit of knowledge, even though they are not concerned to complete the courses prescribed for degrees. It [the university] thus becomes an organ for extending the resources of science beyond the limits of the school, it becomes 'an instrument of the people,' placing its resources at the disposal of all members of the State who need its aid. No doubt this ideal is easier to describe than to fulfil: the duty is not fulfilled by merely distributing lecturers or books to miscellaneous audiences; still less by offering instruction of an elementary grade, such as the schools should provide; nor is the ideal attained by ministering only to one class of the community, artisan or other, which can make its voice heard. The university of the future will place at the disposal of all classes, for the common benefit, both the methods of study and the result of research which give to it its special character; and it will discover manifold means by which such a purpose can be achieved." When one considers the potentialities of broadcasting, this description of Prof. J. J. Findlay's seems almost prophetic, though he could not have foreseen the possibility of "taking the mountain to Mahomet" when he wrote "The School."

Broadcasting offers unique opportunities for the encouragement of scientific study. In spite of anti-highbrow campaigns in the daily press, there is undoubtedly an audience of some millions who are finding an interest in the broadcast science talks. In some cases it is the professional interest of a garage mechanic in talks on metallurgy, and in others it is a purely intellectual interest, in talks on, say, astronomy. In any event the audience is certainly there, and it is an audience which cannot be reached in the first place by other means. A small proportion of its members habitually buy scientific reference books or go to public lectures, but large numbers can and do listen to the unseen lecturer. This is probably accounted for by reason of the fact that the value of the broadcast lecture lies in its capacity for awakening and sustaining interest rather than its capacity for supplying information.

The exposition of science in popular periodicals

and in the daily press has not always been in the right hands. There have been notable exceptions, of course, but many articles appear in print which do little more than appeal to a sense of the marvellous. Scientific exhibits also are often regarded as like unto conjuring tricks; and their meaning is not understood. There is a demand for sensationalism and 'latest theories' from an over-credulous public, ready to believe all conclusions without having any idea of the sort of evidence behind them—the experimental work, etc.—and often without any knowledge of the scientific method. We are living in a new age of faith. As a result the conscientious scientific worker is apt to shrink from popular exposition, and too often others have rushed in where he feared to tread.

From time to time there emerge from amongst workers in science, men who combine scientific ability with a gift for the interpretation of experimental work and its dependent theories, in lucid and non-technical language. Such men are all too rare. A great task confronts them, and no opportunity for the dissemination of their influence should be lost. It is of growing importance that there should be a widespread and intelligent understanding of the work of science. Research work is, of course, often carried out by individuals working at the universities, or in their own laboratories, quite independently of public support. The situation is, however, now changing. The extreme specialisation which is becoming the rule necessitates team work and a multiplication of the actual number of workers. Much work will be needed to consolidate the new ground which has been broken so rapidly of late years, and there are signs that an expansion of the research world is actually taking place. The growth of organised State-aided research work and the foundation of research laboratories by large industrial firms will, before long, make it much to the advantage of science to have a sympathetic electorate. It is important that the public should have a sense of proportion of the utility of research work. Work must not be thought worthless because it has no obvious practical application; nor, on the other hand, must research work in pure science be expected to put atomic energy and the transmutation of metals on an economic basis forthwith. A widespread knowledge of scientific principles would, in addition, be of great value to the community.

There is, then, an important field for broadcast lectures of an introductory character which will awaken interest, give a grasp of the fundamental principles involved, and provide sound guidance for further study of a serious nature.

A considerable number of science talks have already been broadcast, but these have so far been of an experimental nature and were intended to investigate the demand for such talks. In the early days of broadcasting, single talks on a variety of scientific subjects were given, but more recently connected series of six or a dozen talks of a more advanced and serious nature have been the rule. (The names of Sir Oliver Lodge, Prof. H. H. Swinnerton, Prof. W. Cramp, Prof. A. V. Hill, and Prof. C. H. Desch are to be seen in the B.B.C. list of lecturers for the past year.) The number of interested listeners is encouraging and seems to justify the development of regular short courses, in spite of the growing competition for programme space.

In a report on Natural Science in Adult Education (Paper No. 8 of the Adult Education Committee of the Board of Education) the comparative neglect of science in adult education is deplored. The explanation given for this neglect is that, in comparison with subjects such as history and economics, there is a shortage of suitable lecturers; that provision for experimental work is always a matter of difficulty; and that in the minds of those attending adult schools science courses savour of technical instruction. When once half-hearted classes have discovered that the science course is intimately related to daily life, and that it stimulates their powers of reflection and judgment, the success of the course is assured. The report cites the interest shown in broadcast science talks as evidence of the great latent interest which is believed to exist.

Attention has recently been directed in these pages to the teaching of science in schools. It has been said, apparently with considerable justification, that the "teaching of science in our schools is parrot work, confined to special subjects, and failing to impart any notion of the scientific method." All the conditions obtaining in the smaller secondary schools combine to produce this state of affairs. The laboratory equipment is inadequate, and there are insufficient supplies to make the construction of apparatus and glass-blowing possible. Stereotyped and exacting syllabuses determine largely the scope and character of school text-books and make insistent demands upon the time available for instruction. Yet a large number of pupils who will go on to science courses at a university are trained under these conditions. The state of affairs is due in part to the school certificate and university scholarship

syllabuses, and in part to limited finance, which leads to inadequate staffing and equipment. Broadcasting, perhaps, can be of assistance here. Some thousands of elementary schools are finding that their staff can virtually be increased by means of the broadcasts to schools that are given daily from the B.B.C. stations, and this year, as an experiment, the B.B.C., in consultation with teachers, has started to give weekly talks for secondary schools. The talks deal with subjects of general interest, on which it is unlikely that there will be authoritative exponents among the school staff, and in science an attempt is being made to give short courses of an introductory character on subjects which are not normally in the school curriculum. The virtual neglect of all sciences other than physics and chemistry in boys' schools, and botany in girls', is much to be deplored. It is not suggested that a number of branches of science should or could be taught in detail, but it should not be possible for pupils to leave school with no more familiarity with science than accrues from the mechanical performance of the usual experiments in physics and chemistry.

There is no doubt that the distribution of university entrants among the various branches of sciences suffers an artificial bias to physics and chemistry. Undergraduates faced with a choice of subjects are chary of embarking on an unfamiliar science, and frequently do so only to make up the requisite quota enforced by the university regulations. With the view of filling the gap in school science teaching, talks on geology and anthropology have been broadcast during the past term, and various other courses, including biology, are projected for the future. An attempt is made to link up the various courses and show how each branch of science depends on its related branches. The talks are given at 4.15 P.M. after the normal school hours, and it is found that groups of pupils stay behind voluntarily to listen.

The desire for intellectual adventure is characteristic of the adolescent, and broadcasting can give the right amount of guidance for private study without destroying the sense of independence which is such a rich source of energy. Both in adult and in adolescent education, broadcasting has a useful sphere of activity, but the extent to which it can be effective depends upon the co-operation and support given by other educational bodies. We ourselves have no doubt as to its potentialities as a means of creating interest in science among the general public and affording a valuable educational aid to the work of the school.

The Societies of Ants.

The Social World of the Ants compared with that of Man. By Dr. Auguste Forel. Translated by C. K. Ogden. Vol. 1. *Pp.* xlv + 551 + 10 plates. Vol. 2. Pp. xx + 445 + 16 plates. (London and New York: G. P. Putnam's Sons, Ltd., 1928.) 63*s*. net.

AUGUSTE FOREL is one of the grand old men of science, a survivor from the heroic heyday of Darwinism, and a welcome reminder, in this epoch of specialisation, that a man can excel in several branches of learning. To the general biologist he is known (not to mention his contributions to comparative physiology, such as his "Senses of Insects") as one of the greatest authorities on ants, both their systematics and their behaviour; he was one of the notable pioneers of neurology and brain anatomy (I recollect, when I visited him in his home above the Rhone Valley, his showing me some brain sections: "You see those," he said, "those were the first microscopic sections of the human brain to be made. I made them, in the 'seventies."); to the medical profession he is a very distinguished psychiatrist; to the sociologist, the author of that arresting book, "La Question sexuelle."

The lover of natural history will rejoice to learn that all these activities had their root in Forel's passion for observing ants. At the age of ten he made an interesting original discovery—that certain small ants lived as thieves in the nests of other larger species; and when only seven he had, without knowing of Huber's classic work, gone far towards an independent discovery of the famous slave-making habits of *Formica rufa* and *sanguinea*. Then came the happy accident. His grandmother gave him a book. It was Huber's publication of 1810, "Recherches sur les mœurs des fourmis indigènes"; Huber himself had been an old flame of hers, and had presented it to her! However, as she said, she had never been able to get through the book: "It was not her style"; but the eleven-year-old Auguste devoured it, and it became his Bible.

Out of Forel's passion to know the habits of ants there came the desire to know more of their structure and physiology; this led him to take up the study of biology; from this in turn he was led to medicine, and thence (with his love for studying behaviour) to psychiatry.

The English-speaking world will be grateful to Mr. Ogden for translating Forel's summary of his main life-work, and to the publishers for the

admirable way in which it is turned out. For it is indeed a classic. W. M. Wheeler's "Ants" is the only book with which it can be compared, and that is perhaps, for all its fascination, a shade stiff for the non-biologist. This is not to say that the layman will by any means always find Forel's pages easy going; but the personal touch and the enthusiasm with which the book is written will carry him over many hard passages.

The whole ant-world is here: and a strange world it is. Here is a classification of the five thousand or so ant species, with the fossil record and probable evolutionary history of the ant stock. Here is their geographical distribution, their anatomy, the physiology of their senses. But more than two-thirds of the two volumes is taken up, as is fitting, in describing and discussing their ways of life—their nest-building, their nuptials and the founding of new colonies, their daily routine, labour and sleep, toilet and games, feeding and language. Then come their diverse specialisations, how some tend cattle, others store grain, others make of themselves living honey-pots, others use child-labour in building their nests; how some are thieves, and others parasites, some predatory nomads, and others base their communities on slavery. Then there is an admirable résumé (Wheeler has put it vividly before us already in his "Social Life Among the Insects," but it is good to have another survey at a somewhat different angle) of the food-economics of the ant-community and of the extraordinary guests and parasites of ants, which include several thousand species of animals not found elsewhere than in ants' nests, some of them with habits unparalleled in strangeness in the whole of the rest of the animal kingdom, save perhaps in man alone. The perversion of instinct occasioned in the ants by the secretions of some of these guests, sometimes leading to the neglect of the ants' own brood, has its only parallel in the abuse of alcohol and other drugs by human beings.

Nor finally must we omit to mention the valuable appendix by Prof. Bugnion on "The War between the Ants and the Termites"—a most interesting study of the competition between the two different types of terrestrial social insects. There will be no biologist who will not gain new facts, new ideas, and new points of view from this storehouse of first-hand knowledge on the most successful type of invertebrate organism; it has obvious interests for the sociologist, for the psychologist, and the student of the origin of language; and it will well repay the general reader.

It would be both impossible and impertinent to attempt any detailed criticism of the book in such a review as this, and I propose to confine myself to some general reflections, inspired by the author's epilogue and the translator's foreword.

Mr. Ogden begins his preface with the words, "There are scientists who hold that in due course Man will yield to the Ant the mastery of a planet grown less hospitable to the relatively idle and unorganised." The author near the close of his work writes, on the resemblances and differences between ants and man, "Among ants we find weavers, butchers, cattle-rearers, masons, road-makers, harvesters, bakers, mushroom-farmers, excellent nurses of various kinds, gardeners, warriors, pacificists, slave-makers, thieves, brigands, and parasites; but we find no professors, orators, governors, bureaucrats, or generals, nor even corporals, nor do we find capitalists, speculators, or even swindlers. Think carefully about that, dear reader, and it will give you the key to the mystery."

The key to the mystery is of course, as Forel points out a few pages later, that, in spite of their antennal language, ants have no tradition in the broad biological sense, no transmission of experience from generation to generation, no real education; and this because their whole behaviour and existence is on a different plane from ours, being based primarily on instinct, while ours owes its distinctive qualities and its biological success to the capacity for conceptual thought or reason, and to the power of rapid learning. Once this is grasped—and, in spite of the lucubrations of non-scientific popularisers, of whom Maeterlinck on Termites is a recent flagrant example, there is no doubt of the reality of the difference and of its fundamental biological significance—it is difficult for anyone, scientist or no, to believe that man will yield his supremacy to ants unless there were to be some very radical and peculiar changes in the conditions of this planet.

Consider the vital differences which this one original difference brings in its train. Man, through tradition, is capable of rapid change in the organisation of his societies, rapid improvement in his control over Nature: ants are confined to the slow changes of random variation sifted by the wasteful hand of natural selection. Man can consciously envisage improvement in his conditions, and deliberately set about the control of his racial destiny; ants can do nothing of the sort. Ants have probably been in existence since the Secondary period; since the Oligocene, perhaps fifty million

years ago, they have not progressed or even changed in any essentials: man did not become man until the Pliocene at earliest, and even since that time, first he and then his societies and traditions have been evolving at an ever-accelerated rate, which shows no sign of slowing down. His species is thus still in its youth, while ants have long reached evolutionary stability. Then there exist some five thousand quite distinct species of ants, biologically separate and mutually sterile: man exists in but one species, whose races are all fertile *inter se*. Man has the longest infancy and the longest period of dependence and education of any organism: ants, after their larval existence as 'growth-machines,' followed by the radical remodelling of their passive pupal period, emerge fully-formed, ready at once to undertake their most elaborate actions, and never grow or moult again. A society of men is based primarily upon a common tradition, and is built round a scaffolding of authority and obedience: a society of ants is based primarily upon a differentiation of instincts, and lacks any central government or system of authority, the obedience of ants being obedience to their own instincts instead of to leaders. The patriotism of men is based upon ideas and tradition: the patriotism of ants is based upon smell.

Finally, and perhaps in a way most striking, the division of labour in human society depends chiefly upon learning to use different tools and technical methods, and there is no structural differentiation into well-marked castes; while that in ant communities depends upon differences present from the moment of emergence, differences not only in the structure of the brain and consequently in the instincts, but also in the general structure of the body. The ant-soldier hatches predestined from its cocoon, with head and jaws already turned into weapons; the human infantryman, however, is not born with one hand in the form of a rifle and the other in that of a lance, but weapons have to be manufactured for him by society, and he has to learn their use. Again, the range of size in normal human adults, including pigmies, is from about 50 lb. to 250 lb. But there are ants (*e.g. Carebara*) in which the members of one caste—the queens—are at least 2000 times as bulky as the worker individuals.

The ants were already in their present position of dominant land invertebrate in the Oligocene. But they were powerless to prevent the evolution of the higher mammalia and of man, or man's subsequent rapidity of progress. There seems no reason whatever why they should, after so long a stable period, re-acquire the capacity for rapid evolutionary change, or suddenly succeed where they have previously failed.

If we ask what is the secret of this failure to attain complete biological dominance, in spite of such large measure of success, the probable answer lies in their small size. This is inherent in the very nature of insectan organisation. The arthropods in general are limited to sizes far below those attained by cephalopods and vertebrates, owing to the necessity of shedding and re-forming their skeleton in order to accomplish each step in growth. The insects are limited to a much smaller maximum size, as Mr. J. B. S. Haldane has pointed out, owing to their system of respiration. The transport of air direct to the tissues by tracheal air-tubes is extremely efficient for small organisms; but it depends upon diffusion, and diffusion will not be efficient in tubes of more than a certain length. No insect attains more than an ounce or so in weight; and the more active ants are mostly far smaller. This small size limits the number of cells in the brain, and this in turn limits the development of mental faculties; for it appears to be necessary to have many more cells to be capable of rapid learning than for even the most elaborate of instinctive reactions. Had ants been capable of attaining the size of dogs, or even of rats, the course of evolution might well have been very different. . . .

It is to be regretted that Forel has not kept in touch a little more with recent work in heredity, sex, and kindred subjects, for some of his generalisations and explanations are marred by being quite out-of-date: we may cite particularly his discussion of sex-mosaics among ants. In evolutionary theory, he attempts to combine natural selection with Lamarckian views based on Semon's "Mneme." But, as Bateson once put it, to explain heredity by memory is to attempt an explanation of the less in terms of the more complex—as well, be it added, as having no foundation in experimental fact. He asserts with extraordinary dogmatism (vol. 1, p. 15) that those who claim that the castes of ants are determined (as he admits is the case in bees) by feeding, are in error. "They are wrong: polymorphism in ants takes place in the egg." But no proof is given of this, and the evidence that does exist is certainly not against that natural hypothesis. Bugnion's assertion, by the way, which Forel cites on the same page, that the *nasutus* soldier of Termites emerges fully-differentiated from the egg, has since been shown to be erroneous, and the Italian school is making

it quite possible that even Termite castes owe their origin to diet-differences.

However, these are minor points. The book is a great book, full of the meat of fact and the wine of thought, and fragrant with the personality of the author. We are happy that he has lived long enough to crown his eighty years of labour with this monument. J. S. HUXLEY.

The Almagest of Ptolemy.

Composition mathématique de Claude Ptolémée. Traduite pour la première fois du grec en français, sur les manuscrits originaux de la Bibliothèque Impériale de Paris, par M. Halma, et suivie des notes de M. Delambre. (Réimpression facsimilé.) Tome premier. Pp. lxxvi + 476 + 48. Tome deuxième. Pp. viii + 448 + 40. (Paris: J. Hermann, 1927.) 2 vols., 210 francs.

THE publication of this facsimile of Halma's handsome edition of the Syntaxis of Ptolemy shows enterprise on the part of the publishers and will no doubt be welcomed by mathematicians and astronomers interested in the history of their subjects, as copies of the original book have long been scarce. Until the issue of Heiberg's definitive text in 1898 and 1903, Halma's was the only modern edition of the whole of the Greek text, and it has the merit of containing, in addition to a French translation facing the text, a large quantity of notes by Delambre as well as an elaborate historical introduction. Halma also had only one predecessor, Simon Grynæus, the editor of the *editio princeps*, containing the full Greek text with the commentary of Theon of Alexandria, which was published at Basel in 1538, previously to which date scholars had to be content with translations from the Arabic or epitomes of such versions.

The Abbé Nicolas Halma (1755–1828) studied first at the College of Sedan, his native place, and afterwards at Paris. Besides Greek and Latin, he learned Hebrew, German, English, and Italian; he also studied mathematics, geography, theology, medicine, poetry, and even drawing. Principal of the College of Sedan from 1791 until its suppression, he moved to Paris and, after holding various other posts, became professor of mathematics and geography at the Prytanée in Paris, professor of geography at the École Militaire at Fontainebleau, librarian to the Empress, and her instructor in history and geography. It was Delambre who, knowing that Halma combined with his accomplishments as a Greek scholar the necessary mathematical ability, urged him to undertake a work which would, he knew, be difficult but would be as honourable to him as it would be useful to science. After several years of hard work he produced the first volume in 1813. The times were not propitious, and he had to pay the cost of its production (about 30,000 francs) out of his own pocket. The second volume appeared in 1816; it was dedicated to Louis XVIII., with a preface in which that monarch was compared to Antoninus Pius, the patron of Ptolemy; the Ministry of the Interior subscribed for 225 copies and, with this encouragement, Halma decided to add to his edition certain minor Greek astronomical treatises as well as the commentary on Ptolemy by Theon. Of the latter commentary, however, only two Books actually appeared, in 1821 and 1822.

The *editio princeps* of Grynæus had been based on a MS. of the sixteenth century (Paris. 2393), a copy, at second hand, of another written in the ninth century which is the first of those used by Heiberg as the basis of his text. Halma used Grynæus's text as his groundwork, but consulted, in addition, four of the MSS. which are the main foundation of Heiberg's text. Unfortunately, Halma's philological qualifications were not quite adequate to enable him to produce a really authoritative text; while Manitius, the editor of the German translation of Heiberg's text (Teubner, 1912, 1913), says that in most of the difficult passages the French translation leaves us in the lurch. Nevertheless, with all its faults, Halma's edition will always retain its great historical interest. T. L. H.

Infection and Immunity in the Bee Mite.

L'Infection microbienne et l'immunité chez la mite des abeilles, Galleria Mellonella. (Monographies de l'Institut Pasteur.) Par S. Metalnikov. Pp. iv + 139. (Paris: Masson et Cie., 1927.) 18 francs.

THIS monograph gives an account of researches carried out at the Pasteur Institute over a period of more than ten years on the microscopic infection and immunity in the mite of bees. This insect, which has been of interest to scientific workers since Aristotle, is peculiar in that it is the only known animal which derives its nourishment from wax. The present work, in fact, shows that wax in some form is essential to its life and development. Ordinarily, the night-flying moth deposits its eggs in the hives of bees, where they hatch and pass through the successive stages to the fully-developed winged form. In the larval stage it

feeds upon the wax of the bees, and although experiments have been carried on with the insect in all stages, it is upon the larval one that the bulk of the present work has been done.

The author begins with an account of the biology and physiology of the insect. He has successfully cultivated it under laboratory conditions and made a minute study of its digestive apparatus and nutrition. It has, in fact, become in his hands a laboratory animal which lends itself to most types of experiments. Then the question of infection and immunity is dealt with. By injection of small and large doses into the body cavity, he has been able to determine whether and to what degree natural immunity exists. Immunity is hereditary, providing several generations have been immunised. A chapter on phagocytosis describes in detail the types of cells and the part played by each. The reaction is apparently specific for each organism, and is demonstrated by changes within the protoplasm of the cells. For example, an injection of tubercle bacilli brings about in a few minutes the formation of granules, followed in several hours by the formation of a giant cell. The leprosy bacillus, on the other hand, is clumped within single cells, and the cholera vibrion leads to formation of vacuoles.

The part played in immunity by the nervous system is striking. The third pair of thoracic ganglia is intimately concerned in that its destruction results in loss of ability to become immune. The remainder of the nervous system seems to have no such connexion and may be damaged without affecting immunity. A special chapter deals with tuberculosis. The fact that wax in some form is essential to the life and development of the larvæ makes it peculiarly suitable for experiments with the tubercle bacillus. The larvæ, also, have a complete natural immunity to this organism. The defence mechanism is shown to be similar to that of man and the higher animals, except that in the larvæ the process is much more rapidly brought about, being a matter of hours only. This rapid response is thought to be due to a cellular lipase, probably of the same order as that postulated by Metchnikoff and Koch. It is by an increase in this substance that favourable results in clinical tuberculosis are obtained, and, in the author's opinion, proper treatment favours such an increase.

In the final chapters the phenomenon of anaphylaxis and the factors in immunity are discussed. In connexion with the former it is interesting to note that anaphylactic shock cannot be induced by foreign proteins such as horse serum, but is brought about by blood from the same larva or one of the same or related species. The factor involved seems to be the altered state, apparently by oxidation, of the injected blood. In immunity the part played by the cell is stressed throughout as the factor of first importance, that of antibodies being secondary.

The subject is well presented and contains much useful material on a subject of importance to biologists generally. Throughout the monograph references are quoted and discussed.

The Basic Science.

A Short History of Physics. By H. Buckley. Pp. xi + 263. (London: Methuen and Co., Ltd., 1927.) 7*s.* 6*d.* net.

THE degree to which specialisation has been advanced in every branch of science, coupled with the not unnatural desire on the part of university teachers to equip their students with the necessary technical knowledge to encourage further advances in even more specialised fields, tends to discourage students of science from delving into the history of the earlier developments of their particular subject matter, particularly if this knowledge has to be culled from a large number of different works, not always easily accessible. For some time past attention has been given to remedying this defect. The University of London has founded a chair in the 'history of science,' and already several excellent volumes have been published giving a broad survey of the outstanding contributions of scientific investigators to the progress of scientific thought and the harnessing of natural forces in the service of men. The Cambridge University Press and other publishing houses have also printed series of volumes with the same object in view.

This "Short History of Physics" by Mr. Buckley is most welcome. It is to be hoped that he will be encouraged to write a long one, for this is a most stimulating production. Within the small compass of 250 pages the author ranges over the field of physics from the earliest recorded physical observations to the latest developments of the theory of relativity, the quantum theory, and the latest experimental work on the structure of the atom. Most of his chapters are models of compression and clarity, no salient fact escaping his attention, while his selected quotations from the writings of the great ones of physics are the quintessence of appositeness. Possibly he over-emphasises the influence exerted by the Greek philosophers, culminating in

Plato and Aristotle, and under-estimates the effect of great historical events in stemming the advancing tide of learning: but his tribute to the debt which civilisation owes to the Arabs is welcome at a time when we are apt to regard their descendants as crude barbarians.

The last chapters are the least satisfying from the point of view of historical study, though unquestionably of the greatest value to the advanced student of physics. Not that Mr. Buckley can be held responsible. Modern physical theory has not yet reached that stage of perfect clarity which characterised the work of the investigators of the preceding two centuries. Their work could be explained in terms of fairly familiar concepts, whereas some modern theories make almost impossible demands upon the imagination of those without more than a fair amount of mathematical knowledge. Eddington and Jeans, it is true, are making them plainer, but still not plain enough for the average well-educated member of the community to comprehend their full significance. It is interesting to speculate whether the intellectual gulf separating the great physical scientists from the rest of their fellows is not greater now than at any previous period in the world's history; whether they have not usurped the place of the metaphysicians.

A. G. C.

Our Bookshelf.

Müller-Pouillets Lehrbuch der Physik. Elfte Auflage. Herausgegeben von A. Eucken, O. Lummer, E. Waetzmann. In fünf Bänden. Band 5: *Physik der Erde und des Kosmos (einschl. Relativitätstheorie).* Zweite Hälfte: *Physik des Kosmos (einschl. Relativitätstheorie).* Herausgegeben von August Kopff. Pp. xii + 596 + 14 Tafeln. (Braunschweig: Friedr. Vieweg und Sohn A.-G., 1928.) 36 gold marks.

The volume on the "Physik des Kosmos," which forms one number of Müller-Pouillet's "Lehrbuch des Physik," gives an interesting up-to-date account of astrophysics, looked at from the physicist's point of view. It is edited by Dr. Kopff of Berlin-Dahlem, with chapters by different specialists such as Prof. Emden, who writes on "The Sun." The German style is on the whole easy and readable, the descriptions of instruments and methods clear, and the work of a high standard of accuracy. As is perhaps inevitable in a work composed by a number of different authors, there is occasional overlapping and a lack of balance between the different branches of the subject. The work of the English mathematicians is very fully discussed, especially the theories of Prof. Eddington. References are freely given in some chapters, but more might have been given with advantage in other chapters, for example, Chap. iii., especially in the summary of theories of stellar radiation at the end. Many familiar photographs are to be found illustrating the chapters on clusters and nebulæ, two chapters which seem rather long for the scale of the book. On the whole, the book deals rather more with stellar statistics than would seem to be necessary if written primarily for the physicist.

The chapter on cosmogony is interesting. Prof. Kienle is, on the whole, somewhat too content to give the views of others and does not often express his own views. Where he does do so definitely, the reviewer is not generally able to agree with him, but it must be admitted that Prof. Kienle is both fruitful and suggestive in emphasising fresh points of view. The chapter on relativity is interesting both historically and as giving a reasonably short description of both the special and the generalised theories and their applications to astronomy. Very few mistakes have been noted, but the line of unknown origin of wave-length 5316·87 A. has long been known. It may be natural that the English reader and the German writer should feel different needs in the matter of references, but for at least one reader who wishes to go behind the text of the book, its value would have been enhanced considerably by a fuller use of references to original work.

F. J. M. Stratton.

Religious Conversion: a Bio-Psychological Study. By Prof. Sante De Sanctis. Translated by Helen Augur. (International Library of Psychology, Philosophy and Scientific Method.) Pp. v + 324. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1927.) 12*s*. 6*d*. net.

This treatise on religious conversion by the professor of psychology in the University of Rome is of importance. The author defines conversion as "an exceptional process representing an intellectual and moral regeneration of the person in whom it occurs"; but its etiology is "far too complex to allow us to ascribe it to disease, age, endocrine variations, or the like." Of its psychic antecedents the experience of suffering, whether of illness, domestic misfortune, moral perturbation, or some similar condition, seems the most common. With regard to the suddenness of onset of conversion, this is probably less definite than appears to the patient, since "an emotional shock suffices to blot out mnemonic pictures nearest to the event itself." Yet Prof. De Sanctis does not regard the process as dissociated from the will of the patient. Lasting effects upon the consciousness cannot be produced "unless it has been adapted by preparation and unless it assumes a decisive attitude of action"; and Ruysbroeck's saying is quoted, "You are saints according to the measure of your desire to be such."

In short, Prof. De Sanctis does not pay to Freudian theories all that tribute of uncritical respect which has become customary. He uses the happy term 'mutation' to describe the process and results of conversion; old elements of personality are so recombined as to give birth to entirely new quality of life. It will be seen that this involves

the spontaneity of the *psyche*, which is to be regarded as a form of activity *sui generis* "regarding whose essence and origin psychology should remain entirely agnostic." This book displays an independent point of view and will be read with much interest. J. C. H.

Regeneration und Transplantation. Von Prof. Dr. E. Korschelt. Band 1: *Regeneration.* Pp. xii + 818. (Berlin: Gebrüder Borntraeger, 1927.) 60 gold marks.

PROF. KORSCHELT'S modest book of 1907 is now swollen almost beyond recognition. The second edition of "Regeneration und Transplantation" is a massive volume of eight hundred pages dedicated to the four hundredth anniversary of the University of Marburg. That the work of twenty years should involve the printing of some six hundred additional pages is no doubt evidence of progress; it is also a very depressing fact, for it tends to limit the interest in a definite and fundamental property of living animals to a select band of specialised individuals instead of providing for the needs of a more numerous public. At the same time, an encyclopædia has its uses, and when it is written by Prof. Korschelt, it will long remain a source of accurate information and instruction.

The arrangement of the book is good, and most of the illustrations are new and helpful. Without doubt, the author has provided by far the most comprehensive text-book available, and it is regrettable that some sections are strangely inadequate. The phenomena of autotomy and regeneration in the Crustacea are described as though they were in the same nebulous state as those of other groups. This is unfortunate, for the physiological mechanisms involved are now adequately known, and they should not have been omitted from a work of this nature.

Prof. Korschelt's second volume will deal with the more exciting results of transplantation, and it will be awaited with interest. At present we have to thank the author for collecting into one volume the scattered results of many researches, and for presenting them in a not too forbidding form.

The Journal of the Institute of Metals. Vol. 38. Edited by G. Shaw Scott. Pp. xii + 813 + 59 plates. (London: Institute of Metals, 1927.) 31*s.* 6*d.* net.

A FEATURE of the new volume of this Journal, containing the papers presented at the last autumn meeting of the Institute, is the attention given to the accurate determination of equilibrium diagrams, in which English metallurgists are now taking the lead. Mr. Hume-Rothery has re-determined the system magnesium–cadmium; this system has been included in all text-books on account of its unique constitution, but it now proves to be incorrect, although the system still shows several interesting peculiarities. A revision by Mr. Raper of one of the most discussed portions of the copper–tin diagram again shows the essential accuracy of the original work of Heycock and Neville, modified as it has been in minor details. Several papers deal with ternary systems. A memoir by Miss Gayler on some of the light aluminium alloys is of interest as containing the first determination of the supersolubility curve, as found by Miers in various nonmetallic systems, for a series of alloys. It has importance in connexion with the modified structures of such alloys as those of aluminium and silicon. Age-hardening has been measured in alloys of magnesium as well as in those of aluminium, and a paper on this subject is contributed from the Berlin aircraft experimental station, whilst the Royal Aircraft Establishment contributes two papers on the anodic protection of aluminium against corrosion. The standard of the contributions is high. Dr. Aitchison has given an interesting lecture on the use of non-ferrous metals in transport, and the volume contains the usual very thorough abstracts of the literature.

Statistique mathématique. Par Prof. G. Darmois. (Encyclopédie scientifique: Bibliothèque de mathématiques appliquées.) Pp. xxiv + 363. (Paris: Gaston Doin et Cie, 1928.) 32 francs.

THIS is a very readable account of the applications of the theory of probability to statistics. A knowledge of the calculus is assumed. In England the treatment of probability except for specialists has suffered from an excess of amusing but useless developments, and as a reaction against this the subject has lately been neglected. Now that the calculus is learnt at a much earlier stage than was formerly customary, it is possible that an elementary course might be devised which would have its value as leading up to the kind of work dealt with in this volume. Apart from the question of educational value, a knowledge of the elements of probability might serve as a corrective against the extraordinary views held by the man in the street about chance, and the mathematician should not ignore a movement towards the re-introduction of the subject, however unwilling he may be to add to his syllabus. A. R.

Royal Botanic Gardens, Kew. Popular Official Guide to the Royal Botanic Gardens: including an Historic Notice and Descriptions of the Collections in the Botanic Gardens proper, the Glasshouses, Museums, and Arboretum. Second edition. Pp. 118. (Kew: Royal Botanic Gardens, 1928.) 6*d.* net.

THE plan of this new guide to the Royal Gardens at Kew is well described in the title. The material in it has been thoroughly revised and brought up-to-date and has been set in a new style. The guide contains an interesting account of the history and functions of the gardens, and each section is clearly described and the outstanding species noted. With this guide in hand, the visitor, whether botanist or layman, needs no other directions for an intelligent and profitable tour of the famous gardens. The key plan at the beginning of the book has been done in some considerable detail, and will be useful to those wishing to visit any particular spot or examine particular types of plants.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

X-ray Studies on the 'Nitrides' of Iron.

EXPERIMENTS made by Fowler, Baur and Voermann, White and Kirschbraun, and Tschischewski show that iron 'nitrides' with a maximum amount of about 11 per cent nitrogen are formed when ammonia is led over heated iron. The most favourable temperature for the reaction seems to be about 450° C. Some of the authors are of the opinion that definite chemical compounds, that is, nitrides, are formed, while others consider the products to be

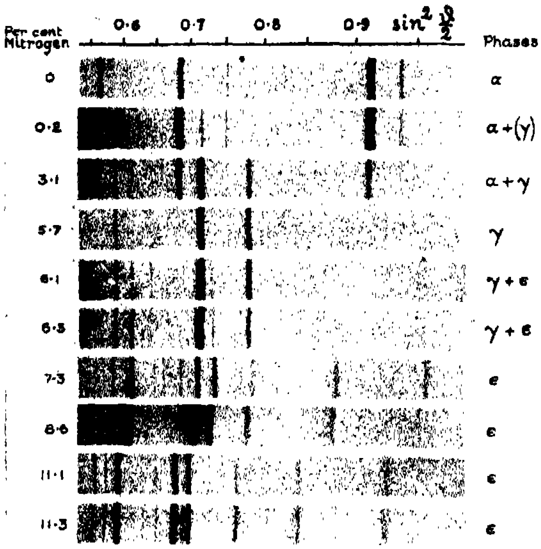

FIG. 1.

solid solutions of nitrogen in iron. Studying the iron-nitrogen system by means of X-rays, I have found the latter opinion to be the correct one.

Pure iron, obtained by reducing carefully prepared iron oxide with hydrogen, was treated with pure ammonia in a porcelain tube heated in an electric furnace. The temperature was measured with a nickel-nichrome thermo-couple. The chemical analyses of the products were done according to different methods. The maximum amount of nitrogen was found in a preparation containing 11·3 per cent nitrogen. It may be pointed out that no trace of hydrogen could be shown.

The X-ray analyses were carried out by the powder method in three focusing cameras using the *K*-radiation of iron.

The structure of the 'nitrides' was found to be dependent only on the nitrogen content and not on the conditions (temperature, duration of treating with ammonia, etc.) under which the 'nitride' was prepared.

Photograms of the most deviated lines from preparations with different contents of nitrogen are compared in Fig. 1. Already at 0·2 per cent nitrogen very faint lines belonging to a face-centred cubic (=close-packed cubic) phase (γ) appear, and at 5·7 per cent nitrogen all lines of α-Fe have disappeared. The lines of the α-Fe do not change their positions, which shows that its lattice dimensions remain constant. The lines of the new phase also remain fixed with increasing nitrogen content. The edge of the elementary cube is 3·789 A., which is somewhat larger than the parameter of pure γ-Fe (=3·6 A.), but as the existence range of this new phase at high pressure certainly will join the existence range of γ-Fe, it seems justifiable to give this phase also the denomination γ.

The γ phase is therefore to be considered as a *solid solution of nitrogen in γ-Fe. The iron atoms* are arranged in a cubical close-packed lattice, and the nitrogen atoms are located in the interstices between them. The distance between the centres of the iron atoms is $a/\sqrt{2}=2\cdot679$ A. Nothing in the photograms indicates regular distribution of the nitrogen atoms.

Between 5·7 and 6·1 per cent nitrogen, new lines belonging to a hexagonal close-packed phase (ε) appear. The new lines are at first fixed, showing the existence of a two-phase range. Between 7·3 and 8·6 per cent nitrogen, however, the lines begin moving inwards, showing an increase in the lattice dimensions. The percentage at which the homogeneous range begins is estimated to lie between 7·5 and 8 per cent nitrogen. The parameters of the ε phase are here, $a=2\cdot695$ A. and $c=4\cdot362$ A. (axial ratio $c/a=1\cdot619$). In this case, when the atoms are not absolutely spherical, one has to distinguish two values of distances between the centres of adjacent atoms. One is $=a=2\cdot695$ A. and the other (the shorter of the two) is $=\sqrt{\frac{a^2}{3}+\frac{c^2}{4}}=2\cdot679$ A. The latter accurately coincides with the shortest distance between the atom centres in the γ phase.

As more nitrogen enters the ε phase, the parameters increase, c, however, relatively less than a, so that c/a decreases.

In the photogram of the preparation with the maximum nitrogen percentage of 11·3, some of the lines are split, owing to the fact that the preparation consists of two parts with different nitrogen content. As c is not very sensitive to changes in the nitrogen content, the lines will be the more split the greater the angle the reflecting net plane forms with the basal plane. In this photogram the part richest in nitrogen has the parameters $a=2\cdot782$ A. and $c=4\cdot419$ A. ($c/a=1\cdot588$).

The ε phase may evidently be considered to be a solid solution of nitrogen in a hexagonal close-packed form of iron, where the nitrogen atoms are situated in the interstices between the iron atoms. No photograms of this phase show any lines indicating a regular distribution of the nitrogen atoms.

There seem to exist several analogies to this type of solid solutions in other systems; for example, the tungsten and molybdenum carbides described by Westgren and Phragmén, the nickel hydride described by Bredig and Allolio, and probably the copper hydride described by Müller and Bradley. The hexagonal close-packed form of chromium which Bradley and Ollard showed in some preparations of electrolytic chromium might also be an analogous hydride.

It is of interest to note that some of the concentration limits of the homogeneous phases lie very close to stoichiometric proportions of iron and nitrogen. Thus, the upper limit of the γ phase, which, as already mentioned, seems to lie between 5·7 and 6·1 per cent nitrogen, might coincide with the formula Fe_4N with 5·9 per cent nitrogen. In the same manner, the lower limit of the homogeneous ε phase, which was supposed to lie between 7·5 and 8 per cent nitrogen, might coincide with the formula

Fe_3N with 7·72 per cent nitrogen. It is also worth mentioning, that all recent investigators of the iron-nitrogen system put the upper limit of nitrogen concentration attainable at atmospheric pressure to slightly above 11 per cent nitrogen, which is close to the formula Fe_2N with 11·14 per cent nitrogen. These coincidences may of course be only accidental, but it is also possible that they are related to certain concentrations of valency electrons.

In recent years the method of treating iron with ammonia has sometimes been used in industry to obtain very hard surfaces (cf. the articles by A. Fry in the *Kruppsche Monatshefte*, 1923 and 1924). With the purpose of showing to what extent an iron surface will be 'nitrated,' a thin iron sheet was heated in ammonia for four hours at 450° C. The thin grey film on the surface caused rather strong γ lines and weak ϵ lines to appear in the photogram.

The fact that the iron 'nitrides' are solid solutions of nitrogen in iron will also furnish a possible explanation of the action of iron as a catalyst in the Haber ammonia process. The catalysing substance is there prepared by reducing iron oxide with ammonia and will therefore consist mainly of iron 'nitride.' The nitrogen dissolved in the iron is probably monatomic, and as such must be expected (cf. 'active' nitrogen) to react easily with hydrogen, forming ammonia.

A more detailed report on this investigation will be published later.

The experiments are being continued with 'nitrides' of other metals.

GUNNAR HÄGG.

Institute of Metallography,
Institute of General and
Inorganic Chemistry of the University,
Stockholm, April 5.

The Colour of the Peacock's 'Eye.'

I HAVE for some time past been experimenting at intervals on this subject. There has been much debate as to whether the animal colour in this and other difficult cases is due to pigments, or to a structure on a scale comparable with the wave-length of light, which gives colour by interference. It is not proposed here to embark on this controversy, but to mention some observed facts, reserving discussion for the present.

If the feather is exposed to strong ultra-violet radiation from a quartz mercury lamp placed a few inches away, the colours soon begin to alter, for the most part becoming less brilliant. The effect is noticeable after an hour, and conspicuous after several hours. It is convenient to screen half the feather, thus reserving it as a standard of comparison. The various zones of colour are affected in different ways, entirely new tints being produced in certain cases. This shows the complexity of the phenomenon. I am not ready to give a full description at present. The effects are naturally different for the different zones as we go out from the centre of the 'eye,' and depend also on the obliquity or otherwise of the reflection.

The conditions are simpler if we examine the feather through a monochromatic filter. Two striking cases may be mentioned. For the sake of description, I consider the feather as showing four chief zones, disregarding minor and transitional zones of colour. The four are numbered from the innermost.

Examining the feather in sunlight at normal incidence through a red filter, it is found that the second zone is made notably brighter, and the third notably darker than it was before exposure. If we use oblique incidence and a blue filter, it is found that exposure has made the second zone much darker, and the fourth zone, including the straggling outer portions of the feather, much brighter than originally. This observation is most striking if we use a glass mercury vapour lamp as illuminant, because it is rich in blue rays.

Prolonged exposure (hundreds of hours) to the quartz mercury lamp destroys the colour of all the zones entirely, leaving only a black background, on which, however, the position of the zones formerly seen in colour can be distinguished.

Experiments of the same kind have been made on some other cases of brilliant animal colours. It may be mentioned that the colour of the brilliant blue butterflies from Brazil, used in making 'butterfly jewelry,' is almost immediately affected, and after a few hours entirely discharged. On the other hand, the golden beetles, in which I was able to detect interference spectra (*Proc. Roy. Soc.*, A, vol. 103, p. 233; 1923), are entirely unaffected by very prolonged exposure, running to hundreds of hours.

RAYLEIGH.

Terling Place,
Chelmsford, May 10.

Hardness of Alloys.

IN a letter to NATURE, published in the issue of May 7, 1927, I gave curves showing the hardness of some alloys of copper in terms of the percentage of the alloying metal. I here add similar curves for alloys of lead with antimony, tin, and bismuth (Fig. 1).

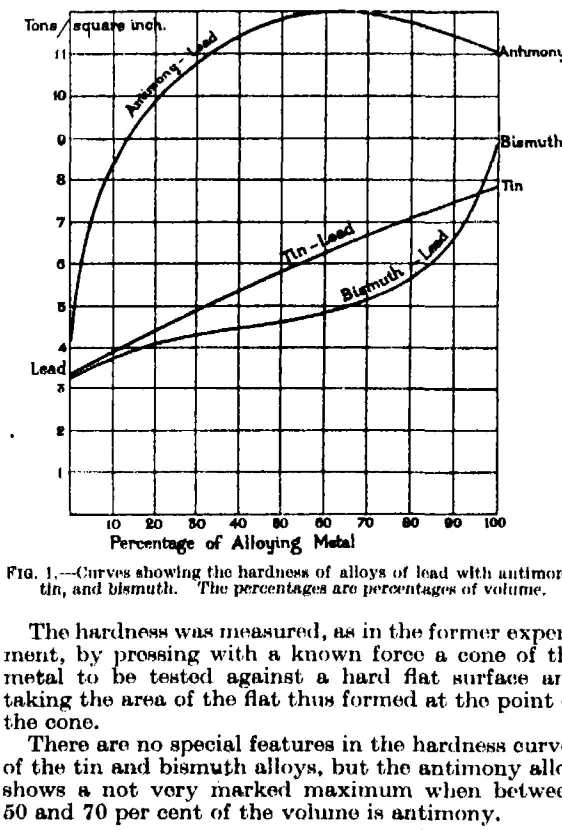

FIG. 1.—Curves showing the hardness of alloys of lead with antimony, tin, and bismuth. *The percentages are percentages of volume.*

The hardness was measured, as in the former experiment, by pressing with a known force a cone of the metal to be tested against a hard flat surface and taking the area of the flat thus formed at the point of the cone.

There are no special features in the hardness curves of the tin and bismuth alloys, but the antimony alloy shows a not very marked maximum when between 50 and 70 per cent of the volume is antimony.

A. MALLOCK.

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Exeter.

The Quantum Postulate and Atomic Theory.

EVERY physicist is greatly indebted both to Prof. Bohr for committing to paper, and to NATURE for printing, the admirable account of the new wave mechanics entitled "The Quantum Postulate and the Recent Development of Atomic Theory," which appeared as a Supplement to the issue of April 14. It sets out in an extraordinarily luminous manner the essentials of the new ideas.

Bohr speaks of a 'complementarity,' which is a duality of observed phenomenon and observing mechanism. He points out that in the delicate observations involved in the study of interactions between atoms, or between atoms and radiation, the two are no longer separable but become two aspects of one whole. I wish to suggest that Bohr's complementarity is rather a trinity, of which the third member *is the 'conscious' observing mind. It will* be seen in the sequel that this leads directly to an explanation of the origin of the quantum.[1] The extension is, indeed, clearly involved in Bohr's statement: the demarcation between subjective and objective disappears, as he says in his conclusion, and the subjective involves at least the living factor, which is a part of consciousness.

The three are one. Consider, for a moment, the observation of a spectrum band (not line) of the hydrogen spectrum, seen by the eye. The energy of the band is contained within a small but finite width: we are accustomed to associate with it a definite wave-length, but such a narrow band, covering a range of wave-lengths, is more properly represented by a succession of wave-groups with indefinite boundaries, following one another with a certain frequency: we may speak of this as a series of 'beats.' The eye must be attuned to the beats and will absorb their energy by resonance: the response of the resonant mechanism, whatever it may be, requires time. The response is thus associated with a quantity of dimensions energy × time, and I suggest that there is a minimum of this 'action,' a *minimum visibile*, a *minimum sensibile*, to which the eye, with the mind behind it, will respond. Quantum theory tells us that this is the same, or approximately the same, for different colours.

Let us accept this suggestion as an hypothesis, and reconsider our point of view. Starting from the observer end of the 'trinity,' what the eye receives is a series of 'beats,' associated with a certain frequency. Tracing the energy back to our conception of a spectrum, we represent this energy by $\int I d\lambda$. λ, the 'line' wave-length, is at once seen to be no longer definite: it is an abstraction, the boundary merely of an integral field. The quantum, which experiment has shown to be constant, is the 'real' thing: its basis is the human possibility of perception. Hitherto, in our conceptions of spectra, we have started from the abstraction, the wave and the wave frequency: we ought to start from the quantum, with its associated beat frequency, dependent on the eye mechanism, and we can, of course, at once reproduce the conception, the wave. The same idea follows through all encounters of atoms and atoms, atoms and radiation, using the method of resolution of the Hamiltonian 'action' into wave-groups, as suggested by wave mechanics.

Every observation is a trinity in unity. Every physical quantity, the result of such observation, is expressed in terms of three units, of length, time, mass, but preferably for our present purpose of length, time, action. Every event perceived involves all three: we can leave out one in our conceptions for convenience, but in any full description of the event, that is, of our perception, all three are involved as part of one whole. We can change the measure of any one with consequent changes in the measures of the other two; but there is a *minimum sensibile* which fixes a limit *to the whole, a subjective unit; to talk* of its absolute size is meaningless; the measurements in Lilliput would be indistinguishable, save by external omniscience, from those in London.

It will be seen from the preceding paragraph that the limiting velocity of Einstein, the velocity of light, at once follows from the general conception. We *never need to use a greater velocity in describing our* perceptions. Quantum theory completes and rounds off the theory of relativity into one consistent whole.

The *minimum sensibile* in the above, it will be noted, is a *minimum visibile*. The *minimum sensibile* is not necessarily the same for other sense perceptions.

In "Space, Time, and Gravitation," Eddington wrote: "We have found a strange foot-print on the shores of the unknown. We have devised profound theories, one after another, to account for its origin. At last we have succeeded in reconstructing the creature that made the foot-print. And lo! it is our own." No words more apt could be written in relation to quantum theory.

I wish to say one final word. All the ideas contained in the above are to be found in Bohr's paper. He speaks even of the 'individuality' associated with an event. I have but rearranged the setting of the picture. F. J. SELBY.

Teddington, May 1.

[1] I use throughout the quantum of 'action,' Planck's constant h.

The Application of the Irregular Doublet Law to Complex Spectra.

PROF. M. N. SAHA and Mr. P. K. Kichlu have recently (NATURE, Feb. 18, p. 244) shown that the irregular doublet law, which has been applied by Millikan and Bowen to locate approximately the spectra of elements which are reduced by electric discharge to the same electronic configuration, can also be applied to complex spectra. We have tested this hypothesis by taking the two groups (1) Ne, Na^+, Mg^{++} . . . and (2) A, K^+, and Ca^{++}. In group (1), one of us has already demonstrated the applicability of the law. It now remains to add that the spectrum of Mg^{++} can be predicted with the aid of this law, since the spectra of both Ne and Na^+ are known. A number of strong lines, some of which were previously obtained by Handke and by McLennan, have been located between the wave-lengths $\lambda 2400$ and $\lambda 1800$. This is quite in accordance with the prediction of Messrs. Saha and Kichlu.

In the group A, K^+, Ca^{++}, the spectrum of A is now completely known, thanks to the work of Meissner (*Zs. für Phys.*, vol. 40). The lines of K^+ have been grouped into energy levels by T. de Bruin (*Proc. Amst.*, vol. 29), though he has not yet attempted the comparison with the predictions of Hund's theory. This can be easily done from his work, and the $5M_3(N_1 \longleftarrow N_2)$ lines written down. The fundamental difference ${}^3P_1 - {}^1P_1$ comes out to be 2425. As regards Ca^{++}, the spectrum was obtained by Anderson (*Astro. Jour.*, vol. 59, p. 76) by using the condensed discharge in vacuum, and a large number of lines entirely new (about 800) were obtained between the wave-lengths $\lambda 2100$ and $\lambda 4800$. One of us has undertaken the analysis of this spectrum and has been able to identify the group $5M_3(N_1 \longleftarrow N_2)$. The fundamental difference is ${}^3P_1 - {}^1P_1 = 3766$. The correctness of this difference is shown not only by the fact that it connects a number of the strongest lines given by Anderson, but also by the fact that it is approximately the difference (actual difference is 3804) between the two strongest

lines, λ403·8 and λ410·1, obtained by Millikan and Bowen in the hot spark spectrum of Ca in the extreme ultra-violet. These must be the $^1S_0 - {}^1P_1$, $^3P_1$ lines of transition $5M_2(M_2 \longleftarrow N_1)$. The applicability of the irregular doublet law is illustrated in the following table :

Group I.		Group II.	
$5M_2(N_1 \longleftarrow N_2)$.	$^3P_2 - {}^3P_2$.	$6M_2(N_1 \longleftarrow N_2)$.	$^2S_{\frac{1}{2}} - {}^2P_{\frac{1}{2}}$.
A	13987	K	12985
K^+	25647	Ca^+	25192
Ca^{++}	37194	Sc^{++}	36566
Sc^{+++}	(48600)	Ti^{+++}	47534

A further comparison has been made between the spectra of A and K, K^+ and Ca^+, Ca^{++} and Sc^{++} (*vide* table above). The lines compared belong to the groups $5M_2(N_1 \longleftarrow N_2)$ and $6M_2(N_1 \longleftarrow N_2)$ in each case. The difference is that the second group has only one more electron in the inner M_2-level. The value of $^3P_2 - {}^3P_2$ line in group I is almost identical with the value of the $^2S_{\frac{1}{2}} - {}^2P_{\frac{1}{2}}$ line in group II (lines arising out of the transition $6L_2(M_1 \longleftarrow M_2)$). The same analogy has been obtained in the spectrum of the groups Ne, Na, Na^+ ; Mg^+ ; Mg^{++}, Al^{++}.

The analysis of the Ca^{++} spectrum lends no support to Pannoecock's view that the spectrum of the solar corona is made up of the lines of Ca^{++}. The ionisation potential of Ca^{++} comes out to be approximately 52 volts, and the excitation required for stimulating the line $\nu = 37194$ would amount to about 53 volts if we start from the neutral state.

K. MAJUMDAR.
G. R. TOSHNIWAL.

Department of Physics,
University of Allahabad.
Mar. 22.

Apparent Distortion in Sports Photographs.

IN conversation with various people of some scientific attainments (even with some who have considerably greater technical skill in practical photography than I have myself), I have found usually that not enough allowance is made for the distortions produced by so-called *instantaneous* photographs. In my own Goerz-Anschutz focal-plane camera (some twenty-five years old), the nominal exposure of $\frac{1}{1000}$ sec. is obtained by allowing a slit of about $\frac{1}{25}$ the width of the plate *to travel in front* of the plate, at such a speed as to cover the whole plate in $\frac{1}{40}$ sec. In later patterns some increase in speed may exist, but the essential idea is the same.

The distortion is illustrated in the simplest possible way by considering a man of, say, 6 ft. to be running at such a speed as to cover 100 yd. in 12 sec., that is, at 25 ft./sec. The photographer will endeavour to place himself so as to get the runner to cover about $\frac{3}{4}$ of the height of the plate ; or the slit corresponds to $\frac{1}{25}$ ($\frac{4}{3}$) 6 ft. $= \frac{8}{25}$ ft. at the distance of the runner. Compared with the speed of the runner, this distance would correspond to $\frac{1}{25}$ ($\frac{8}{25}$) sec. $= \frac{8}{625}$ sec. $= \frac{1}{80}$ sec. roughly. But this is very nearly half the time during which the slit falls.

Probably a graphical investigation will help to make the matter clearer : we can simplify our ideas by taking in the first place the effect of, say, 25 strips on the plate, each having (theoretically) *instantaneous* exposures, at intervals of $\frac{1}{40}$ sec.

In the first strip affected by the runner (some strips will not receive his image at all) there will be a straight line[1] : in the next strip, an equal vertical line displaced a distance to the side. This displacement will correspond to $\frac{25}{40}$ ft. $= \frac{5}{8}$ ft. at the distance of the runner : and 8 ft. at that distance is represented by the height of the plate. Thus the sideways displacement is $\frac{5}{64}$ of the height of the plate : while each strip is $\frac{1}{25}$ of the height. Accordingly, the general effect is to produce an appearance of the form sketched (Fig. 1) :

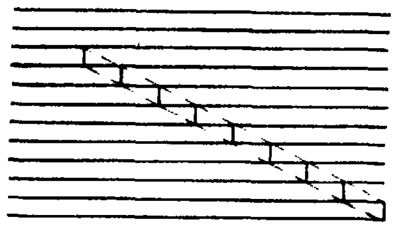

FIG. 1.

where the slanting lines make with the horizontal an angle the tangent of which is $\frac{64}{125} = 0{\cdot}512$. This angle is roughly 27°.

In the actual case of continuous exposure, a vertical line (moving at right angles to the line of sight) is therefore swung (by the camera alone) through about 63° (= 90° − 27°).

No doubt, in few *actual* photographs can such enormous distortion appear : for usually the photographer (from experience of previous bad results) is likely to stand near the finish of a race and to point the camera so that its axis makes an angle of (perhaps) less than 20° with the direction of the race. This would reduce the angle of swing to something more like 25° or 30° ; but even this is enough to distort entirely the photographs commonly reproduced in illustrated papers.

Another cause of distortion, perhaps less readily recognised, in (say) a tennis photograph is due to the variations in the distance of different parts of the player (and specially during the swing of the racket) while the slit travels over the plate.

T. J. I'A. BROMWICH.

April 21.

[1] For simplicity consider the runner as merely a vertical line.

The Buoyancy of Whales.

MR. R. W. GRAY'S series of letters make interesting reading to one who has been associated with various attempts to enable men to dive a little deeper than usual. From what has been published, and from other documents Mr. Gray has kindly lent to me, the evidence that whales can dive to 500 fathoms and beyond seems good, while it is certain that, after being harpooned, they can remain submerged for 40 minutes, and much longer in the case of the bottle-nosed whale. Since they can exist so long without taking breath at a time when they are exerting their utmost energies to escape, there need be little difficulty in accepting the view that when resting or sleeping (and consequently using oxygen at a slower rate) they can remain under the ice or on the sea bottom for some hours.

I find it difficult to accept the hypothesis that they can regulate their buoyancy by actively compressing the air in their lungs. Raising the intra-thoracic pressure to any useful extent would surely interfere with the circulation, as in Valsalva's classic experiment, which, with Muller's experiment and everyday experience of human divers with various forms of

apparatus, impresses on one the fact that the mammalian circulation cannot carry on unless the air in the lungs is kept at practically the same pressure as the fluid environment of the body, whether that be air at atmospheric pressure or water at a hydrostatic pressure many times as great.

When a whale starts to dive, part of its buoyancy is derived from blubber and part from the volume of air in its lungs, and assuming, as I think one must, that the increasing hydrostatic pressure of the sea water acting through the body walls automatically compresses the air in the lungs in accordance with Boyle's law, it follows that as soon as the whale has reached the small depth of 5 fathoms, the air volume, and consequently the buoyancy, due to it is halved. Mr. Gray has shown that the blubber alone is insufficient to support the animal, so that the descending whale will eventually reach a certain critical depth, probably not a great one, at which the air buoyancy is so much reduced that the density of the whole animal becomes the same as that of the sea water; and if the whale dives below this and dies, it will tend to sink still farther, as in the instances Mr. Gray has described.

In diving to 500 fathoms, the air in the lungs would be compressed to about $\frac{1}{100}$ part of its original volume, and the lungs must shrink to a corresponding degree: it is not surprising, therefore, that anatomists have commented on their remarkable elasticity. Hunter's words (for which I am indebted to Mr. Gray) are that they are so elastic "as to squeeze out any air that may be thrown into them and to become almost at once a solid mass having a good deal the appearance, consistence, and feel of an ox's liver." The human lungs and chest are so formed that (without distortion) they cannot hold less than about $\frac{1}{4}$ of the volume of air contained after a deep inspiration, so that naked pearl divers cannot descend much beyond twenty fathoms.

The appearance of drops of condensed water in the spout of whales in the tropics may be attributed to the rapid expansion and consequent cooling of the air in the lungs as the animal ascends from a great depth.

G. C. C. DAMANT.

Photography of the Infra-red Solar Spectrum.

NEARLY fifty years ago, Sir William Abney (*Phil. Trans.*, Part II., p. 653, 1880, and Part II., p. 457, 1886) photographed and measured fine detail in the solar spectrum out to λ9867. He also recorded, with low resolving power, a few broad absorption bands of greater wave-length, but he evidently observed no individual absorption lines having wave-lengths exceeding that of the line mentioned. It is remarkable that, in spite of some subsequent improvements in equipment, no one has measured lines in the solar spectrum out to the limit reached by Abney. The nearest approach of which I am aware is that of Brackett (*Astrophysical Journal*, **53**, 121; 1921), who measured λ9849 and could see a few more faint lines beyond.

With the aid of plates sensitised by neocyanin, the solar spectrum is now being examined once more, using both prisms and gratings. A filter of iodine in carbon disulphide, described long ago by Prof. Tyndall, is found to be the most efficient means of preventing fog. On the prismatic plates about a dozen lines are observed between λ10,000 and λ10,750, one of which is fully as conspicuous as Hα. It stands clear of the great water-vapour band ρ, and several photographs made at various solar altitudes and on days of very different humidity fail to show any change in its appearance. On spectrograms made with the grating, dispersion 4·7 A. per mm., it appears as a single wide line of wave-length 10049·8 A. The line is clearly of solar origin. Its wave-length, width, and general appearance leave little doubt that it is really the fourth member of the Paschen series of hydrogen, the calculated wave-length of which in air is λ10049·4. Later members of this series fall in the water-vapour band between λ9000 and λ9600, so that they are very difficult to observe. In addition to the lines already mentioned, fifteen others, faint and sharp, have been measured with the grating out to λ10,220.

In spite of this extension of Abney's limit by nearly 900 A., my experience leads to the belief that his emulsion was far more sensitive in this spectral region than any of those now available. He mentions Tyndall's filter, but seems actually to have used copper-flashed ruby glass, transmitting the red as well as the infra-red. Fog due to false spectra and the diffusion of shorter wave-lengths must have caused his failure to observe the lines recorded here.

HAROLD D. BABCOCK.

Mount Wilson Observatory,
Pasadena, California,
Mar. 24.

Observed Relative Intensities of Stark Components of Hα.

BY means of wave mechanics, Schrödinger (*Ann. d. Phys.*, **4**, 80, 437; 1926) has made quantitative calculations of the intensities of Stark components in hydrogen which are commonly considered to be an improvement on the earlier estimates based on the correspondence principle (H. A. Kramers, *D.K.D. Vidensk. Selsk.*, **8**, 3, 287; 1919). That this is so in the case of Hβ was shown recently by the writers in a quantitative experimental investigation (NATURE, Oct. 23, 1926).

The greatest variation of the new theory from Prof. Stark's results, however, occurs in the parallel components of Hα. There are three pairs of such components which have been photographed, and in the original experiments, as well as in the older quantum theory, the outside components were found to be the strongest. This is further supported by the recent calculations of Epstein on wave mechanics (*Phys. Rev.*, **28**, 695; 1926). In contrast to these results, Schrödinger finds the greatest intensity for the pair with intermediate displacements (Fig. 1). The

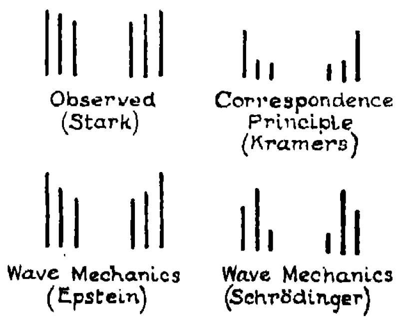

FIG. 1.

difference between Schrödinger's calculations and the observations of Stark is obviously rather large to be considered as an experimental error. Yet this is what it appears to be according to numerous plates obtained by the junior author in an extension to the earlier experiments, the new results being in general agreement with the calculations of Schrödinger.

The new photographs are taken by the Lo Surdo

method, with a tube designed to give components which run parallel for a short distance on the plate. It is not thought probable that this source should produce components with intensities essentially different from those which might be obtained from a canal-ray tube. Its design permits the use of a micro-photometer in the ordinary way. On the plate from which the accompanying curve (Fig. 2) was

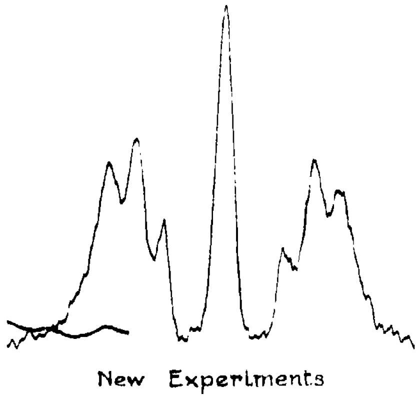

FIG. 2.

taken there appears to be a strong undisplaced parallel component, but, in reality, this is due to the overlapping of the images on the slit.

Quantitative measurements of the intensities by a wedge method are in progress. The present note is just to state that on this most outstanding point Schrödinger is correct.

J. STUART FOSTER.
M. LAURA CHALK
(National Research Student).
Macdonald Physics Laboratory,
McGill University, Montreal,
Mar. 21.

Genes and Chromomeres in Flowering Plants.

THE objection to identifying chromomeres with genes was that there were not supposed to be enough chromomeres. In my opinion this supposition was based on post mortem changes, or on too low a working aperture in the microscope. I have studied the pachyphase (pachytene stage) in *Aloe*, *Lilium*, *Kniphofia*, and *Agapanthus* especially. The less the opportunity for change before fixation, the greater the number of cells showing the ultimate chromomeres.

These ultimate chromomeres appear about twice as broad as long, in all positions of the fibre. They differ in size; and sometimes only the scattered largest ones take the stain, and the others are nearly or quite invisible. They show equally well in iron-acetocarmine squeezes, or in smear preparations fixed in chromic-acetic-formol and stained with iron-brazilin. Their lateral extension is due to their composition out of the laterally joined homologous chromomeres of four strands, and the longitudinal divisions can sometimes be made out.

In many pachyphase cells these chromomeres are seen merged into long blocks, or into a continuous thread; but the writer considers this phenomenon to be a post mortem change. In *Aloe purpurascens* an enumeration of the ultimate chromomeres in pachyphase, by an apparently trustworthy method, gave approximately 1250 for the total in the cell. These chromomeres averaged less than a third of a micron apart, and so approached the limits of microscopical separation. At diaphase, and still more at metaphase, the number of separable chromomeres has greatly decreased; but these are obviously compound bodies. Hence a useful working hypothesis seems to be that the ultimate chromomeres are genes.

JOHN BELLING.
Carnegie Institution of Washington,
Department of Genetics,
Cold Spring Harbor, N.Y.,
April 14.

Milton and Modern Science.

IF Lucretius can be quoted in NATURE as anticipating modern scientific discoveries, perhaps space may be found for a far greater English poet, John Milton.

Are not Millikan's cosmic rays foreshadowed in Bk. IV. of "Paradise Lost"? Eve has just asked (657-8):

But wherefore all night long shine these? for whom
This glorious sight, when sleep hath shut all eyes?

Adam replies:

Those have their course to finish round the Earth
By morrow evening, and from land to land
In order, though to nations yet unborn,
Ministering light prepared, they set and rise;
Lest total darkness should by night regain
Her old possession,
. . . these soft fires
Not only enlighten, but with kindly heat
Of various influence foment and warm,
Temper or nourish, or in part shed down
Their stellar virtue on all kinds that grow
On earth, made hereby after to receive
Perfection from the sun's more potent ray.

Again, Bk. XI., from v. 429 onwards, contains an excellent description of a cinema show, and the chariot of Paternal Deity (vi. 750) is a motor-car. Truly,

What the sage poets, taught by th' heavenly Muse,
Storied of old in high immortal verse

("Comus," 517), is well worth rescuing occasionally from the oblivion into which such things fall.

C. L. BARNES.
Manchester, May 13.

Ultra-Violet Transmission of New Glasses.

DR. L. C. MARTIN, in his interesting article in NATURE of April 21, on "The Ultra-Violet Transmission of Transparent Materials," makes a reference to the new glass of the Corning Glass Co., and states that it is not yet available in large pieces.

The chemical composition of this glass undoubtedly involves manufacturing difficulties at present greater than are met with in the preparation of Vita-glass and the newer ultra-violet transmitting window glasses now being marketed in Great Britain, Germany, and America. It may interest readers of NATURE, however, to know that early this year I received from the Corning Co. a sheet of the new glass, known under the name of Corex, of dimensions $8\frac{3}{4}$ in. × $6\frac{3}{4}$ in. and 4 mm. thick, a size sufficient for many screening purposes. The sheet appeared to be quite homogeneous and clear. In thickness of 2 mm. it was found to transmit down to $0{\cdot}212\mu$ and to have the following percentage transmissions: 86·5 at $0{\cdot}295\mu$; 66 at $0{\cdot}250\mu$; 35 at $0{\cdot}230\mu$; and 13 at $0{\cdot}220\mu$.

W. E. S. TURNER.
Department of Glass Technology,
The University, Sheffield, April 21.

Shipworms in San Francisco Bay.

THE San Francisco Bay Marine Piling Committee was established in 1920 by the American Wood-Preservers' Association, following a serious outbreak of damage by shipworms to timber structures in the northern part of San Francisco Bay. The Committee's work was, almost from the first, associated with the national scheme of research on the same subject begun by the U.S. Forest Service and later co-ordinated by a special committee of the National Research Council. The final report now issued[1] brings together the results of all the researches undertaken. While a good deal of the ground has already been covered by the report of the National Committee published in 1924 (see NATURE, Nov. 22, 1924, p. 744), the fuller account of the local conditions and of the admirable series of biological, hydrographical, and engineering researches carried out at San Francisco is very welcome.

It is now possible to get a clear picture of the succession of events in this region. It is pointed out in the historical section of the report that shipworms have been active at San Francisco at any rate since the days of the gold rush in 1849. By 1857 many wharves were derelict and tottering from their attacks. This was at the water-front of San Francisco itself, just within the Golden Gate, and no doubt the species of shipworm causing most of the damage was *Xylotrya* (now *Bankia*) *setacea*, described by Tryon in 1863. This species is probably indigenous to the Pacific coast, and in San Francisco Bay it is confined to the region of high and constant salinity (not much less than 25 per mille), not penetrating to the northern districts (San Pablo and Suisun Bays) where the salinity is low and fluctuating. An isolated record of the species from San Pablo Bay is considered to be due to the shipworms having been present in the piles before they were driven.

Before the seventies of last century, the Crustacean borer *Limnoria* was unknown at San Francisco, but in 1873 it is mentioned as having "only recently made its appearance in our waters," and it speedily became very destructive. The distribution of *Limnoria* within the bay coincides with that of *Bankia*, and nearly all the damage done in the middle and southern parts of the bay is caused by these two species. In these districts their destructive activities have been long guarded against by the use of piling protected by impregnation with creosote or by other methods.

In the northern districts, where the salinity is greatly diminished by the influx of fresh water from the Sacramento River, no dangerous borers had ever been known to occur, and extensive wharves and other structures were built of unprotected timber. In 1914, however, a species of shipworm, later identified as the European *Teredo navalis*, was found to be causing damage at the Mare Island Navy Yard in San Pablo Bay. No further damage was reported until 1917, when the pest broke out again, and in the following years assumed disastrous proportions. Wharves collapsed on all sides, sometimes carrying buildings with them, until, by the end of 1921, "the bulk of structures with untreated piling had been destroyed," and the total losses were estimated at the enormous sum of twenty-five million dollars. Precautions against the recurrence of such a catastrophe are now taken by using piles of reinforced concrete and by protecting the timber piles by creosoting, concrete jacketing, and other methods.

From the biological point of view, there are several features of interest in this story. It is evident that the special destructiveness of *Teredo navalis* as compared with other species is due to its peculiar adaptability to low and fluctuating salinity. This enables it to take advantage of a favourable season to establish itself in localities where it is not expected and precautions against it have not been thought necessary. At San Francisco, as was shown long ago in Holland, the outbreaks could be definitely correlated with years of reduced rainfall and consequent increased salinity in harbour waters. Once established in the timber, the animals can survive many weeks in water of reduced salinity by closing the mouths of their burrows with the pallets and resume their activity when the salinity rises again. Since the individuals rarely survive for more than one year, a succession of favourable years is probably necessary to cause a severe and prolonged outbreak.

Doubt has been cast on the popular opinion which attributes sudden outbreaks of shipworm to importation from abroad, but in the case of the San Francisco outbreak, at any rate, there is good reason to regard it as justified. Investigations on the shipworms of the bay were made in 1910–11, and again in 1912–13, and no specimen of *Teredo navalis* was recorded. It is just possible that it may have existed in small numbers in some part of the region, but favourable conditions must have occurred many times before 1914 which would have led to its invasion of the northern districts had it been there to take advantage of them. It is much more likely that the species was introduced in some unknown manner in 1913 or 1914. When first discovered, it was described as a new indigenous species, and it was only after prolonged and careful study that its identity with the European species was established.

It is sometimes assumed by practical men that the only help to be expected from scientific research in dealing with marine timber pests is the discovery of new kinds of poison for protecting the wood. Fortunately, the American investigators have taken a wider view. They have shown that detailed studies of the systematics, distribution, physiology, and bionomics of the shipworms and other marine boring animals can yield results that are of immediate practical importance to the engineer.

W. T. C.

[1] Marine Borers and their Relation to Marine Construction on the Pacific Coast: being the Final Report of the San Francisco Bay Marine Piling Committee. C. L. Hill and C. A. Kofoid, editors-in-chief. Pp. ix+357. (Berkeley, Cal.: University of California Press, 1927.) 4 dollars.

The Glasgow Meeting of the British Association.

MANY of the senior members of the British Association still carry in their memory pleasant recollections of the last meeting in Glasgow twenty-seven years ago, and of the wonderful excursions by sea and loch and glen of which it was the centre. There have been many changes of personnel since that meeting, when such names as Rücker, Kelvin, Geikie, Lister, M'Kendrick, and Bayley Balfour were conspicuous in the list of members, but there are not a few still in the position of being able to look forward to repeating this year (Sept. 5-12) their experiences of 1901.

The invitation to the Association is again a joint one from City and University. The University, with its spacious premises, is able to exercise the unusual hospitality of accommodating the entire sectional and administrative activities of the Association within one boundary-fence, while the City—Lord Provost, Corporation, and citizens—is leaving no stone unturned to make the meeting a success.

The main activities of the meeting will be concentrated in the University, that impressive pile of buildings—situated on the high right bank of the Clyde valley just where it is cut through by the tributary Kelvin—which looks out from its dominating position across the broad river valley with its alluvial flats now covered in great part by busy streets and docks and shipyards. The great hall of the University—the Bute Hall—will function as Reception Room, with general offices, post-office, bookstall, etc.: the adjoining Randolph Hall will be used as a writing-room; while in close proximity accommodation will be provided for the president and general officers, the secretaries and local secretaries, and the representatives of the Press.

The individual sections will be housed as a rule in the University department devoted to their particular subjects, thus ensuring the availability of suitable furnishings and equipment. In a few cases, to secure greater convenience, this general rule is departed from; thus Section C (Geology) will meet in the old Natural History Lecture Room, E (Geography) in the Department of History, F (Economics) in that of English, J (Psychology) in the newly completed west wing of the main University building, M (Agriculture), and also the forestry sub-section of K, in the new medical block.

Long experience has demonstrated the great practical advantages to be derived from the secretarial staffs of the different sections being housed together in one residence during the meeting. In organising the Glasgow meeting it was found impossible to obtain adequate accommodation for this purpose in immediate proximity to the University, and the secretariat is consequently to be housed in the Training College Hostel at Jordanhill, about two miles to the north-westward. The local committee is, however, providing transport arrangements which will, it is hoped, reduce the practical inconvenience of this arrangement to negligible dimensions.

For the presidential address, the Corporation has placed at the disposal of the Association the finest of its halls, St. Andrew's Hall, with seating for 4000 and admirable acoustic properties. For the evening discourses the governors of the Royal Technical College are giving the use of their great hall.

As regards lodging accommodation, the chief Glasgow hotels are much in demand, so prospective visitors will do well to secure their accommodation as soon as possible. As, however, the meeting of the Association takes place out of term, many of the lodgings normally occupied by students will be available, and the same applies to the various students' hostels. Further information regarding lodging accommodation may be obtained from the Local Secretaries, 30 George Square, Glasgow, C.2.

The attractions of the Glasgow meeting will not be confined to those of a purely intellectual kind. On Thursday, Sept. 6, the Lord Provost and Corporation will welcome the members at an evening reception and dance in the magnificent City Chambers, while on the following Monday evening the hospitality of the Corporation will again find expression when the Kelvingrove Art Galleries will be placed at the disposal of the local committee for a second evening party. At this party, members who slip away for a while from the extensive galleries devoted to the sciences, in which as members of the British Association they are primarily concerned, will have the opportunity of revelling amongst the artistic treasures which form one of the chief glories of Glasgow.

Nor again will the meeting be devoid of tempting distractions outside the city. Even those who are unaware of the charms of Glasgow itself are dimly conscious that it guards the gateway to the wonderful scenic beauties of the western Highlands. Many undoubtedly will see in the Glasgow meeting an excuse for a prolonged Highland holiday either before or afterwards. But even those who do not will have the opportunity of devoting the Saturday to one of many excursions which have been organised for that day. Biologists will be drawn towards Millport, with its admirably situated and well-equipped biological station, where the Scottish Fishery Board's research vessel *Explorer* is expected to be an object of special attraction. Archæologists will tend to Bute with its ancient remains and modern developments: engineers to the Falls of Clyde and its electric power station. Others will devote the day to recuperation by a long day's sail round Bute and Arran and Ailsa Craig or round the various sea-lochs, or by an expedition by land to the Trossachs and Loch Katrine and Loch Lomond, or farther afield to Aberfeldy and Loch Tay. Other interesting excursions will be to the

Burns Country, and to Peebles and its neighbourhood.

Saturday is, as usual, devoted entirely to excursions, but in addition there will be numerous half-day and afternoon excursions during the week. Many of these will be of special sectional interest, or will be devoted to visits to particular works and industrial centres. That great achievement in applied science, the Port of Glasgow, with its quays and docks and shipyards, will, of course, be of special interest to many visitors, and to facilitate its inspection the Clyde Trustees are generously proposing to place their steamer *Comet* at the service of members of the Association.

The Harvey Tercentenary.

THE place that William Harvey occupies in the development of modern physiology and medicine can only be properly appreciated when his work is viewed in the light of the current scientific knowledge of the seventeenth century. Like many other great discoveries, that of the circulation of the blood owed something to the work of previous observers, but all the more honour is due to Harvey for proving experimentally beyond the shadow of a doubt that the blood circulates, when others had approached the truth but had failed to draw the correct inference from the facts available, and had not devised experiments to test the correctness or otherwise of this deduction.

Ever since the time of Galen, it had been held that some of the blood must pass from one side of the heart to the other through the wall or septum separating the two ventricles: in the earlier part of the sixteenth century, the anatomist Vesalius proved that there was no direct communication between these two chambers of the heart, but such was the force of tradition that he did not directly deny Galen's teaching, the difficulty being surmounted by assuming that the blood passed through invisible channels in the muscle. At about the same period, Servetus described the circulation through the lungs, but failed to correlate this observation with the circulation of the blood through the rest of the body.

Harvey studied at Cambridge and at Padua: at the latter University he came under the influence of Fabricius ab Aquapendente, who published at about this time—in the first few years of the seventeenth century—a treatise on the valves in the veins, which was probably the starting-point of Harvey's discovery. It is easy to demonstrate in the human arm that the blood in the veins can only flow towards the heart owing to the existence of these valves. During the next ten years Harvey was working at the problem arising from these facts: and in 1616 he was lecturing before the College of Physicians in London on the circulation of the blood. Accepting the truth of the facts previously demonstrated, he saw that the only explanation possible must be that the blood reaching the right side of the heart from the veins, was pumped by the right ventricle through the lungs, returning to the left side of the heart, whence it was pumped to all other parts of the body. By animal experiment he was enabled to demonstrate the truth of the conclusion drawn from the anatomical data at his disposal. The work was not published in book form until 1628, when the first edition of "De Motu Cordis (Exercitatio anatomica de motu cordis et sanguinis in animalibus)" was printed by Wilhelm Fitzer of Frankfurt-on-Main.

Harvey may be truly described as the founder of modern physiology and scientific medicine: he refused to be bound by tradition, yet, whilst discarding traditional teaching for which he could find no basis in fact, he paid honour to the earlier workers: above all, he always insisted on testing the truth of inferences and on seeking the explanation of observed facts by means of animal experiments, not excluding observations on man himself

The celebration of the tercentenary of the publication of the "De Motu Cordis" was arranged by the Royal College of Physicians of London: delegates attended from nearly thirty different countries. The celebration took the form of orations to Harvey's memory, a reception of the delegates by the King, and scientific demonstrations and visits to places and institutions especially associated with Harvey.

The proceedings commenced on May 14, when the delegates were received by the King at Buckingham Palace, being introduced by Sir John Rose Bradford, president of the Royal College of Physicians. Harvey, as a physician, was closely associated with both James I. and Charles I., and accompanied the latter to Oxford: King Charles always supported Harvey's experimental work so far as he was able. In the afternoon, the delegates were welcomed at the Royal College of Physicians and presented their addresses from universities and learned institutions throughout the world. The rare honour of honorary fellowship was conferred upon Lord Balfour, Sir Ernest Rutherford, Prof. I. P. Pavlov, of Leningrad, and Prof. K. F. Wenckebach, of Vienna. Eulogies of Harvey were delivered by Sir Charles Sherrington, Prof. Chauffard, of Paris, and Dr. Keibel, of Berlin.

Sir Charles Sherrington said that the Renaissance occurred first in letters and scholarship, then in the physical sciences, but last in the study of living animals. Harvey was really the first to investigate their function, as distinct from study of their outward form. It is experiment, together with observation, which is at the basis of medicine as we know it to-day. Prof. Chauffard compared the

period of twelve years during which Harvey continued his investigations before the "De Motu Cordis" was published with the same period Francis Bacon required for the maturing of his work, and with the twenty years which elapsed between the time Newton and Darwin began their work and their dates of publication. Perhaps the most striking characteristic of Harvey's work is its modernity: the outlook and the methods are those of to-day.

On May 15 the delegates visited St. Bartholomew's Hospital, where Harvey was physician for twenty-one years: after lunch, Sir Wilmot Herringham gave an account of Harvey's connexion with the hospital and paid a tribute to his memory. On May 16 the delegates were entertained at dinner at Guildhall by the president and fellows of the Royal College of Physicians. In connexion with the celebrations, demonstrations and exhibitions of objects of interest at University College and at the Royal College of Physicians were also arranged. The celebrations were concluded by visits to Merton College, Oxford, of which Harvey was warden, on May 17, and on May 18 to Caius College, Cambridge, from which Harvey graduated.

In connexion with the tercentenary, Dr. Geoffrey Keynes has published an attractive little bibliography of Harvey's writings.[1] The text is illustrated with reproductions of the title pages of certain of the editions, two portraits of Harvey, and several prints illustrating the valves in the veins. Although the "De Motu Cordis" is the best known of Harvey's writings, he published also two short essays on the circulation of the blood in 1649, addressed to John Riolan the younger, professor of anatomy at Paris, in answer to certain criticisms of his work, and two years later his "Exercitationes de Generatione Animalium" appeared. Although the latter has been somewhat neglected, it is almost as great a contribution to science as the "De Motu Cordis," and reveals the master mind of the Father of modern physiology.

[1] A Bibliography of the Writings of William Harvey, M.D. Discoverer of the Circulation of the Blood. By Dr. Geoffrey Keynes. Pp. xii+68+8 plates. Edition limited to 300 copies. (Cambridge: At the University Press, 1928.) 21s. net.

Chemical Industry in Modern Life.

WHEN public attention is from time to time directed towards the great scientific achievements of the age, the seeker after the mysteries of Nature is assured of the respectful praise and admiration of modern British men and women as he displays the results of his labours, whether his audience understand their significance or not. It is probably true to-day to say that there is in all civilised countries a keen appreciation of such successes, and a general desire that they shall be acknowledged by public honour, equally, for example, with the no less worthy achievements in the realms of art and literature.

Chemistry, however, and its sister sciences, have now reached a stage of development in which they operate so profoundly on the course of human affairs, and especially on national health and safety, that it becomes necessary to put clearly and frequently before the public such facts as will lead to a proper recognition of the magnitude of the issues which exercise the minds of scientific men. It becomes necessary, for example, to present what may be described as interim non-technical reports exemplifying the progress that is being made in preserving the general well-being of the community and in meeting the demands of modern conditions of existence, and indicating the broad lines along which—perhaps not without public support—development can from time to time be foreseen. The Chemical Industry Conference, organised by the Society of Chemical Industry in co-operation with its London section and Chemical Engineering Group, and with the Institution of Chemical Engineers, which was in session in London on May 11-15, was not intended to introduce new technical data to a technical circle; its function was rather to present such general reports primarily to its members and guests, and also to the Press, and hence to a far wider audience. Such a conference, apart from the offer of opportunities of personal contact and discussion, performs the valuable service also of bringing the labours of one group of workers more vividly before the minds of other groups than is possible through the medium of technical publications.

The conference opened, on its professional side, with an address by Mr. F. H. Carr, president of the Society of Chemical Industry, who dealt with some chemical engineering aspects of the fine chemical industries. Sir Arthur Duckham, the first president of the Institution of Chemical Engineers, contributed an important paper on the fuel industries and the work of the chemical engineer, emphasising the necessity for practical training, and for closer contact between the university and the factory. He confessed that, with ever-widening experience, he became more and more convinced of the great scope which exists for improvement even in our latest methods, and of the splendid prizes still to be won by application of technical knowledge, imagination, and driving force to the daily problems of industry; he put the matter in a nutshell when he stated that the basic need in industry is to get exact knowledge of what we are doing.

Lieut.-Col. G. P. Pollitt described developments in the heavy chemical industry, pointing out that we are at the beginning of a period of replacement of natural products by products made by synthetic and partly synthetic processes, and that what is a 'fine' chemical now may well become 'heavy' in a few years' time. In this paper the general effect of the War on chemical manufacturers was summarised, and the principal differences between pre-War and post-War practice were indicated; recent achievements, such as the synthesis of ammonia, the hydrogenation of coal, and the artificial silk industry, were also passed under review. Prof. G. T. Morgan's contribution was an account of a

chemical study of low-temperature tar, a material the investigation of which has been carried out chiefly since the War. All these papers thus dealt with matters of the highest technical importance, and gave some idea of the responsibility that rests on the chemical engineer in transferring successful laboratory processes to the domain in which mechanics and economics occupy so dominating a position.

Other papers were more general in their appeal. Sir Alfred Mond, as was to be anticipated from the title of his paper, "Scientific Research as applied to Industry," delivered a most inspiring and convincing address on the broad questions at issue. He was rightly insistent, in the first place, that science is not national, but human, and that little is therefore to be gained by attempts to nationalise it. He was also anxious to remove the widespread impression that chemical industry and the manufacture of dyes are synonymous terms, and incidentally showed that the obstacles which in the past have stood in the way of rapid development of that branch of the industry within the shores of Great Britain are to be sought in the patent laws rather than in any deficiency in British technical capacity. Indeed, it was most encouraging to hear him—a man of great experience and responsibility—declare that in Great Britain we have now, and probably always have had, the right kind of men who can be entrusted with the care of our important chemical industries, and that we can claim a superiority in this respect over other countries. Further, although the ability for original inquiry is inborn, and hence not to be acquired to order, the spirit of research and the intelligent, courageous application of new knowledge should permeate the factory ; conversely, of course, practical considerations must always occupy a prominent place in the field of vision of the researcher. One might, indeed, go further, and say that the diffusion through civilised communities of such a spirit, call it what one may, is one of the prime factors in our progressive attempts to make the world a better place to live in.

Sir Alfred has had unique opportunities of estimating the cash value of research, and he sees in large industrial combinations the opportunity of making the best use of specialised talent and new possibilities. His statement that the leaders of chemical industry nowadays are the guardians of the nation's defence and prosperity could have encountered no lurking doubts in an audience of men and women acquainted with some of the relevant facts ; the dependence of a cheap and plentiful food supply on cheap synthetic or artificial fertilisers, and the possibility of the economic conversion of coal into fuel oil, are but two examples of the vital considerations which were evidently in his mind.

Sir Ernest Rutherford, under whose chairmanship Sir Alfred Mond was speaking, amplified the discussion by pointing out that at the foundations of the applied research which means so much for industry are the labours of those devoting themselves to 'pure' science, and he exemplified the manner in which apparently academic or unpractical investigations may in a surprising way lead to applications of the greatest significance.

Water supplies formed, under Lord Desborough's chairmanship, the subject of another session of the conference. An abundant supply of pure water, especially in urban areas, is now so universal and commonplace a service that few other than those directly concerned give a thought to the extent to which its provision draws on our resources of scientific knowledge and invention, and—in average seasons, at any rate—how it depends on considerations of fluctuating supply and demand. As Lord Desborough showed, the question is not altogether devoid of anxiety, and the matter requires constant skilled and highly organised supervision. Sir Alexander Houston gave a most interesting account of the various ways in which London's water supply is purified before it reaches the consumer, and expressed some apprehension concerning the possible pollution of water supplies by gulls. Mr. J. H. Coste discussed more fully the pollution of tidal and non-tidal waters by house rubbish and sewage, and by the waste products of trades, whereby a pleasant river may be rendered unsavoury or unsafe, and normal life in it, of fish in particular, may be degraded or destroyed. Mr. Coste referred to the nature and movement of the pollution, discussed the causes of the unfitness of water for fish life, the standards applicable to, and treatment of, works' effluents, and the legal and administrative steps that have been taken to protect streams from unnecessary pollution.

The scientific assistance which can be afforded to agriculture was represented by Sir John Russell's paper on the part played by British workers in the application of fixed nitrogen to the soil. In the unavoidable absence of the author, the paper was read by Dr. B. A. Keen, who said that in agricultural chemistry two main considerations are in the foreground, namely : "What is 'quality'?" and "What is the detailed effect of fertilisers on yields?" The paper presented a concise, yet informative, account of experiments which have been carried on for many years at Rothamsted Experimental Station, Harpenden. Such a mass of data has accumulated from these continuous field experiments that the application of modern and newly devised statistical methods has been necessary in its interpretation. These new methods have paved the way to a study of the effect of soil and climatic conditions on the effectiveness of fertilisers. The investigations indicate the possibility that, if the general character of a season could be predicted, appropriate manurial schemes could be drawn up for mitigating its bad features and utilising to the fullest extent all its good ones. Alternatively, it would be possible to construct tables of expectancy of crop yield, on the basis of which large fertiliser combines could insure farmers using recognised fertiliser mixtures against getting less than an agreed yield per acre. If it is true that 1400 million people till the soil in order to feed and clothe 1800 million inhabitants of this planet, could science be applied in any more vital interest?

News and Views.

PROF. J. W. GREGORY has received a cable from Sir Edgworth David announcing the discovery of a rich fossil fauna of ancient annelids and arthropods throughout the whole of the Adelaide Series which lies at the base of the Cambrian System in South Australia. The appendages are excellently preserved. Sir Edgworth David considers the age probably Lipalian, but possibly Lower Cambrian. The newly discovered fossils extend from 2000 ft. to 12,000 ft. below the fossiliferous Cambrian beds. The Lipalian is the name given by Walcott to a division of time a little lower than the Cambrian. This discovery, amongst its many other bearings, may be expected to throw important light on the age of the ancient glacial deposits of South Australia which have been assigned either to the Cambrian or to the pre-Cambrian.

AFTER an interval of more than six years, the non-magnetic sailing ship *Carnegie*, of the Carnegie Institution of Washington, set out on May 1 on another scientific world cruise. The scientific and navigating staff of the yacht numbers eight men. The cruise is intended to cover three and a half years; the places to be visited, in order, are England, Germany, Iceland, the West Indies, Panama, the South Pacific (the Society Islands, Easter Island, Peru), Japan, California, Honolulu, Samoa, New Zealand, Cape Horn, South Georgia, South Africa, Ceylon, India, Western Australia; across the South Pacific again and around the Horn to Buenos Ayres, Argentina, St. Helena, Azores, Madeira, and back to Washington. The first object of the cruise is to take magnetic observations, in order to determine the secular variation without which the magnetic charts, used nowadays for aerial as well as ocean navigation, cannot be kept up-to-date; atmospheric electric observations will also be made, as on the preceding cruise. In addition the staff are taking up new work of three kinds: the investigation of radio-propagation, in accordance with a programme of transmission and reception arranged with the Washington Naval Research Laboratory; the investigation of the sedimentary deposits on the ocean bed; and the mapping of the sea bed by sonic depth-finders. The *Carnegie* is due to arrive at Plymouth on May 26, and will be there until June 8. During her stay at Plymouth, Capt. J. P. Ault and his staff will welcome visits from scientific workers anxious to see the vessel and examine her equipment.

THE expedition organised by the British Association Great Barrier Reef Committee will leave England for Brisbane by the R.M.S. *Ormonde*, which sails from Tilbury on May 26. The party, which is now fully constituted, will consist of the following: Leader, Dr. C. M. Yonge, Balfour Student in the University of Cambridge; second in charge and leader of the boat party, Mr. F. S. Russell, assistant naturalist at the Plymouth Laboratory; leader of the reef party, Dr. T. A. Stephenson, lecturer in zoology, University College, London; chemist and hydrographer, Mr. A. P. Orr, chemist, Marine Station, Millport; phytoplankton worker, Miss S. M. Marshall, assistant naturalist, Marine Station, Millport; botanist, Mr. G. Tandy, Department of Botany, British Museum (Natural History); zoologist and leader's assistant, Mr. G. W. Otter, University of Cambridge; medical officer, Mrs. C. M. Yonge. Mrs. Russell and Mrs. Stephenson will accompany the party. There will follow later, Mr. J. A. Steers, fellow of St. Catherine's College, Cambridge, and Mr. M. Spender, of Balliol College, Oxford, who will carry out geographical work under the auspices of the Royal Geographical Society, and also Mr. J. S. Colman, of New College, Oxford, who will assist Mr. Russell in his work on the distribution of zooplankton. Valuable assistance is expected from Australian sources. With the exception of Mr. Russell, Mr. Tandy, and Mr. Steers, who will be in Australia for six months only, the members of the expedition will carry out continuous observations for a period of about thirteen months.

A GREAT quantity of apparatus is being taken by the Great Barrier Reef Expedition, for the object aimed at is a repetition under tropical conditions of the standard observations, chemical and planktonic, made in temperate seas, so that not only will the results obtained give new and much-needed information about the conditions prevailing in tropical waters, but also they may throw considerable light on conditions in temperate seas when the results of parallel observations in the different localities are compared. The conditions underlying the formation of coral reefs will, naturally, receive the greatest attention, the nutrition and calcium metabolism of corals and associated organisms being one of the chief objects of the expedition, while the many economic possibilities of the Great Barrier Reef will be fully explored. The total cost of the expedition will be some £10,000, of which about £8000 has been received to date, the money having been provided by the Empire Marketing Board, the Commonwealth Government, the British and Australian Associations for the Advancement of Science, the Australian Great Barrier Reef Committee, the Royal Society, the Royal Geographical Society, the Zoological Society, and a number of private individuals. The committee hopes to raise the remaining £2000 during the coming year, and any subscriptions towards this would be welcomed by the committee, the chairman of which is the Right Hon. Sir Matthew Nathan; the treasurer, the Hon. J. Huxham, Agent General for Queensland; and the secretaries, Prof. J. Stanley Gardiner and Mr. F. A. Potts, Zoological Laboratory, Cambridge.

VERY hearty congratulations are extended to Sir Daniel Morris, K.C.M.G., botanist, and Col. R. E. Crompton, C.B., electrical engineer—two octogenarian men of science—who celebrate, respectively, their eighty-fourth and eighty-third birthdays on May 26 and May 31. Sir Daniel Morris was born at Loughor, Glamorgan, and was educated at Cheltenham and

Trinity College, Dublin. Early in his career Sir Daniel's particular studies and efforts were directed towards promoting the economic resources of tropical parts of the British Empire by means of scientific exploration and research. Appointed Director of the Royal Botanic Gardens, Ceylon, in 1877, he afterwards became Director of the Botanic Department, Jamaica, vacating this post on his appointment as Assistant Director of the Royal Botanic Gardens, Kew. Here he remained for twelve years (1886–98), becoming then Imperial Commissioner, West Indian Agricultural Department. From 1908 until 1913 he was scientific adviser in tropical agriculture to the Colonial Office. Sir Daniel was president of Section K (Botany) at the Bournemouth meeting of the British Association in 1919.

COL. CROMPTON, the distinguished engineer, who forms one in a still living group of veterans in that branch of science, is a Harrovian. After leaving school he began training as a mechanical engineer, but for family reasons entered the army and for some years served with his regiment in India. Whilst on the Commander-in-Chief's staff at Simla, he persuaded the Governor-General, Lord Mayo, to promote the first large-scale road transport experiment. Returning to England in 1876, Col. Crompton engaged in electrical engineering, founded the firm of Crompton and Co., and remained its managing director for nearly thirty years, a period of unceasing application to electrical undertakings at home and abroad. For long Col. Crompton rendered unstinting service to the National Physical Laboratory in a consultative capacity. He has been twice president of the Institution of Electrical Engineers, and he was, in 1926, awarded the Faraday medal of the Institution. Still actively engaged, he is a member of council of the Institution of Civil Engineers, and representative of that body on the official Advisory Panel (Ministry of Transport).

A CONVERSAZIONE was held at the East London College on May 15 to commemorate the twenty-first birthday of the College as a 'school' of the University of London. The College has, however, provided education of university type for more than forty years, and for eighteen years has participated in the Government grant to university colleges. His Majesty the King is Patron of the College, and the King and Queen visited it five years ago. On the present occasion the Duke and Duchess of York were distinguished guests, and, with the Masters and Wardens of the Drapers' Company, the Vice-Chancellor and the Principal of the University of London and more than 2000 others, were received in the Queen's Hall by the Deputy Chairman of the College Council, Sir Lynden Macassey and Principal Hatton. After the presentation of the members of the College Council, of the Academic Board and of the officials of the Students' Union to the Duke and Duchess, their Royal Highnesses made a tour of the laboratories, in which about 150 experiments had been arranged and were demonstrated by the staff or the students. Short lectures on broadcasting, television, and noctovision, and on other subjects were given by Capt. P. P. Eckersley, Mr. J. L. Baird, and members of the staff.

A FEATURE of the laboratory exhibits, somewhat unusual at a conversazione, was the amount of apparatus and the number of experiments representing research either completed or in progress in East London College. As examples may be mentioned: in the physics laboratories, the elasticity of metals and experiments on sound; in the geology laboratory, the photomicrography of rocks; in the botany laboratory, the exhibit by Dr. W. A. Goddyn of Leyden, illustrating natural hybrids between plants and between humans, and that of mosquito larvæ and their food; in the electrical engineering laboratory, the investigation of the electrical field about high-voltage apparatus and of the three-carbon arc; in the mechanical engineering laboratory, the researches on the temperature distribution in a dual cycle oil engine and that on the application of the principle of similitude to earth pressures; in the chemical laboratories, the furnace for specific heats of gases at 1500° C. and the apparatus for measuring heats of solution; and in the zoology department, the specimens illustrating species. The fine library on the lines of the British Museum reading room, with its large collection of books relating to Shakespeare from the library of the late Sir Sydney Lee, provided interest for the literary guests, while the dancing to which the Queen's Hall was devoted after 9.30, kept many of the students and guests until nearly midnight.

THE annual general meeting of the Institute of Physics was held on May 15, when the following officers were elected for the year 1928–29: *President*, Sir Frank Dyson; *Vice-Presidents*, Dr. Alexander Russell and Mr. C. C. Paterson; *Honorary Treasurer*, Major C. E. S. Phillips; *Honorary Secretary*, Prof. A. O. Rankine. Sir Ernest Rutherford and Sir Richard Glazebrook were elected honorary fellows of the Institute. The president, in moving the adoption of the Report of the Board for the year 1927, referred to the substantial additions to the membership of the Institute during the year, and to the increased activities which coincided with the transfer of the offices to South Kensington. The Royal Meteorological has been added to the list of participating societies. The report affords evidence of the progress made by the *Journal of Scientific Instruments*, which now, at the close of its fourth annual volume, may claim to be firmly established. The journal has become a recognised medium for the publication of papers dealing with the instrumental aspects of scientific work. An important announcement in relation to the journal, of interest to present and future members of the Institute, was made at the meeting, namely, the decision of the Board that, commencing in January 1929, the journal is to be distributed without charge to fellows, and at a small charge to associates. Dr. C. V. Drysdale's resignation from the editorship, largely on account of ill-health, has been accepted by the Board with great regret; the secretary of the Institute, Mr. Thomas Martin, has been appointed his successor.

AT the close of the annual meeting of the Institute of Physics, Sir Frank Dyson gave his presidential address, taking as his subject "Physics in Astronomy." Among the developments of astronomy and astrophysics in which physics has played an important part are the successive improvements in the construction of clocks which have led to accurate timekeeping. The independence of the 'judiciary' and the 'executive,' that is, of the pendulum and the clock train, is largely secured by Riefler's work. The latest solution of the difficulties, resulting in a nearly perfect timekeeper, has been made by Mr. Shortt in conjunction with Mr. Hope Jones of the Synchronome Company, in the clock they have produced. Sir Frank Dyson also referred to the work of astronomers in ensuring uniformity of timekeeping by the distribution of time signals, from the dropping of the time-ball by hand, which was instituted by Pond at Greenwich at the commencement of the last century, to the final stage in which wireless is used in the co-operation of Greenwich with the British Broadcasting Corporation. Increase in the size of telescopes has called for the assistance of the engineer and physicist in the provision in the observatory of driving clocks and electric motors for moving the instrument and turning the domes and shutters; while the manufacture of optical glass has provided one of the principal and most important fields for the practice of physical science in the service of the astronomer.

PROF. S. LANGDON's summary of the sixth season's work of the Oxford-Field Museum Expedition's work at Kish, which appeared in the *Times* of May 17, serves to emphasise once more the remarkable additions to our knowledge of the early age of metal which have been made by the excavations in Mesopotamia of the last few years. In the past season this expedition has been engaged under its field director, Mr. M. F. Watelin, in the excavation of a mound to the north-west of the great stage tower of Hursagkalamma. After laying bare to a depth of 25 feet, the ruins of a temple of Sargonic times, dating from about 2700 B.C., over an area of 300 yards square, beneath a sterile stratum 7 ft. thick was reached a continuous red earth stratum of five feet in thickness which extended over the whole area and represented the temenos platform on which the stage tower and three great temples of Kish were erected. This represents plain level. At this point there is a definite break between the objects of the red stratum and those of the earlier civilisation beneath, which yields, as Prof. Langdon points out, "a most valuable chronological and archæological criterion in the evolution of ancient civilisation." In this earlier stratum excavations were carried down 25 ft. below plain level. Here were found a long series of brick-vaulted tombs with true arches, in which the bodies were laid upon boards resting on layers of potsherds. Inscribed cylinder seals and tablets cease at this level, and the funerary equipment is entirely different from that of the later strata. Stone bowls and spouted painted pots characterise the cemetery. Two of the tombs contained two- and four-wheel chariots mounted in bronze and with the bodies of the oxen. It would appear, therefore, that the custom of sacrificing oxen and attendants to accompany their master was practised. The overlying red layer is definitely dated as preceding 2900 B.C. Prof. Langdon dates this pre-Sumerian culture at about 1000 years before the oldest Sumerian inscriptions which can be translated. Prof. Langdon concludes by announcing that Dr. Rushton Parker has generously offered to give to the funds of the expedition 10 per cent of the total amount of any contributions received before Oct. 1 next.

THE Huxley-Wilberforce debate at the Oxford meeting of the British Association in 1860 has come to be regarded as a classic encounter in the progress of modern scientific thought, typifying the overthrow of rhetorical distractions, prejudice, and intolerance in face of cool reason. On all hands the effectiveness of Huxley's closing words were admitted, and it is strange that in spite of this unanimity, no member of that memorable audience could recollect the exact terms of his overwhelming retort to the Bishop of Oxford. Prof. E. B. Poulton's contribution to the *Jesus College Magazine* Lent Term number, therefore, makes some welcome additions. He shows that Huxley was present at the meeting against his own inclination, and quotes several versions of the encounter, revealing that the article in *Macmillan's Magazine* for October 1898 was written by Mrs. William Sidgwick. But the most accurate account is that contained in the letter from J. R. Green, who had just graduated B.A., to his college friend, now Sir William Boyd Dawkins. (It is amusing to picture this doyen of British prehistoric archæologists 'chucking' a snowball through the glass of Green's window, as he confessed to the author he had done.)

GREEN's letter was written three days after the meeting, and Prof. Poulton prints a communication from Huxley himself, written less than a year before his death, stating that in his opinion its account, with one emendation, was accurate. "I asserted, and I repeat, that a man has no reason to be ashamed of having an ape for his grandfather. If there were an ancestor whom I should feel shame in recalling, it would rather be a *man*, a man of restless and versatile intellect, who, not content with [an equivocal] success in his own sphere of activity, plunges into scientific questions with which he has no real acquaintance, only to obscure them by an aimless rhetoric, and distract the attention of his hearers from the real point at issue by eloquent digressions, and skilled appeals to religious prejudice." We have placed in parentheses the words which Huxley considered he did not use. Sir William Boyd Dawkins has expressed his intention of presenting the letter from which the above is a short extract, together with others of the deepest interest, to the archives of Jesus College, Oxford.

A CUNEIFORM tablet of Rusa I. of Chaldæa (733–714 B.C.), found by the Armenian scholar Avdalbegian in July last at Nor-Bayazet in Armenia, proves to be of considerable historical importance. It definitely identifies the Velitkukhi region with the district of

Nor-Bayazet, confirming the indication of another tablet of King Rusa in which Velitkukhi is mentioned among twenty-three countries conquered by that king. Some scholars identify Velitkukhi with Colchis, thus extending the Chaldæan conquests far into the north. The inscription is cut on a massive basalt slab, apparently the corner stone of some edifice, and consists of eight lines. An illustration, with translation, appears in the *Weekly News Bulletin* of Feb. 4 of the Russian Society for Cultural Relations with Foreign Countries.

THE *Eugenics Review* begins its twentieth volume in a new dress, in accordance with its increasing importance as a periodical dealing with everything that concerns eugenics or racial welfare. It is edited for the Eugenics Society by Mr. Eldon Moore. The current number contains the annual Galton Lecture by Dr. C. J. Bond, on the causes of racial decay. Mr. W. T. J. Gun replies to Prof. Raymond Pearl's rather hasty conclusion that great men have usually sprung from mediocre families, and Miss M. C. Buer discusses present and past birth- and death-rates in a review of Griffith's "Population Problems of the Age of Malthus." Other short articles are on "The Cost of a Child" and "Temperament and Social Class." The remainder of a number containing 74 pages is devoted to notes, book reviews and notices, and current periodicals. The net is spread widely, and everything bearing on the current problems of eugenics finds a place. The journal is valuable to all those interested in the problems of sociology, medicine, anthropology, and heredity applied to man.

THE popular interest taken in evolution in America is shown by a new monthly journal called *Evolution*, published in New York. A recent number has on its front page the "Family tree of Man," in which the relationships of the various types of human, prehuman, and anthropoid ape skulls are diagrammatically shown from an exhibit in the American Museum of Natural History. The nature of the contents of the number can be judged from some of the titles, which include "Thomas H. Huxley and Peter Kropotkin," "How Man differs from the Ape," "X-rays stimulate Variation," "Evolution and the New Perspective of Life Purposes," "How old is the World?" The editor does not deal gently with the Fundamentalists. The result should be to spread a more rational and unprejudiced attitude to the whole subject of man's origin and development.

IN September next, the Folk-Lore Society, which was founded in 1878, will celebrate its fiftieth anniversary. The occasion is to be marked by an International Jubilee Congress of Folk-Lore which will be held in London on Sept. 19–25. An influential advisory council is in process of formation. Among those who have already intimated their willingness to serve are: Sir James and Lady Frazer; Prof. R. M. Dawkins, president of the Folk-Lore Society; Prof. J. L. Myres, president of the Royal Anthropological Institute; Dr. M. Gaster; Dr. Haddon; Lady Gomme; Prof. Halliday; Sir Everard im Thurn; Prof. Westermarck; Sir Richard Temple; Prof. Sayce; Prof. Seligman; Sir D'Arcy Power; Mr. Henry Balfour; as well as a number of distinguished continental and American folklorists and anthropologists.

IN the issue of *Chemistry and Industry* for April 20 is an account of an address delivered by Prof. H. E. Armstrong before the Lancaster Astronomical and Scientific Association. The subject of the address, which was reported in full in the *Lancaster Observer and Morecambe Chronicle* for Mar. 23, was Edward Frankland. Prof. Armstrong was at one time an assistant to Frankland, and he gave an interesting account of Frankland's life as a man, rather than of his work as a chemist, which has been told before. One of Frankland's greatest scientific contributions was his investigation of public water supply and drainage, which led to a great reduction of cholera and typhoid fever during the latter half of the nineteenth century.

THE annual visitation of the Royal Observatory, Greenwich, will be held on Saturday, June 2. The Observatory will be open for inspection by invited guests at 3.30 P.M.

THE British Empire Cancer Campaign has received an intimation that His Majesty The King (Patron of the Campaign) will receive the overseas delegates to the forthcoming International Conference on Cancer at Buckingham Palace on Monday, July 16.

A PUBLIC meeting will be held at King's College, London, at 5.30 P.M. on Thursday, May 31, under the auspices of the University of London Animal Welfare Society, to discuss "Man's Duty to Animals." The chair will be taken by Prof. Hobday, Principal of the Royal Veterinary College, who is president of the Society.

A LARGE earthquake was recorded at Kew Observatory on May 14 at 22 hr. 27 min. 26 sec., G.M.T. The epicentre is estimated to be 5850 miles away in an easterly direction and is probably one of the islands off the Asiatic coast. The main shock was followed by a smaller one at the same distance away on May 15 at 2 hr. 49 min. 00 sec.

BY the will of Lieut.-Col. A. J. C. Cunningham, R.E., who died on Feb. 8, aged eighty-five years, the London Mathematical Society will receive £1000 for the improvement of the method of factorisation of large numbers, and £2000 for the publication of Col. Cunningham's unpublished printed mathematical works and the completion and publication of his mathematical MSS., and also his library of mathematical books. The residue of his estate is to be divided as to one-twelfth to the London Mathematical Society, and one-twelfth to the British Association, mathematical subsection, for preparing new mathematical tables in the theory of numbers.

AT a general meeting of members of the Institute of Metals, held in London on May 8, an invitation was received from the American Institute of Mining and Metallurgical Engineers to hold a meeting in the United States in 1932. The invitation was accepted,

and it is hoped the ample notice given of the proposed meeting will make possible a good attendance. The council of the Institute is endeavouring to arrange for an inclusive fare of about £100 to cover the entire cost of the trip, which will be of about five weeks' duration, and will take place in the autumn, both Canada and the United States being visited.

THE centenary of the incorporation by Royal Charter of the Institution of Civil Engineers will be celebrated on June 3–7. On Sunday, June 3, the president and council of the Institution, with members and delegates, will attend a service at 3 P.M. at Westminster Abbey. On the following day an address will be given by the president, Mr. E. F. C. Trench, at a reception in the Hall of the Institution, and in the afternoon the thirty-fourth James Forrest Lecture will be delivered by Sir Alfred Ewing on "A Century of Inventions." The remaining days of the celebration will be occupied by a conference dealing with railway, marine, hydro-electric, and other aspects of engineering, and with visits to engineering works. Cards of admission to the meetings of the conference can be obtained from the secretary of the Institution by members of other engineering societies.

THE council of the Institution of Electrical Engineers has made the following awards of premiums for papers read during the session 1927–28 or accepted for publication: The Institution Premium to Mr. F. H. Rosencrants; Ayrton Premium to Mr. F. Lydall; Fahie Premium to Mr. B. S. Cohen; John Hopkinson Premium to Mr. D. B. Hoseason; Kelvin Premium to Messrs. T. N. Riley and T. R. Scott; Paris Premium to Messrs. A. H. Law and J. P. Chittenden; Extra Premiums to Mr. E. C. McKinnon, Mr. H. B. Poynder, Dr. T. H. Turney, Mr. P. D. Morgan; Wireless Premiums to Prof. E. V. Appleton, Lieut.-Col. A. G. Lee, Messrs. G. W. N. Cobbold and A. E. Underdown; and Willians Premium to Lieut.-Col. H. E. O'Brien.

THE annual congress of the South-Eastern Union of Scientific Societies opens at Rochester on June 6, and Sir Martin Conway will take as the subject of his presidential address "Mountain Exploration." As a veteran explorer and traveller, his reminiscences on this subject will undoubtedly prove of much interest and importance. The congress will last over four days, and addresses will be given by Prof. E. W. MacBride, Dr. Mortimer Wheeler, director of the London Museum, Dr. William Martin, the well-known London archæologist, Mr. H. B. Milner, of the Royal School of Mines, who will lecture on "Geology from the Air," and others. Visits will be paid to Rochester Cathedral and Castle, Gads Hill and Dickens Land, Blue Bell Hill, where is the famous Kits Coty dolmen and other stone age relics, and other places of interest. Further information can be obtained from the honorary secretary, Mr. Edward A. Martin, St. Lawrence, Isle of Wight.

THE annual free booklet published by Messrs. Burroughs Wellcome and Co. is this year entitled "Pictorial Perfection in Photography," and besides some interesting pictorial illustrations and elementary details of manipulation, includes time and temperature tables for development with the various 'tabloid' developers prepared by the firm, some details regarding enlarging, and colour effects obtained by staining, by toning, and by double toning.

THE February issue of *X-Ray News and Clinical Photography*, published by Kodak Limited, is devoted to the use of X-rays in dentistry. The factors treated of are illustrated by diagrams, photographs, and examples, and include the position of the patient's head, the fixation of the head, the use of a film holder to prevent the film from slipping, the correct angle of the tube, and the exposures necessary for the various teeth under conditions that are given. Extra-oral work is also described showing how to avoid the super-imposition of the image of the anterior jaw on the area under examination.

ON the occasion of the Linguistic Congress at The Hague last month, an International Society of Experimental Phonetics was founded. The following elections took place: *President*, Prof. E. W. Scripture, of Vienna; *Vice-President*, Dr. E. A. Meyer, of Stockholm; *Honorary Members*, Prof. A. Meillet, of Paris, and Prof. L. Zwaardemaker, of Utrecht. The object of the Society is the promotion of scientific research in experimental phonetics. A *Bulletin* will be issued from time to time. The membership fee for 1928 is 5 shillings, or a dollar and a quarter. Applications with fee are to be sent to Prof. E. W. Scripture, Strudelhofgasse 4, Vienna, Austria.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A principal of the Acton Technical Institute—The Secretary, Middlesex Education Committee, 40 Eccleston Square, S.W.1 (May 30). An instrument maker to assist in making and repairing scientific instruments, at the Bradford Technical College—The Principal, Technical College, Bradford (May 31). A part-time lecturer in sociology at Bedford College for Women—The Secretary, Bedford College for Women, Regent's Park, N.W.1 (June 4). An assistant in the mining department of the North Staffordshire Technical College—The Clerk to the Governors, Town Hall, Hanley, Stoke-on-Trent (June 4). A lecturer in architecture in the University of Sheffield—The Registrar, University, Sheffield (June 4). A full-time teacher in the department of mechanical engineering of the Rugby College of Technology and Arts—The Organiser of Further Education in Rugby, 61 Clifton Road, Rugby (June 6). A senior technical officer in the Wireless Department of the Royal Aircraft Establishment, primarily for work on design and development of wireless receivers for use in aircraft—The Chief Superintendent, R.A.E., South Farnborough, Hants (June 9, on form A.258). An assistant lecturer in geography in the University of Birmingham—The Secretary, University, Birmingham (June 11). A lecturer in mechanical engineering and a lecturer in mathematics and physics at the Chesterfield Technical College—The Principal,

Technical College, Chesterfield (June 11). A part-time demonstrator in biology at King's College for Women (Household and Social Science Department)—The Secretary, King's College for Women, Campden Hill Road, W.8 (June 16). A reader in chemistry at the East London College—The Academic Registrar, University of London, South Kensington, S.W.7 (June 21). The John Lucas Walker studentship of the University of Cambridge—Prof. H. R. Dean, Pathological Laboratory, Medical School, Cambridge (June 29). A leather research chemist for the New Zealand Tanners' Research Association—The High Commissioner for New Zealand, 415 Strand, W.C.2 (June 30). A dairy bacteriologist, a dairy chemist, two senior plant pathologists, a senior plant geneticist, and a senior plant physiologist, each under the Australian Commonwealth Council for Scientific and Industrial Research—The Acting Secretary, Commonwealth Council for Scientific and Industrial Research, 314 Albert Street, East Melbourne, Victoria, Australia (Aug. 15). A test assistant at the Royal Aircraft Establishment for calculation work in connexion with engine investigations—The Chief Superintendent, R.A.E., South Farnborough, Hants (quoting A.275). A senior research assistant, experienced in the science and practice of poultry husbandry, at the National Institute of Poultry Husbandry—The Director, National Institute of Poultry Husbandry, Newport, Shropshire. Teachers of engineering and of mathematics and a full-time instructor in engineering workshops, with special qualifications in metal plate work, at the Wandsworth Technical Institute—The Principal, Wandsworth Technical Institute, S.W. An assistant in the physics department, Woolwich Polytechnic—The Principal, Woolwich Polytechnic, S.E.18.

Our Astronomical Column.

The Planet Mercury.—Mr. W. F. Denning writes: "A favourable easterly elongation of the planet Mercury will occur on June 3, and this rather difficult object ought to be well seen as an evening star between about May 26 and June 7. At spring elongations, Mercury is usually seen under the brightest aspect a few evenings before the date of elongation. This year the planet sets about two hours after the sun for about a fortnight, and should be distinctly visible to the unaided eye after sunset whenever the west-north-west sky is clear of clouds up to about June 7. The twilight is very strong at this period of the year, but Mercury will be brighter than a first magnitude star, and should be easily distinguishable by persons of ordinary vision. It exhibits a reddish lustre and presents a starlike aspect from the fact that its small disc shows scintillation similarly to that of the fixed stars. The low altitude at which it is usually observed encourages this appearance as the atmospheric effects are more pronounced when objects are near the horizon than when they are at considerable elevations. Were the English climate more favourable for astronomical observations, Mercury would be often seen either before sunrise or following sunset and considered an easy object, but clouded sky at low altitudes frequently prevents the attempts of observers being successful."

Magnetic Storms and Sunspots.—Among the astronomical exhibits from the Royal Observatory, Greenwich, which were on view during the conversazione held at the Royal Society on May 17, there was a series of solar photographs and reproductions of magnetic traces illustrating the frequent coincidence between very large terrestrial magnetic storms and large sunspots. The period represented by the exhibits was 1874–1927. During these 54 years there were recorded at Greenwich 17 large magnetic storms with ranges as follows: Declination 90′, or, Horizontal Force (or Vertical Force) 500 γ. In 15 of those cases there was, at the time of the commencement of the storm, a large sunspot (mean area 500 millionths of the hemisphere or greater) within 4 days of the sun's central meridian. At the time of one of the two remaining storms there was a smaller spot near the central meridian, but this spot had been a large one in the previous rotation, when it was associated with one of the 15 large magnetic storms. In the case of the remaining storm, there was also no large spot near the central meridian at the time, but possibly it is of significance that one solar rotation (about 27 days) afterwards a large spot originated near the central meridian. The coincidence shown between these very large magnetic storms and large sunspots is strongly suggestive of a relationship between individual spots and individual magnetic storms of a certain magnitude.

A Suggested Cause of New Stars.—M. C. Johnson offers in *M.N.R.A.S.* for March a suggested explanation of new stars. He points out that any acceptable explanation must be adequate to account for the large amount of energy liberated, and must be likely to occur sufficiently often to give two or three novæ annually; this includes the faint novæ that do not attain naked-eye visibility.

Collision of star with star would not occur often enough to be acceptable as a general explanation. The theory that the outburst is due to some sudden change in the star's interior has found favour of late, but we have no data for estimating whether such changes would occur sufficiently often to explain all cases.

We know that gaseous nebulæ extend through vast regions of space, so that the impact of a star with a nebula is not too improbable as an explanation; but the boundaries of nebulæ are so diffused that it has not been considered likely that a collision would give rise to such a sudden outburst as we observe in novæ. Mr. Johnson suggests that the first effect of the entry of a star into a nebula may be to form a blanket round the star which obstructs the output of its heat and so causes a gradual accumulation of heat which culminates in a violent outburst. The suggestion is similar to the explanation of long-period variables by supposing a smoke-cloud to form round them, bottling up the heat, until the latter accumulates and dissipates the cloud.

The author gives reasons for thinking that the entry of a faint dwarf into a nebula would be the most likely to produce the required conditions. It might be in the nebula for two centuries before the outbreak occurred, its light being dimmed by 40 per cent. Its surface temperature, taken as 3000° previously, might then rise to 11,000° for three months or so. Col. F. J. M. Stratton and Prof. E. A. Milne have helped and encouraged Mr. Johnson in this study.

Research Items.

GHOSTS IN EAST AFRICA.—A further contribution to the study of ghosts and devils in East Africa, by Mr. G. W. B. Huntingford, appears in *Man* for May. Among the Bantu, ghosts visit the huts of sick people only. When they appeared it was usual to go to a medicine man for medicine to exorcise them. A goat was killed, some of its blood put in a pot with the medicine, and it was left at some distance for the ghost to eat. The spirits of the dead live in holes in the ground and people in good health do not see them. A kind of evil spirit which is abroad at night takes the form of a black bird. Among the Syan of Bugishu in Uganda it is customary to make yearly offerings of eleusine corn to the spirits of the dead. If anyone neglects this custom the angry spirit comes at night and seizes him by the neck with its hands. In the morning he is ill and cannot eat. He must go at once to a medicine man, who will tell him to make an offering of a goat or fowl and beer. The goat or fowl is put in a tree at some distance, while the beer is put in a hole dug just outside the door of the hut. Certain of the witch doctors are said to turn into hyenas at night and to prowl around the huts of people they do not like, howling like hyenas (the Kitosh of northern Kavirondo). Among the Nilo-Hamitic peoples, the Nandi believe in a devil with one leg, nine buttocks, and a mouth which shines like a lamp, which they call Chemosit. It wanders about at night looking for children to eat, whom it entices by singing. Tobolwa Hill, in north-west Nandi, is said to be haunted. The spirits of people, cattle, and goats may be heard there. While others deny this, it is evident that the hill is not liked, and there are no huts or people anywhere near it.

PAGANISM IN THE CHURCHES.—Some interesting examples of survivals of pagan beliefs and practices in early and modern Christianity were cited in an article by Mr. C. E. Lart in the *Hibbert Journal* for April. The Edict of Theodosius of A.D. 380, later ratified by Gregory the Great in his letter to Mellitus, the missionary to Britain, allowed heathen temples to be reconsecrated to Christian use, and sanctioned the continuation of such rites and usages as could be turned to the purpose of the church. This recognised a practice which had already begun in the Church of the Catacombs. As a result, while the Church forbad the worship of sticks and stones, the local god became a saint, the pagan holy stone was sprinkled with holy water and a Latin cross was cut on it. The worship of fire, lighted torches, trees, fountains, wells, and menhirs were forbidden by numerous Church Councils from that at Arles in A.D. 453 down to that at Toledo in 692, and similar practices were forbidden by Charlemagne in 789, including that of beating the bounds. St. Patrick took holy stones into the church after sprinkling them with holy water, one such, covered with gold plates, being preserved in the Cathedral of Clogher until 1498. Traces of sun worship are numerous, for example, in the use of the south side of the churchyard, the north being allotted to suicides. The wedding ring is a symbol of the sun. Monasticism was taken over from Buddhism, and the nun was the vestal, the 'bride of the god.'

THE RODENTS OF CEYLON.—In continuation of his guide to the mammals of Ceylon, W. W. A. Phillips now describes the rodents (*Spolia Zeylandica*, vol. 14, 1928). Greater in numbers than any other mammalian order in the island, with the exception of the bats, they also show more differentiation in structure, as is indicated by the large variety of families, genera, and species. Of the twenty-seven indigenous forms, the majority are squirrels and rats, apart from which there occur only a porcupine and a hare. The specific descriptions contain many interesting notes on habits. It is remarkable to read of the ferocious disposition of the Ceylon gerbil, which has been observed to kill and devour a young rat and a small bat, and to have attacked a small monkey. Seasonal movements, and the control of the balance of Nature, are well illustrated in the succession of events which follow the maturing of the 'nillu' (*Strobilanthes*), a jungle plant common on the hill-sides. As soon as the abundant seed commences to ripen, a local migration takes place, and jungle fowl, bronze-winged doves, and many rats of different species make for the area, and gorge upon the seed. Some of the gourmands eat to death, and others reach the same end by becoming so lethargic that they fall easy victims to the carnivores which have followed hard upon the heels of the first migrants.

THE CLASSIFICATION OF SPIDERS.—Twenty-five years have passed since the last volume of Simon's "Histoire Naturelle des Araignées" was published, and in that time the study of spiders has so increased the number of known species and genera, that a revision is welcome. Prof. A. Petrunkevitch, whose preliminary paper on the subject was noticed in these columns four years ago, has now produced a striking and invaluable work—"Systema Aranearum"—in *Trans. Connect. Acad. Sci.*, **29**, 1-270. This lists the whole of the 2144 genera established to date, arranged in 55 families. Tables for dividing the families into sub-families are given wherever they are required, followed by the genera of each sub-family, printed alphabetically, with their authors, dates, and types. Finally, there is an alphabetical list of 623 generic synonyma, with their authors, dates, types, and the genera to which they should be referred. It is at present useless to expect complete agreement of all authorities upon every title, and there are a certain number of details which do not conform to the present British custom; but these are small blemishes in a work the importance of which it would be hard to overestimate. After long uncertainty, the order of spiders is reaching a welcome condition of stability.

STOMIATOID FISHES.—The species of the deep-sea Stomiatoid fishes have recently been reviewed by Mr. A. E. Parr as a result of a very rich collection of these fishes made by the *Pawnee* under the direction of Mr. Harry Payne Bingham (Scientific Results of the Third Oceanographic Expedition of the *Pawnee*, 1927. *Bulletin of the Bingham Oceanographic Collection*, vol. 3, art. 2, 1927). More than thirty species were captured, of which twenty-one were new to science, from the waters in the region of the Bahamas. Mr. Parr has grouped the families Astronesthidæ, Idiacanthidæ, and Melanostomiatidæ in a new suborder, the Gymnophotodermi. They are characterised by the presence of highly differentiated luminous organs combined with a primitive (though secondary) nakedness of the skin. The author has not included in this suborder the genus *Stomias* on the grounds that fishes of this genus possess scales that cannot be considered as having been redeveloped from a naked ancestor. At the same time, the genus cannot be regarded as a direct representative of a scale-bearing ancestor of the first Gymnophotoderm owing to the positions of its fins. Regarding *Astronesthes* as the most primitive of the recent Gymnophotodermi, the author traces the probable phylogenetic relationships of the genera of

the Melanostomiatidæ. Keys are given to the genera and species, and the new species are described, with illustrations by the author and by Mr. W. S. Bronson.

CHROMOSOMES IN MEIOSIS.—*Thespesia populnea* belongs to a genus of Malvaceæ related to the cottons (*Gossypium*). Youngman (*Annals of Botany*, v. 41, p. 755) finds that it has 13 haploid chromosomes, the same number as the Asiatic cottons, while the American cottons are known from the work of Denham to have twice as many chromosomes. Youngman describes a peculiar behaviour of the chromosomes of *Thespesia* during meiosis. He states that the 13 bodies of the heterotypic prophase become massed together and emerge in the metaphase as an equatorial belt of 8 bodies. This is interpreted to mean that 10 bodies fuse in pairs, leaving 3 unpaired. The latter pass undivided into one daughter nucleus, while the 5 pairs separate. A tetrad results, in which one nucleus has more chromosomes than the other three. The explanation suggested is that transverse fragmentation of certain chromosomes takes place at some stage in the life history. Some of the figures suggest imperfect fixation, but the problem involved is a very interesting one and will no doubt be cleared up by further investigation.

LONG-LIVED PLANT CELLS.—D. T. MacDougall and his collaborators have made some interesting observations regarding certain types of plant cells which seem to show remarkable longevity (*Amer. Nat.*, **60**, 393, and **61**, 385). Living medullary cells of the tree cactus (*Carnegiea*), well over a century old, have been recorded, and examination of elements of all ages indicates active enlargement during the second half of the century. The melon cactus (*Ferocactus*) has also been found to contain similar medullary cells of great age, the active growth in this case, however, ceasing after the first decade. In all of these cells, the carbohydrate constituents, pentosans and hexoses, progressively decrease with age, while the fatty constituents and nitrogenous materials change much less. Transformation of sugars to wall material with consequent thickening is apparent in *Carnegiea* and in the medulla of *Ferocactus*. It is interesting to note, however, that the disappearance of carbohydrates in the cortical cells of *Ferocactus* extends even to the cell walls, which are thinner after a hundred years than after the first ten years of their life, suggesting the removal and liquefaction of pentosans. Still more recently MacDougall and Smith have recorded living ray cells in the heartwood of *Sequoia sempervirens* (*Science*, vol. 66, No. 1715). The changes in the Redwood are accompanied by the disappearance of starch and protoplasts from all wood parenchyma cells, and the formation of an orange-coloured resin that completely or partially fills the lumina. Similar disappearance of starch from the ray parenchyma cells is not always followed by the death and disintegration of the protoplasts, and a thin layer of cytoplasm and a conspicuous nucleus are sometimes retained. Cells of this kind have been recorded by the authors from places seventy layers deep in the heartwood, and, as the sapwood was about twenty-three layers in thickness, the approximate age of the cells was reckoned at nearly a century.

ON *PALUDINA DILUVIANA*.—With the view of ascertaining which living form is nearest akin to the *Paludina diluviana*, Kunth, V. Franz (*Biblioth. Genetica*, Bd. 11) discusses the whole of the European species of *Paludina* (now better known as *Viviparus*). Following the earlier continental textbooks, the author reverses the names of the two common species, *V. viviparus* and *V. fasciatus*, a fact which has to be borne in mind when studying his paper. Careful descriptions of the shells of the several species with excellent figures and elaborate tables of measurements are given, but no anatomical details. The conclusion reached is that *P. diluviana*, Kunth, stands nearest to *P. pyramidalis*, Crist. and Jan, and belongs to the relatively thermophil group, so that its presence in deposits north of the Alps is thus indicative of warmer interglacial periods.

GEODETIC TABLES.—New geodetic tables for Clarke's figure of the earth of 1880 are published by the Royal Geographical Society (R.G.S. Technical Series, No. 4, 5*s*.). In a preface to the tables, Mr. A. R. Hinks explains that the International Congress of Geodesy and Geophysics at Madrid in 1924 decided to accept not Clarke's, but Hayford's figure of 1910 as the standard figure of the earth. The publication therefore contains also the transformation to the Madrid figure, that is to say, the 1910 figure of Hayford.

SURVEY OF NEPAL.—The General Report for 1926–27 of the Survey of India records that after three years' field work, the first survey of Nepal has been completed. The task was undertaken by the Maharaja of Nepal, who asked for the co-operation of Indian surveyors. The result is that it is now possible to publish a skeleton map of Nepal, a country of about 55,000 square miles, pending the preparation of maps on larger scales. The skeleton map showing the main features of the structure and drainage is attached to the report. Field work was carried out on a scale of 4 miles to 1 inch, and an 8-mile contoured map in three sheets is now being prepared. The new information will afterwards be incorporated in revised editions of the standard 'degree sheets.' The survey presented considerable difficulties by reason of rugged relief and diversity of climate. It is believed, however, that any inaccuracies will be practically inappreciable on the scales to be used. None of the triangulation stations is likely to be so much as 100 ft. wrong in position or 20 feet in height.

THE EAST AFRICAN EARTHQUAKE OF JAN. 6, 1928.—Mr. W. C. Simmons, of the Geological Survey of Uganda, has sent us an interesting account of an earthquake of intensity 10 (Rossi-Forel scale) which occurred on Jan. 6 in the Subukia Valley, thirty miles north of Nakuru, in the Great Rift Valley, Kenya. We regret to be unable to find space to print the communication in full, but the following digest gives some of the points of particular value included in it. The epicentre of the earthquake may be taken as about 0° 12′ N. lat., 36° 15′ E. long. On the eastern side of the Subukia Valley, near the foot of the Laikipia escarpment, a fault-line, indicated on the surface by a small scarp and series of cracks, was traced by Mr. Simmons for about 15 miles, running north-northwest and south-southeast. Where the slope of the escarpment approaches 40°, the fault appears to have a downthrow to the west of as much as 8 feet. The fault was nowhere seen in solid rock, but was always best developed in scree slopes and soil deposits on the hill-sides, so that the apparent downthrow is exaggerated by the slip. Where the fault crosses horizontal ground, it either becomes a crack with little downthrow or a series of anastomosing cracks, or is represented by a mound of soil running in the same direction. There is apparently very little horizontal displacement with the fault. It seems clear that this earthquake was due to the opening up of an old fault, and, as the Rift Valley shows very numerous lines of fault and is itself due to faulting, it is to be expected that earthquakes should occur.

A NEW INCINERATING FURNACE.—A furnace which has recently been designed to replace the old-fashioned muffle-furnace for the incineration of samples for chemical analysis is described by Dr. Fortnet of Berlin in the *Chemiker-Zeitung* of April 21. In this furnace the bulky fireclay parts have been very greatly reduced in extent and replaced by tall thin cylindrical shells, in which the air can circulate freely under its own draught round the specimen. Four of such shells are mounted on one base and the simultaneous combustion of four samples can be completed in less than an hour without the addition of oxygen or of solid oxidising reagents; nor does the sample require attention during the combustion. The furnace is supplied by Messrs. Armin Kühn of Charlottenburg.

A PATHOLOGICAL MICROSCOPE.—Reference was made in NATURE, April 14, to several distinctive features of the Beck Pathological Microscope which has been adopted for use in the laboratories of the London School of Hygiene and Tropical Medicine. A complete description of the instrument has now been included in Messrs. R. & J. Beck's catalogue (Section F). The microscope is of large size, and suitable for advanced students' use and for research investigations in bacteriological, medical, and general work. An important feature is the built-in mechanical stage, which is provided with a special holder to take ordinary slides. This can be easily removed, and the top plate will then accommodate a large petrie dish or culture plate which can still be moved by the mechanical motions. The usual cylindrical fittings of the substage have been replaced by dovetailed slides by means of which the change from one form of illumination to another can be made rapidly, accurately, and with the minimum disturbance of the adjustments of the instruments. The milled heads for the adjustment of the mechanical stage and of the substage have been placed on the left-hand side so as to leave the right-hand side clear for drawing. The fine focussing adjustment is operated by two milled drums, one on each side of the limb. Rotation of one of these moves the body at twice the speed obtained by rotation of the other. An intermediate as well as a fine adjustment is thus provided.

RUTHS' STEAM ACCUMULATOR.—In any industrial undertaking, shortage of steam in any one department has a serious effect on the output. In many cases the steam consumption of the various departments fluctuates widely, and the sudden demands have often no relation to one another. Owing to the limited thermal storage capacity of a steam boiler, it is not suitable to meet wide fluctuations in the load. To get over this difficulty, Dr Ruths invented some years ago a steam storage system which enables the steam to be generated at a constant rate although the load fluctuates between wide limits. His steam accumulators are now in use in several hundred factories, mills, and power stations throughout the world. The system is described in a booklet by A. J. T. Taylor, of Africa House, Kingsway, London, W.C.2. By using a steam accumulator, the requisite number of boilers can be considerably reduced, and yet the plant is able to carry on easily over the peak load. The accumulator is shaped like a very large cylindrical boiler, and special methods are used to ensure its thermal insulation. If the initial pressure of the steam in it is 60 lb. per square inch and the final pressure 10 lb., then the amount of steam produced would be 4·24 lb. per cubic foot of water initially in the boiler. A pressure variation of 50 lb. per square inch would be inadmissible in almost any boiler, but the Ruths' accumulator is specially designed for a large pressure drop. In a typical case investigated, the equalising effect of a steam accumulator due to its thermal capacity was found to be eight times that of a Lancashire boiler and forty times that of a standard water-tube boiler. The thermal loss by radiation from the steam accumulator is about 0·2 of a British thermal unit per square foot of exposed surface per hour per degree Fahrenheit. It is so small that the accumulator can be located outside the building, even when it is exposed to the rigours of a Swedish winter.

APPARATUS FOR USE WITH METALIX X-RAY TUBES.—We have received from Messrs. Watson and Son (Electro-Medical), Ltd., a catalogue of their 'Sunic' apparatus specially designed for use with the Philips 'Metalix' X-ray tube. The weight and cost of X-ray apparatus had been gradually increasing as the need for adequate protection was appreciated, until the introduction of the Metalix tube with its self-contained protection enabled apparatus to be made lighter and less costly, but at the same time providing adequate protection. On examining the apparatus described in Messrs. Watson's catalogue, one immediately notices the absence of the large and unwieldy protective box which had become such a familiar feature of most apparatus. As Messrs. Watson remark, though the protection at the tube is all that can be desired, it cannot protect against the scattered radiations from the patient: hence the provision of the usual lead rubber aprons and screens. All types of apparatus for diagnostic work are described and the combined couch and screening stand is of interest. In this apparatus, one tube and its carriage are used for upright screen, over and under couch work, and in addition, the apparatus can be used for tele-radiography, up to more than six feet tube to patient distance. All the tube movements can be made quickly without disturbing the patient. All the apparatus is of excellent quality and construction. A wide range of Metalix tubes is described, and a tube can be found suitable for any apparatus for diagnosis or therapy.

THE DETECTION OF FLAWS IN CASTINGS.—By the use of γ-rays so penetrating that they will pass through pieces of metal fifteen inches thick, the Russian State Radium Institute of Leningrad has effected, according to a *Daily Science News Bulletin* issued by Science Service of Washington, D.C., a marked improvement in the examination of thick metal castings, etc. Examination in this way, when compared with the normal X-ray investigation, possesses several distinct advantages. It is cheaper, since the radium lasts indefinitely: large and expensive photographic plates are unnecessary, since the rays which pass through the metal are detected by a special sensitive electroscope, and an automatic record can be taken which may be filed for reference. Another very distinct advantage is that the time required may be cut down to a couple of minutes for a large casting, whereas with X-rays an exposure of the order of several hours might be required, even when the metal is not much more than two or three inches thick. The apparatus is very simple: a glass capsule with the radium preparation is inserted into a deep hole bored in a large ingot of lead; all rays except the strong, narrow beam passing along the bore are stopped. The beam, after passing through the casting, encounters two filaments electrically charged and enclosed within a copper cage. So long as no ray penetrates the metal the air space between the filaments and the cage acts as an insulator. As soon, however, as the γ-rays get into the cage, the air is ionised and a current flows from the filaments to the cage, then through the galvanometer and back to the battery.

The Royal Society Conversazione.

THE first of the two annual soirées of the Royal Society was held at Burlington House on May 17. Sir Ernest Rutherford, president of the Society, received the guests, who were, on this occasion, supplemented by a number of the delegates attending the Harvey tercentenary celebrations. Fortunately for their peace of mind, visitors to this old-established gathering are under no stress to find the "principal scientific exhibit of the year"; an unwritten law of equality reigns, embracing all the departments of science.

A highly interesting illustration of the changes in crystalline form of ammonium nitrate with change of temperature came from the Explosives Branch, Research Department, Woolwich. The substance may occur in five different crystalline forms, according to temperature. Successive changes during cooling from the molten condition were demonstrated by illumination with polarised light and screen projection. Certain difficulties met during the filling and storage of shell with ammonium nitrate explosives are due to these changes.

Sir William Bragg demonstrated the crispations formed on liquids lying on vibrating surfaces, in the study of which Faraday had originally occupied himself, and described, in 1831. These effects underwent re-examination in 1883 by Lord Rayleigh, who confirmed Faraday's interpretations. The exhibit was a model of careful preparation and successful exemplification outside laboratory confines.

The British Museum (Natural History) provided five exhibits; in mineralogy (Dr. L. J. Spencer), the fluorescence of minerals in ultra-violet rays; in geology (Mr. W. E. Swinton), a model of an armoured dinosaur, but with a conjectural head; in zoology (Dr. Baylis), parasitic infection in a whale; the giant shipworm mollusc, allied to *Teredo*, with its shelly tube (Mr. G. C. Robson); and anatomical preparations of Ratite birds (Mr. P. R. Lowe). Dr. Imms, Rothamsted Experimental Station, suitably illustrated biological control in relation to insect pests and noxious plants. In conjunction with the Cawthron Institute, New Zealand, aided by grants from the Empire Marketing Board, and the Government of New Zealand, experiments are in progress with the view of checking the spread of gorse and the notorious ragwort, by the utilisation of insects. The biology of certain species concerned are being studied at Rothamsted prior to shipment. Mention should be made of an exhibit of marine animals and bottom deposits, obtained by the staff of the recent *Discovery* expedition.

The National Physical Laboratory had two exhibits, a high-temperature electric resistance furnace (Dr. Rosenhain and Mr. Prytherch), and an optical interference method of observing modes of vibration of piezo-electric quartz resonators.

The Royal Observatory, Greenwich, showed a transparency of the total solar eclipse, June 29, 1927, and also solar photographs and magnetic traces illustrating the frequent coincidence of large magnetic storms and big sunspots (*v.* p. 842).

Imperial Chemical Industries sent specimens of new ketone dyes; the British Silk Research Association specimens of fibre and yarn-testing instruments; the Cambridge Scientific Instrument Company an apparatus developed in conjunction with the British Research Association for the Woollen and Worsted Industries, and designed for maintaining constant the humidity of the air in rooms where hygroscopic substances, such as textile materials, tobacco, paper, etc., are being tested or stored.

Sir Robert Hadfield, among other interesting items, showed a machineable non-magnetic steel possessing a high yield point, and also samples of recently developed corrosion-resisting steel, indicating in particular greatly improved resistance to dilute sulphuric and phosphoric acids.

Lord Rayleigh demonstrated and offered interpretations of the fading of peacock's feathers in ultra-violet light, described by him in a communication in our correspondence columns (p. 827), and Prof. C. V. Boys exhibited solid dipleidoscope prisms, by means of which an object seen by external reflection from one face may also be seen in the same direction by light which has made two internal reflections.

The International Standard Electric Corporation sent an ingenious machine, though of strange and complicated make-up (of the kind that would have delighted Lord Kelvin) designed for the production, distribution, and analysis of artificial telephone traffic. Where automatic switches are arranged in simple groups, the quantities required to ensure a given grade of service can be determined from curves based on the theory of probability, but to test the efficiency of more complicated switch arrangements it has been necessary to resort to artificial traffic experiments, impracticable by mathematical means.

The Royal Botanic Gardens, Kew, sent examples of grasses used as cereals by African natives; and plants yielding an oil coming into repute in the treatment of leprosy. The species are tall trees occurring in the dense forests of India, Burma, and Siam. The Marine Biological Association showed Dr. Poole's submarine photo-electric photometer apparatus, as used on the Association's trawler. The photo-electric current is measured by a potentiometer, using an interrupter, condenser, and amplifier, with a telephone to indicate the null point.

Mr. J. Reid Moir exhibited limestone implements found at Coney Island, Rosse's Point, and Ballyconnell, Sligo, Ireland, which have been the subject of much discussion. The specimens, which are of limestone and exhibit early Mousterian forms and technique, were found by Mr. J. P. T. Burchell; and they are regarded as important evidence in support of the view that Lower Palæolithic man inhabited Ireland.

From the Pharmaceutical Society's School of Pharmacy came specimens of the animal materia medica of the seventeenth century. At this period entire animals, as well as parts and excretions of animals, were largely used medicinally.

An exhibit from the British Mosquito Control Institute, Hayling Island, shown in the principal library, occasioned much interest. With the projection on a screen of living larvæ and pupal stages, it proved highly instructive. The exhibit was arranged by the director of the Institute, Mr. J. F. Marshall, whose work in mosquito control has had important practical issues.

Among the general exhibits was a theodolite made in 1574 and signed by Humphrey Cole, the Elizabethan craftsman, described by Mr. George H. Gabb as the oldest known instrument of the kind; and there was shown, by Capt. R. Berkeley, a portrait of Sir Isaac Newton, which, although itself of considerable artistic merit, was somewhat unconvincing as regards recorded lineaments.

In the meeting room Dr. Stanley Kemp gave a short lantern lecture on the whaling industry in the Antarctic, which proved attractive and informative.

Oilwells in Great Britain.

IT will be recalled that during the late years of the War, a determined effort was made by the Government to locate oilfields in Great Britain, unfortunately without any commercial success. Of the eleven wells put down at the time, only two can be said to have given technically favourable results, one at Hardstoft, in Derbyshire, the other, the Darcy Well, near Edinburgh. Since that time, in the absence of any striking developments, interest in British oil possibilities has naturally waned, and most people are probably unaware that Hardstoft No. 1, first brought in on May 27, 1919, is still contributing its mite to the world's annual production.

Between that date when it was brought in and the end of last year, this well yielded 2500 tons of oil, about 17,500 barrels, equivalent to an average of just under 6 barrels per day. This oil is of good quality, and in many respects resembles some of the best Pennsylvanian crude. The gravity is 0·823 and, according to Hackford's analysis, the oil yields on refinement 7·5 per cent motor spirit, 39 per cent kerosene, 20 per cent gas oil, 30·5 per cent lubricating oils, 0·26 per cent sulphur, and 3 per cent of paraffin wax. In colour it is dark brown, with green fluorescence, has a setting point of 0° F., and viscosity at 100° F., Redwood 48 seconds. In common with Pennsylvanian crude, the Hardstoft oil possesses in its lubricating fractions a high percentage of oils suited to steam cylinder lubrication, which makes the analogy between the two crudes a still closer one.

The well is situated on a subsidiary anticline of the Pennine system, actually on a local dome developed on this fold, striking north-west-south-east; the folding is accompanied by much faulting. The well is drilled 3070 feet in a sandy limestone near the top of the main carboniferous limestone, though there seems to be some difference of opinion as to the precise horizon responsible for production.

Interest in Hardstoft has been reawakened by Dr. A. Wade's recent paper on this and two subsequent oilwells at Hardstoft, read before the Institution of Petroleum Technologists on April 3. The wells are on the Duke of Devonshire's property, and his agent, Capt. J. D. Penrose, has been instrumental in preserving detailed records and history of operations, without which many of the facts would have been lost to the public.

Hardstoft No. 2 was started on May 16, 1924; its location was chosen about 600 feet west of No. 1, and it was drilled 3125 feet without any other success than a good oil show at 760 feet (a 10-gallon sample after the well had stood for 24 hours), and 20,000 cubic feet of gas at 370 lb. pressure from 1620 feet, afterwards utilised as fuel for the boilers. This well went ultimately to water, and with 2800 feet constant head in the hole, which could not be reduced by bailing, it was abandoned on Mar. 24, 1925.

Hardstoft No. 3 was selected 600 feet north of east of No. 1 well and was started on Aug. 5, 1925. In results it was as disappointing as No. 2, though it was carried much deeper (to 3825 feet), being finally abandoned in a bed of lava on June 8, 1926. In this hole, shows of oil were struck at 1900 and 1978 feet, and a gas show at 1812 feet.

While it is evident that the general geological structure of the district is comparatively determined, the results of these three borings, with their contrasted logs and behaviour, show clearly that the subsurface structures are far from being understood, largely, no doubt, due to the extensive faulting prevalent. We are not aware of what particular methods were employed for subsurface correlation of the well-samples, whether, in point of fact, anything more than casual logging by the drillers was carried out. In any case, the very remote possibility of finding a commercial oil-pool in this area, or in any other in the British Isles for that matter, warrants further drilling neither in Derbyshire nor elsewhere, and although these three wells furnish a pretty problem for the oil geologist, they and their predecessors serve as a warning of what awaits further search for petroleum in Britain.

The Iron-Chromium-Carbon System.

AN important paper on "The Structure of the Iron-Chromium-Carbon System" was presented by Messrs. Westgren, Phragmén, and Negresco at the May meeting of the Iron and Steel Institute (May 3). As a result of the X-ray determination of the lattice dimensions of various iron-chromium alloys, it is shown that there is a progressive change from end to end of the system, confirming the general view that these metals form with each other an unbroken series of solid solutions. Three carbides of chromium have been detected in the *chromium-carbon series*, one, cubic, with a probable formula Cr_4C, a trigonal one Cr_7C_3, and an orthorhombic carbide Cr_3C_2. In the ternary system containing iron, cementite, which may contain chromium to the extent of rather more than 15 per cent, is also present.

For each of the chromium carbides substitution of iron for chromium may to some extent take place. In the cubic form the chromium may be replaced by iron up to about 25 per cent: in the trigonal carbide the iron content may rise to 55 per cent, but in the orthorhombic carbide only a few per cent of chromium can be replaced by iron. No definite double carbide, the presence of which would necessitate the presence of both iron and chromium atoms, is found.

In annealed chromium steels containing only one or two per cent of chromium, the only carbide found is cementite, the iron of which is partially replaced by chromium. The difference of distribution of the carbide in such steels appears to be due not to any definite difference of composition, but to something of the nature of segregation. The carbide in stainless steel is the cubic one saturated with iron. In a steel containing about 1 per cent of nickel, 11 per cent of chromium, and 2 per cent of carbon (used for dies), the trigonal carbide occurs, rather more than half of the chromium of which is replaced by iron. Sections through the ternary solid model show that as the chromium content is raised the area of the γ-iron phase is gradually reduced and finally disappears: the eutectic occurs at a lower carbon content than in iron-carbon alloys, for example, at about 3·7 per cent with 15 per cent of chromium.

The solubility of the carbide in austenite is reduced as the chromium is increased, and the cementite line consists of two distinct portions corresponding to the solubility of different types of carbide. With 3 per cent chromium, for example, the lower portion of the curve represents the solubility of the trigonal carbide, and the higher temperature region the solubility of cementite. With 15 per cent of chromium the lower temperature portion gives the solubility in the γ-phase of the cubic carbide, and at higher temperatures of the trigonal one.

University and Educational Intelligence.

CAMBRIDGE.—Sir Richard Threlfall, Gonville and Caius College, has been appointed to represent the University on the Grand Council of the World Power Conference's Fuel Conference. The Committee of the *Privy Council for scientific and industrial research* has appointed Mr. H. T. Tizard as a member of the University Committee for Magnetic Research.

EDINBURGH.—At the meeting of the University Court on Monday, May 14, Dr. F. A. E. Crew was appointed to be professor of animal genetics and director of the University Department of Research in Animal Breeding. The chair, which is to be known as the Buchanan chair of animal genetics, was founded by a donation from Lord Woolavington, supplemented by a grant from the International Education Board, New York.

LONDON.—Dr. Geoffrey Hadfield has been appointed as from May 1 to the University chair of pathology tenable at the London School of Medicine for Women.

Dr. Percival Hartley has been appointed as from Aug. 1 to the University chair of biochemistry tenable at the London School of Hygiene and Tropical Medicine. Dr. Hartley was educated at the Technical College, Bradford, and the Yorkshire College, Leeds. From 1909 until 1913 he was physiological chemist to the Imperial Bacteriological Laboratory at Muktesar, United Provinces, India, and in March 1913 he was appointed first assistant to the head of the Biochemical Department at the Lister Institute; from 1919 until 1921 he was head of the Biochemical Department of the Wellcome Physiological Research Laboratories, and since 1922 he has been on the staff of the National Institute for Medical Research, Hampstead.

Dr. C. B. Fawcett has been appointed as from Aug. 1 to the University chair of economic geography tenable at University College. From 1906 until 1911 Dr. Fawcett was geography master in the Derbyshire County Secondary School at Long Eaton, near Nottingham, and from 1911 until 1913 he worked in the School of Geography at Oxford, obtaining the Diploma in Geography with distinction and the B.Litt. degree as a research student. Later he was lecturer in geography at University College, Southampton, and worked part-time in the Ordnance Survey Office during the War, while since 1919 he has been lecturer, and later reader, in geography in the University of Leeds. Dr. Fawcett was editor of the "General Handbook" for the Leeds meeting of the British Association, for which he wrote two sections.

The title of professor of experimental pathology in the University has been conferred on Dr. Archibald Leitch, in respect of the post held by him since 1921 as Director of the Research Institute at the Cancer Hospital.

The title of reader in pathological chemistry in the University has been conferred on Dr. C. R. Harington, in respect of the post held by him since 1922 as lecturer in pathological chemistry at University College Hospital Medical School. Dr. Harington is known for his work on the chemistry of thyroxine and related subjects, published chiefly in the *Biochemical Journal*.

APPLICATIONS for grants from the Chemical Society Research Fund, made upon forms obtainable from the Assistant Secretary, Chemical Society, Burlington House, W.1, must be received by, at latest, June 1.

THE Committee of Leplay House E. T. A. has organised the following tours for those interested in historical, geographical, and social studies: (1) To south Sweden, visiting Gothenburg, Stockholm, afterwards going to Lappland; (2) to Aldrans, above Innsbruck, in the Austrian Tirol; (3) to St Peter in the Black Forest, 'students' camp.' Particulars of these visits can be obtained from Miss Margaret Tatton, Leplay House, 65 Belgrave Road, S.W.1.

DR. DU BOIS, a Swiss biologist of the University of Geneva, recently working with Prof. Caullery in Paris, has been awarded a Junior Fellowship in Science (£250) by the International Federation of University Women, to enable her to continue her research in Berlin. This is the first of a series of fellowships for graduates wishing to carry on research in a country other than that in which they have previously worked, for which an endowment fund is being raised.

APPOINTMENTS to the twenty fellowships awarded by the Commonwealth Fund and tenable by British graduates in American universities for the two years beginning in September 1928, include the following: Mr. R. H. Angus, of Sydney Sussex College, Cambridge, to Stanford University, in electrical engineering; Dr. G. A. Cumming, of St. Andrews, to the California Institute of Technology, in geology; Mr. Cyril D. Forde, of University College, London, to the University of California, in anthropology; Dr. Norman P. Inglis, of the University of Liverpool, to the University of Illinois, in engineering (metallurgical); Dr. J. M. Robertson, of the University of Glasgow and the Royal Institution, London, to the University of Michigan, in chemistry; Mr. Robert Spence, of Armstrong College, University of Durham, to Princeton University, in physical and engineering chemistry; Miss C. S. Steele, of St. Andrews, to the University of Illinois, in organic chemistry.

THE Association of Teachers in Technical Institutions is holding its annual conference this year at Bradford Technical College, May 26–29. Among the resolutions to be discussed at the conference is one relating to the social applications of biological science. It expresses agreement with the spirit and intention of certain resolutions of a conference of the British Social Hygiene Council and representatives of education aiming at the adoption by health, education, and labour authorities of practical measures for dispelling the prevalent ignorance of elementary biology. "In order to provide a foundation on which an adequate sense of racial responsibility may be developed," biology teaching ought, it is urged, to be extended to all schools, the type of teaching being in each case such as to fit the ages and circumstances of the pupils. Attention is directed likewise to the urgent need of such further education for adolescents between fourteen and eighteen years of age as "would encourage a sense of individual responsibility in the science and art of healthy living." Another resolution signifies approval of the action taken by the President of the Board of Education as a result of the recommendations of the Emmott Committee. The first-mentioned resolution stands in the names of Mr. J. Wickham Murray, secretary of the Association, and Mr. A. E. Evans, of the Battersea Polytechnic, honorary secretary, on behalf of the Association's executive committee. The address of the new president, Mr. W. W. Sirman, of the Technical College, Handsworth, will be delivered on May 28, and there is to be an address on the following day by Mr. Arthur Greenwood, M.P., followed by a visit to the research station of the British Research Association for the Woollen and Worsted Industries.

Calendar of Customs and Festivals.

May 27.

WHITSUNTIDE.—Whitsuntide observances bear a close resemblance to those of Mayday. This is clearly seen in the custom of decorating an individual with green boughs, who, it may be inferred, represents the spirit of vegetation, and occasionally of subjecting him or her to some form of indignity or horseplay which it is not far-fetched to regard as a survival of a sacrifice. The leaf-clad man may be drenched with water, or thrown in a brook, when he scatters water on the bystanders, thus distributing his own 'virtue'; his head may be cut off, or he may be stabbed. Frazer, in "The Golden Bough" (vol. 2, pp. 89 *sqq.*, etc.), quotes a number of instances of this observance at Whitsuntide, among them a Russian example in which a young birch tree is dressed up in female clothes and brought to the village, where 'she' remains as a guest for three days in one of the houses and is then thrown into the water.

In England various Whitsuntide observances have been recorded. None is perhaps in itself so clearly indicative of the nature of the Whitsuntide ceremonial as the central European customs quoted by Frazer, but taken as a whole they point to its origin in a seasonal festival.

One trace at least of its character as the opening of the year survives in the custom of hiring farm servants at this season, the engagement being for the whole of the succeeding year. A similar practice obtains in November, which survives from the Celtic custom of beginning the year at this date. At Whitsuntide it was customary for the hired servants to return to their homes for a week's holiday. It is probably to this interval that we owe the survival of a considerable number of Whitsuntide customs, especially the itinerant performance of Morris dances and the practice of holding sports and contests of the familiar winter versus summer type. Races were one of the features recorded in connexion with Maypole and other Mayday observances.

WHITSUN ALE.—In many parishes throughout the country it was customary for a collection to be made just before or at Whitsuntide. This was expended on the provision of cakes and ale for a feast which was held at the church house. Wardens were elected for the purpose of making the arrangements, and any surplus funds were afterwards reserved for extraordinary parish expenditure. The well-known Eton Montem, which was sometimes attended by the reigning monarch and his consort, was of an analogous character. A procession of Eton scholars in military or fancy dress marched in procession to a mound on the Bath Road, where they took up their position, and then exacted a toll of money 'for salt' from all present and from all travellers passing. Sometimes as much as £1000 or more was collected.

After the Whitsun Ale feast, the afternoon was usually devoted to sports. That this feast was originally of a sacrificial character is indicated by the record of a curious custom at Kidlington, Oxford, on the Monday after Whitsun, when the maids in the town, with their thumbs tied behind them, ran after a lamb, which they tried to catch with their teeth. When it was caught, the successful maid became the 'lady of the lamb,' the animal was dressed and carried in procession on a long pole before the lady and her companions, accompanied by Morris dancers. On the following day the lamb was eaten at the 'lady's feast,' when the lady sat at the head of the table.

In several localities, for example, Heybridge, Essex, Monk Sherborne, Hants, and Herefordshire, rushes were strewn in the church or sprigs of birch were attached to the pews as decorations. Sometimes, as in Northampton, there was a maypole at the Whitsun Ale, as well as a Lord and Lady. At a fair held on Whitsun Monday at Hinkley, Leicestershire, an elaborate procession of the trades took place, which included several grotesque characters, such as Baron Hugo and his lady, the Baroness Adeliza. In Shropshire a 'boy bailiff' was elected for Whitsun week. He was accompanied by a retinue of men and boys mounted on horseback, who carried wooden swords at their right sides. They first rode round the whole franchise and then were met at the Guildhall by the civic authorities. An elaborate Court of Array was held at Litchfield, in which Morris dancers, the bailiffs and city officers, and the members of the trades and guilds with standards or posies took part. The posies afterwards become implements of trade or more puppets or garlands borne upon halberds, which nevertheless were received as they visited each ward with a volley from the men-at-arms. These last also fired over each house at which they received money and liquor from the inhabitants.

Immediately after the annual hirings were completed, it was customary for the men and women to hold a dance, in which the men chose their partners in a more or less recognised manner which suggests a forgotten ritual of pairing. In some parts of Wales it was indeed the custom for boys and girls to retire, each sex apart, to a wood, when individuals in each party elected or declared the choice of a partner from the opposite sex. On their return to the dancing place, each had to take his declared partner, under a penalty in case of default.

THE MORRIS DANCES.—A regular feature of the Whitsuntide observances was the Morris dance. The name Morris was generally derived from the word *Morisco* – Moor, and it was said that the dances came from Spain. More probably, however, the name itself is derived from the fact that the dancers once used to black their faces, and although dances of a similar character are even now regularly performed in elaborate form, including a bear dance, in the Pyrenean area, similar dances are too widely distributed to warrant a Spanish or Hispano-Moorish origin. The dance, it is scarcely open to question, is a survival of a ritual dance, representing the primitive vegetation spirit ceremonies. This was the view suggested by the late Mr. Cecil Sharp. It is a survival of the sacrifice of the vegetation spirit and the subsequent meal in which the worshippers took part. In the related sword dance the knotting of the swords clearly represents the killing of one of the dancers, and although the Morris dancers carry handkerchiefs and not staves, Mr. Sharp's suggestion that the handkerchief is a survival of the sword is probably correct. It is to be noted that in more than one of the Whitsuntide ceremonies, not the dances, it is recorded that those who took part wore wooden swords. In some of the Morris dances a cake is carried on a sword decorated with ribbons and flowers before the six dancers. This may be all that survives to indicate the sacrificial meal, or victim. At Kidlington, however, the lamb, as mentioned above, was actually carried on a pole at the head of the procession before it was eaten. Finally, the religious character of the Morris is indicated by the fact that in some villages the dance took place in the church tower, whither it must have been relegated from the chancel, where in the early Christian church the dances absorbed from paganism used to take place until they were forbidden.

Societies and Academies.

LONDON.

Linnean Society, May 3.—**G. S. Carter**: The swamps of the Paraguayan Chaco. The Paraguayan Chaco is a plain stretching westwards from the Rio Paraguay towards the Andes. A belt within 100 miles of the river consists partly of grassland, in the more open parts of which are large areas of shallow swamps. During the summer months the climate is tropical, and the nature of the water most largely influenced by the amount of the rainfall. The most striking result of the analyses was the evidence that they gave of the small amount of oxygen present in the water at all times. The co-operation of several conditions, such as the absence of disturbance and the large amount of decay in the water, produces this result. The oxygen-content plays a determining part in the control of the fauna, which includes many forms adapted to life in a medium poor in oxygen. This was especially clear of the fishes and the oligochætes.

Royal Meteorological Society, May 16.—**Sir Gilbert T. Walker**: On periodicity and its existence in European weather (*Memoir*, vol. 1, No. 9). When examining the amplitudes of a number p of the periods that can be derived by analysing a series of numbers, it is important to know how many of these are independent. Further, we must compare the biggest amplitude found with the probable biggest that would be produced by purely random figures, and in order to estimate this we want to know how many of our p amplitudes are independent. This is determined as the number of Fourier frequencies, corresponding to submultiple periods, each of which has one or more of the calculated frequencies nearer to it than to any other Fourier frequency. Applying this to European weather, it is concluded that the periods in temperature of 12¼ and 13 months, apart from the annual period, may be regarded as real. Under ordinary conditions it is sufficient if, instead of the accurate figures to be analysed, we use group figures of which the interval is as large as a third of the standard deviation.—**D. Brunt**: Harmonic analysis and the interpretation of the results of periodogram investigations (*Memoir*, vol. 11, No. 15). The paper collects together for convenience of reference the formulæ used in harmonic analysis. In a general discussion of periodogram results, it is shown that Walker's method of deriving the 'probable greatest amplitude' is faulty. Discussing the periodogram of London temperatures, it is shown that only a very small part of the variations of temperature from month to month can be accounted for by the periods the amplitudes of which are equal to, or greater than, 0·39° F.—**C. E. P. Brooks**: Periodicities in the Nile floods (*Memoir*, vol. 11, No. 12). The paper analyses a series of records of Nile floods extending from A.D. 641 to 1451, by means of the 'difference-periodogram.' Nineteen periodicities are determined, ranging from 1·91 to 76·8 years in length, with mean amplitudes up to 16·9 cm. (the standard deviation of the Nile flood is 56 cm.). The majority are submultiples or multiples of 22·12 years. The lengths undergo a fairly regular variation with a cycle of about 500 years, the cause of which is not known.

CAMBRIDGE.

Philosophical Society, May 7.—**J. Taylor**: On the action of the Geiger α-particle counter. The action of the counter, its partial reversibility, and its self-restoring properties are considered as a general problem of intermittency in discharge tubes and explained on three bases: the threshold current hypothesis, the shape and significance of the volt–ampere characteristics, and the photo-electric theory of sparking potentials.—**J. Taylor and W. Taylor**: The high-frequency electric discharge at low pressures. Some new forms of the well-known high-frequency electric discharge at 4×10^7 cycles per sec. are studied at very low pressures (10^{-3} mm. and less) and the presence of more than one type of discharge is demonstrated.—**E. J. Williams**: Some applications and implications of Duane's quantum theory of diffraction. The quantum theory of diffraction is applied to the reflection of electrons by crystals and to the spatial distribution of photo-electrons and fluorescent radiation from a crystal. The extent of coherent scattering of X-radiation by a crystal is also considered.

PARIS.

Academy of Sciences, April 16.—**H. Deslandres**: A new comet discovered at the Paris Observatory. This comet was observed by M. Giacobini on Mar. 17, and was again seen on Mar. 23. Positions are given for Mar. 17 and 28, the latter from photographs by M. Mineur.—**Charles Moureu, Charles Dufraisse, and Louis Girard**: Researches on rubrene. New experiments with rubrene peroxide. Crystallised from various solvents, the crystals always contain solvent of crystallisation. The dissociation of the peroxide by heating gives as the only gaseous products carbon dioxide and oxygen; the latter corresponding to from 74 to 80 per cent of the total oxygen present in the compound.—**H. Douvillé**: Concerning ophite.—**André Blondel**: The adaptation of bifilar oscillographs to the study of triode valves. The bifilar oscillograph in its usual form is not sufficiently sensitive for recording the variable currents in triode valves. Various modifications are suggested, that involving the use of a specially designed transformer proving to be the best.—**Alexandre Pantazi**: The extension of a theorem of Čech on projective applicability.—**Mandelbrojt**: The singularities of Dirichlet's series.—**Michel Broszko**: The yielding of prismatic bars compressed axially.—**Charles Volet**: A new method for the absolute determination of gravity by the pendulum. In the method proposed, all the measurements are made with the same knife-edge submitted to a constant load: the time of oscillation is varied by displacing a mass on the rod. Some advantages over the usual method are claimed.—**R. de Mallemann**: Calculation of the rotatory power of quartz.—**Mlle. M. Hanot and H. Guillemet**: The laws of photographic blackening: the case where the source of light is a series of electric sparks. From the results of the experiments described, it is concluded that in researches in photographic photometry with sparks, such as the study of a spark spectrum, the factor of contrast of the plate may be determined either with a continuous or intermittent source.—**Victor Henri and Svend Aage Schou**: The absorption spectra of formaldehyde and carbon monoxide. Close relationship between the two molecules. Analyses of the absorption spectra show close analogy between carbon monoxide and formaldehyde. The latter is a bivalent molecule having a system of triplets with the same separations as carbon monoxide. Moreover, in the absorption spectrum of carbon monoxide, the intercombination bands $^1S - ^3P$ are found as in the case of bivalent atoms.—**G. Denigès**: The rapid estimation of the phosphate ion in soils and manures by means of molybdenum blue.—**Bodard**: The volcanic activity of Rakata.—**Ch. Jacquet and H. Bellocq**: Magnetic measurements in Corsica and Charente. Results of work done in 1926 at 56 stations, 24 of which are new.—**P. Idrac**: The registration of submarine currents of the Straits of Gibraltar. A change in the direction of the current was proved at a depth of 200 metres.—**Antonin Němec**: Determination of the requirements of the soil in

phosphoric acid according to the soluble silica.—**H. Bierry and Max Kollmann**: The mode of action of vitamin B. From the experimental results described, it is concluded that the stimulating action of the water-soluble vitamin B acts both on the glands with internal secretion and those with external secretion.—**Auguste Lumière and Mme. R. H. Grange**: The comparative toxicity of the serum of arterial blood and that of venous blood. Venous blood serum is always much more toxic than the serum from arterial blood. This is in agreement with the authors' hypotheses on the mechanism of the toxicity of the sera from mammals for animals of another species.—**A. Policard**: The study, by micro-incineration, of the amounts of mineral matter fixed by various parts of the cell. The methods described in an earlier communication have now been applied to animal cells.—**E. Nicolas and K. Katrandjieff**: The antigen character of albumens modified by heating and their specific differentiation by precipitating sera. The authors regard their work as solving the problem of the specific differentiation of cooked meats.—**Costantino Gorini**: Climbing culture and microbial dissociation.—**S. Nicolau and Mlle. E. Mateiesco**: Septineuritis of the rabic virus. Proof of the centrifugal course of the virus in the peripheral nerves of rabbits.

April 23.—**Pierre Termier and Eugène Maury**: New geological observations in eastern Corsica. The radiolarites. The radiolarite abounds in eastern Corsica. It appears, with the same petrographical characteristics, in two kinds of layers, those of the Apennine type, with non-metamorphosed limestones and clays, and in deposits of the Pennine type, with limestone schists much metamorphosed. In the layers of both types it is connected with the green rocks, and there is no essential difference between the two ophiolithic series.—**Louis Roy**: The equations of elastic surfaces with three parameters.—**E. Mathias**: Magnetic measurements in the Allier and the Puy-de-Dôme. These measurements form part of the new magnetic network of France and were carried out in 1925, with the assistance of grants from the Loutreuil Foundation. Elements are given for 37 stations, 28 of which are new.—**L. Féraud**: Surfaces admitting a finite group of projective deformations.—**V. Hlavatý**: The second fundamental form relative to the geodesic curves of a V^*_2 in V^*_3.—**Serge Bernstein**: The polynomials of Jacobi.—**de Possel**: The prolongation of the surfaces of Riemann.—**J. Delsarte**: Certain groups of non-Euclidian functional rotations.—**André Roussel**: A generalisation of the notion of primitive.—**Al. Proca**: Further reflections on dynamics. Interferences.—**F. Margond**: The general equations of a synchronous machine, not saturated, outside the normal regime.—**C. Chéneveau**: The magnetic susceptibility of aluminium. Measurements were made on a specimen of aluminium purified by Hoppes' method (iron 0·06 per cent) and on the commercial metal (iron 0·5 per cent). There appears to be no simple relation between the proportion of iron present in the metal and the magnetic susceptibility of aluminium.—**Mme. Ch. Lapp**: The measurement of the true specific heats of nickel by a direct electrical method. The changes in the specific heat of nickel with the temperature were measured over the temperature range $-175°$ C. to $+460°$ C. The point of discontinuity found at 357·6° C. agrees with the point of magnetic discontinuity (Curie point).—**Y. Rocard**: New diffused radiations. A theoretical explanation of the experimental results of C. V. Raman.—**J. Gilles**: The structure of the second order spectrum of sulphur (S II).—**Maurice Lambrey**: The absorption spectrum of nitric oxide.—**J. Cabannes**: The theoretical calculation of the diffusion of light in a fluid.—**J. F. Saffy**: Profound alteration of a copper-nickel alloy by the action of steam superheated to 350°-400° C. The alloy containing nickel (68·6 per cent), copper (28·9 per cent), manganese (1·6 per cent); it showed great resistance towards a series of corrosive reagents and kept its mechanical properties after seventeen months in steam at 150° C. But this alloy suffered marked change, losing its mechanical properties after a month in superheated steam at 375° ± 25° C.—**Pierre Jolibois, Henri Lefebvre, and Pierre Montagne**: The decomposition of carbon dioxide at low pressure under the action of the electric current. The tube containing the gas had its electrodes connected with a source of continuous current with several megohms resistance in series. For currents varying between 0 and 2 milliamperes the final dissociation equilibrium was independent of the current intensity, but this equilibrium was reached more rapidly with the larger current. The amount of gas dissociated increases as the pressure of the gas is lowered.—**M. Guichard, Clausmann, and Billon**: The expansion in hydrogen of metals and alloys containing a little oxide.—**F. Bourion and Ch. Tuttle**: The cryoscopic determination of the molecular equilibria of resorcinol and pyrocatechol in aqueous solution.—**R. Cornubert and H. Le Bihan**: Attempts at the benzylation and phenylation of α-methylcyclohexanone.—**P. Brenans and Ch. Girod**: Bromoiodo-phenols obtained with the 5-bromo- and 3, 5-dibromosalicylic acids.—**Ch. Mauguin and L. Graber**: The study of micas containing fluorine by means of the X-rays. A lepidolite containing 6·82 per cent of fluorine has exactly the same parameters as a lepidolite containing only 1 per cent of fluorine. The number of atoms of fluorine and of oxygen is variable in different minerals, but their sum is constant, and it appears that one or more atoms of oxygen can be replaced by the same number of atoms of fluorine in the crystalline network.—**Duboin**: The reproduction of tenorite, oligist iron, and cobalt oxide as crystals. The crystals are formed by the prolonged action of fused potassium fluoride (two or three days at a red heat).—**H. Parent**: A Pyrenees irregularity on the edge of the Maurettes.—**Pierre Viennot**: The extrusions which mark the edge of the French Pyrenees.—**J. Repelin**: The tectonic of the hills forming the southern edge of the Marseilles basin (Carpiagne).—**J. Thoulet**: The Humboldt current and the sea of Easter Island.—**Lucien Daniel**: The variations in calcium oxalate in certain grafted plants.—**Michel-Durand**: The physiological rôle of the tannins.—**Jules Amar**: The water united with colloids.—**Philippe Fabre**: The comparison of the parameters of muscular excitability by the microscopic examination of the reactions.—**J. Risler, A. Philibert, and J. Courtier**: The photobiological action of radiations. The light emitted by the instantaneous volatilisation of an aluminium wire by a continuous current has high penetrative power and its bactericidal power is greater than that of any other source of light hitherto studied.—**W. Arciszewski and W. Kopaczewski**: Microbial antagonism and the problem of cancer. The antagonism between *B. tumefaciens* and *Streptococcus erysipelatus* appears to be a biological fact capable of physico-chemical explanation. A real and strong physico-chemical antagonism appears to exist between *B. prodigiosus* and the bacterial agent of erysipelas. Biologically, the introduction of this organism in the treatment of tumours of plants by the Streptococcus is without effect.—**Et. Hubault**: A bacillus parasite of the caterpillars of *Dasychira pudibunda*. A detailed morphological and biological description of this parasite is given: its virulence and toxigenic power are under examination.—**E. Brumpt**: A new trypanosome pathogenic to cold-blooded vertebrates, *Trypanosoma parroti* from *Discoglossus pictus*.

Official Publications Received.

BRITISH.

Proceedings of the Royal Society of Victoria. Vol. 40 (New Series), Part 1. Pp. v+57+7 plates. (Melbourne.)

Memoirs of the Indian Museum. Vol. 8, No. 4: Recent and Fossil Viviparidae; a Study in Distribution, Evolution and Palaeogeography, by Dr. B. Prashad; The Mantle and the Shell of the Viviparidae, by Dr. B. Prashad. Pp. 153-328+plates 19-24. (Calcutta: Zoological Survey of India.) 6 rupees; 9s 9d.

British Chemical Abstracts issued by the Bureau of Chemical Abstracts. Index 1927. Pp. ii+514. (London and Edinburgh: Gurney and Jackson.)

The Physical Society. Proceedings, Vol. 40, Part 3, April 15. Pp. 71-157. (London: Fleetway Press, Ltd.) 7s. net.

Quarterly Journal of Pharmacy and Allied Sciences, incorporating the Year-Book of Pharmacy. Vol. 1, No. 1, Jan.-Mar. Pp. vii+162. (London: The Pharmaceutical Press.) 10s.

Union of South Africa: Department of Agriculture. Science Bulletin No. 63: South African Tanning Materials (The Black-Wattle). By C. O. Williams. (Division of Chemistry Series No. 84.) Pp. 68. (Pretoria: Department of Agriculture.) 6d.

Transactions and Proceedings of the New Zealand Institute. Vol. 58, Part 4, December 1927. Pp. iv+359-638+xii. (Wellington, N.Z.)

Association of Teachers in Technical Institutions. Programme, Bradford Conference, 1928. Pp. 20. (London.)

Transactions of the Royal Society of Edinburgh. Vol. 55, Part 3, No. 27: The Inheritance of Long and Short Wings in the Weevil (*Sitona hispidula*), with a Discussion of Wing Reduction among Beetles. By Dorothy J. Jackson. Pp. 665-735+7 plates. 11s. 6d. Vol. 55, Part 3, No. 29: The Highland Schists of Middle Deeside and East Glen Muick. By Dr. H. H. Read. Pp. 755-772+2 plates. 8s. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

The Institution of Gas Engineers. Seventeenth Report of the Gas Investigation Committee: Examination of Products of Combustion from Typical Gas Appliances. Part 2: Gas Fires. (Presented June 14, 1927.) Pp. 85-154. Eighteenth Report of the Gas Investigation Committee: Studies in Carbonization, Part 2. (Presented June 14, 1927.) Pp. 207-270. (London.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 19 (N.S.), No. 1: Award of the Boyle Medal for Pure Science to William Ringrose Gelston Atkins, O.B.E., Sc.D., F.I.C., F.R.S., 1928; Report of the Committee of Science and its Industrial Applications. Pp. 9. 6d. Vol. 19 (N.S.), No. 2: Award of the Boyle Medal for Applied Science to Walter Ernest Adeney, D.Sc., F.R.C.Sc.I., F.I.C., 1928; Report of the Committee of Science and its Industrial Applications. Pp. 11-15. 6d. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate Ltd.)

British Non-Ferrous Metals Research Association. Eighth Annual Report for the Year ending December 31st, 1927. Pp. 44. (Birmingham.)

Proceedings of the Royal Society of Edinburgh, Session 1927-1928. Vol. 48, Part 1, No. 7: Note on the Sympathetic Nervous System of *Lepidosiren paradoxa*. By Penelope M. Jenkin. Pp. 55-69. 1s. Vol. 48, Part 1, No. 8: The Invariant Theory of the Quaternary Quadratic Complex. I. The Prepared System. By H. W. Turnbull. Pp. 70-91. 2s. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 66, No. 377, May. Pp. 453-568+xxxii. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

The Journal of the Royal Agricultural Society of England. Vol. 88. Pp. 8+326+clxxiv. (London: John Murray.) 15s.

Proceedings of the Society for Psychical Research. Part 106, Vol. 38, May. Pp. 17-48. (London: Francis Edwards, Ltd.) 2s.

Empire Cotton Growing Corporation. Review of the Present Position in the Principal Cotton-growing Territories of the Empire, and a Summary of the Main Activities of the Corporation since their Formation. Pp. 23. Report of the Administrative Council of the Corporation to be submitted at the Seventh Annual General Meeting on May 16th, 1928. Pp. 44. (London.)

Harper Adams Agricultural College, Newport, Salop. Sugar Beet Problems: Report of Conference held at the College on Wednesday, February 8th, 1928. Pp. 24. (Newport, Salop.) 1s.

The Scientific Proceedings of the Royal Dublin Society. Vol. 19 (N.S.), No. 3: A Simple Form of Photo-electric Photometer, using a Neon Lamp to measure the Current. By Dr. J. H. J. Poole. Pp. 17-25. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.). 6d.

Commonwealth of Australia. Journal of the Council for Scientific and Industrial Research. Vol. 1, No. 3, February. Pp. ii+133-192. (Melbourne: H. J. Green). 1s. 6d.

The West of Scotland Agricultural College: Department of Plant Pathology. Research Bulletin No. 1: The Endotrophic Mycorrhiza of Strawberries and its Significance. By D. G. O'Brien and E. J. M'Naughton. Pp. 52+6 plates. (Glasgow.)

FOREIGN.

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 9, 1927. i. Månadsöversikt över väderlek och vattentillgång jämte anstaltens årsberättelse. Pp. 97. (Stockholm.) 2.50 kr.

The Rockefeller Foundation: a Review for 1927. By George E. Vincent. Pp. 54. (New York City.)

Cornell University Agricultural Experiment Station. Memoir 111: A Population Study of Three Townships in Cortland County, New York. By Dwight Sanderson. Pp. 19. Memoir 114: Building up Resistance to Diseases in Beans. By Donald Reddick. Pp. 15. Bulletin 463: Relative Adaptability of Red-Clover Seed of Different Origins. By R. G. Wiggans. Pp. 88. Bulletin 465: Twenty Years Growth of a Sprout Hardwood Forest in New York; a Study of the Effects of Intermediate and Reproduction Cuttings. By J. Nelson Spaeth. Pp. 49+6 plates. (Ithaca, N.Y.)

Department of Commerce: Bureau of Mines. Technical Paper 427: Propagation of Flame in Mixtures of Natural Gas and Air. By H. F. Coward and H. P. Greenwald. Pp. iv+28. (Washington, D.C.: Government Printing Office.) 10 cents.

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 31: Statistics of Private High Schools and Academies, 1925-26. Pp. 39. (Washington, D.C.: Government Printing Office.) 10 cents.

Transactions of the San Diego Society of Natural History. Vol. 5, No. 11: The Trimorphodon (Lyre Snake) of California, with Notes on the Species of the Adjacent Areas. By Laurence M. Klauber. Pp. 183-194. Vol. 5, No. 12: A new Echinoid from the California Eocene. By Hubert G. Schenck. Pp. 195-202. (San Diego, Cal.)

Proceedings of the United States National Museum. Vol. 73, Art. 6: Two new Crabs from the Eocene of Texas. By Mary J. Rathbun. (No. 2727.) Pp. 6+3 plates. (Washington, D.C.: Government Printing Office.)

Svenska Linné-Sällskapets Årsskrift. Årgång 11, 1928. Pp. v+201. (Uppsala: Almquist and Wiksells Boktryckeri A.-B.)

CATALOGUES.

Illustrated and Descriptive Price List of "Edney" Thermographs, Hygrographs, Hair Hygrometers, and combined Recording Instruments. Pp. 8. (London: Pastorelli and Rapkin, Ltd.)

Sotheran's Price Current of Literature. Annotated and Classified Catalogue of Standard Works on Exact Science, with an Appendix of Rare and Valuable Works. (No. 811.) Pp. 172. (London: Henry Sotheran and Co.)

Zeiss Field Glasses. (T380E.) Pp. 54. (London and Jena: Carl Zeiss, Ltd.)

Haveg Chemical Plant. Pp. 16. Rotameter. Pp. 4. (London: Trost Bros.)

Diary of Societies.

SATURDAY, MAY 26.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 3.—R. White: The Use of Carbon Monoxide Masks in Mines.

TUESDAY, MAY 29.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Demonstrations of New Apparatus.

WEDNESDAY, MAY 30.

BRITISH ASTRONOMICAL ASSOCIATION (at Sion College, Victoria Embankment).

THURSDAY, MAY 31.

ROYAL SOCIETY OF MEDICINE (Laryngology and Otology Sections) (continued on June 1 and 2).—Laryngological Papers by Dr. Watson-Williams, L. Yates, Sir StClair Thomson, A. J. Wright, Mr. Rake, and W. Mollison.

Friday, June 1.—Otological Papers:—Prof. O. Mayer: The Pathology of Otosclerosis.—H. Kisch: The Use of Temporal Muscle Grafts in the Radical Mastoid Operation.—D. Guthrie: Fat Grafting.

Saturday, June 2.—W. S. Sharpe: The Influenzal Ear.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Scottish District Meeting) (at The Hydro, Peebles) (continued on June 1 and 2).

FRIDAY, JUNE 1.

PHILOLOGICAL SOCIETY (at University College), at 8.—C. T. Onions: Paper.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—C. L. Woolley: The Results of the Further Excavations at Ur.

PUBLIC LECTURES.

TUESDAY, MAY 29.

MIDDLESEX HOSPITAL MEDICAL SCHOOL, at 5.30.—Dr. J. Eason: Graves' Disease. (Succeeding Lectures on May 30 and 31.)

UNIVERSITY COLLEGE (in Anatomy Theatre), at 5.30.—Prof. G. Elliot Smith: Elephants and Archæology.

GRESHAM COLLEGE (Basinghall Street, E.C.2), at 6.—A. R. Hinks: Gresham Lectures in Astronomy. (Succeeding Lectures on May 30, 31, and June 1.)

THURSDAY, MAY 31.

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, at 5.—Dr. G. V. Anrep: Pathology of Conditioned Reflexes.

KING'S COLLEGE (University of London Animal Welfare Society), at 5.30.—Addresses on Man's Duty to Animals by Rabbi S. Daiches, Rev. R. G. Bourchier, Rev. Father C. C. Martindale, Lt.-Commissioner I. Unsworth, Prof. The Rev. W. R. Matthews. Chairman: Prof. F. T. G. Hobday.

UNIVERSITY COLLEGE, at 5.30.—Prof. Max Bodenstein: Chemical Kinetics. (Succeeding Lectures on June 1 and 4.)

FRIDAY, JUNE 1.

KING'S COLLEGE, at 4.—l'Abbé H. Breuil: Les Industries préhistoriques par rapport à la Géologie.—At 5.30.—Dr. J. Kryzanowski: Polish Culture in the Middle Ages: Secular Literature and Science.

UNIVERSITY COLLEGE, at 5.30.—Prof. C. Spearman: The Psychologist in the School.

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Arctic Aviation.

THE development of aviation, which may already be regarded as a safe means of transport for even comparatively long distances, promises before long to bring the realisation of the sixteenth-century dreams of the north-west and north-east passages and the transpolar routes between Europe and Pacific lands. For three centuries the polar ice has baffled man, but at length the aeroplane and airship have shown him how to avoid it. In 1919, Dr. W. Bruns suggested a series of transpolar commercial routes for airships, and a few years later Mr. V. Stefansson pointed out the advantages that the Arctic offered for flying. Plans for Arctic exploration by air were further discussed at a representative meeting in Berlin in November 1926, which led to the formation of the Internationale Studiengesellschaft zur Erforschung der Arktis mit dem Luftschiff, under the presidency of Dr. F. Nansen. The second general meeting of the society is to be held at Leningrad on June 18-23, when a long programme of papers on Arctic problems will be discussed.

Polar exploration by ship and sledge has made slow advances in recent years. A new method of attack on the inaccessible inner regions of the Arctic Sea is desirable if the remaining problems of the Arctic are to be solved. It was Dr. Nansen who, in defiance of all the accepted canons of polar exploration of the day, introduced the novel idea of a drifting ship in his journey in the *Fram* in 1892–95. At Berlin he dwelt on the value of the airship as an improvement on other means of transport. The new international organisation, of which several well-known British meteorologists are members, aims at raising funds for systematic polar exploration by air, and incidental to that work, the institution of meteorological and magnetic observations in high latitudes. In furtherance of the Association's aims, a quarterly journal entitled *Arktis* (Gotha: Justus Perthes) is being published. The first number, containing several valuable articles on polar work in German, French, and English, has just appeared. It contains also the constitution and membership of the Association, which, for convenience sake, is known as Aeroarctic.

International co-operation in polar exploration is not a new idea. So long ago as 1882–83 eleven States co-operated in a scheme for thirteen Arctic and two Antarctic observatories. The results of that one year's work was the basis of much of our knowledge of Arctic meteorology. To-day there are permanent observatories in west and east

Greenland, Jan Mayen, Spitsbergen, Novaya Zemlya, Siberia, Alaska, and Arctic Canada, but more are needed, and the task of founding and maintaining stations should not prove so arduous as it was forty-six years ago. Northern Greenland, Ellesmere Island, Wrangel Island, the New Siberian Islands, and Nicholas (Northern) Land are among the obvious sites. They could also serve as biological stations, since many of the biological problems of polar regions can be studied only on the spot. At present the Danish station at Disko in Greenland is the only Arctic biological laboratory. Some of the stations might serve as air bases for exploration of the surrounding area. It is important that such stations should be permanent. The intermittency of observations lessens their value. Since the whole of the Arctic regions is now within the nominal political jurisdiction of Denmark, Norway, Russia, the United States, and Canada, it is to be hoped that these States will regard exploration as one of the obligations of sovereignty. To a great extent this has been done already. Arctic sovereignty is no idle claim in Alaska, Arctic Canada, Greenland, Spitsbergen, and Novaya Zemlya.

At the meeting in 1926, when Aeroarctic was founded, discussion favoured the airship rather than the aeroplane in polar exploration. Capt. Amundsen had already used both, and been successful with the airship. The advantages of the airship lie in its great cruising radius and carrying capacity. General Nobile believes that an airship could be constructed to make a non-stop flight of ten days at a speed of 50 to 60 miles an hour; that is to say, it could explore a zone 15,000 miles in length. When he flew with Capt. Amundsen across the Pole, the distance was only 2300 miles, which were covered in 72 hours. Such an airship would obviously be valuable in carrying the materials for establishing a scientific station in regions otherwise poorly accessible. Furthermore, the airship has the advantage over the aeroplane in its powers of going at a low speed or even standing in the air provided the atmosphere is calm. It is said to be possible to land and pick up personnel from an airship. This greatly increases its value in exploration. On the other hand, there is the danger of ice incrustation during fog. However, Capt. Amundsen and Gen. Nobile found this to be less serious than they had anticipated, except when falling pieces of ice were hurled by the propeller against the envelope. The flight of the airship *Norge* in 1926 and *Italia* this year have shown that strong winds can safely be weathered, but it is doubtful if similar craft could face the sudden and incredibly fierce blasts of the Antarctic blizzards.

The aeroplane has been used successfully in the Arctic by Capt. G. H. Wilkins and Com. R. E. Byrd, following on some experimental flights by Mr. G. Binney and others in Spitsbergen and a daring but unsuccessful attempt by Capt. R. Amundsen to reach the Pole in 1925. Compared with the airship, it has the advantage of speed and is less influenced by weather conditions, but its cruising radius is limited by its comparatively small carrying capacity. It has value, however, in reconnaissance work, and might be used for survey of rugged inaccessible country near a convenient base, as in eastern Greenland.

Opinion differs among Arctic airmen as to the use of pack-ice for landing. Capt. Wilkins, from his wide experience, believes that ninety per cent of pack-ice is too rough, but that the remainder is smooth enough to afford frequent landing-places. North of Bering Strait, in 1927, he landed safely on the pack and rose again, and in his long flight across the Arctic Sea this year he saw numerous landing-places, although he had no occasion to use them. Com. Byrd suggests water surfaces as being more useful than ice, but Capt. Amundsen in 1926 nearly lost his hydroplanes in a lead in the pack, and, after extricating one with great difficulty, had to abandon the other. Antarctic pack certainly offers little likelihood of landing-places, while the low air temperatures in the south, even in the height of summer, would increase the danger of alighting on water by ice forming and adding to the weight of the machine. A better knowledge of Arctic meteorology may increase the flying season, but owing to the prevalence of fog in summer, April and May are now regarded as the best months. The disadvantage of that season is that the winter snow still lies and obscures underlying surface features.

All countries will benefit from the work proposed. A fuller knowledge of Arctic meteorology and magnetism will have universal value. There can be no national boundaries in scientific research. The Arctic flights that have so far been made have contributed little to our knowledge of the Arctic, although they have shown the skill and daring of the navigators and pilots. They discovered no new land where none was expected. Capt. Wilkins had fog in the one area where land might have been found. That is no reason, however, why other flights should not have important results. For example, a course from Spitsbergen eastward to Nicholas Land and the New Siberian Islands, which Gen. Nobile has followed, will have interesting

results even if they are negative in the discovery of land. In a few hours of flying instead of weeks or even months of laborious sledge travelling, the limits of Northern Land will be defined and the mystery of Sannikov Land solved. Apart from weather, success depends on mechanical efficiency, but the risk is no greater than that of failure of human endurance in the old methods of travelling. The full value of polar flying, however, will not be reached until the problem of voluntary descent and ascent is solved. Ground observations are essential. Without them the work is incomplete; but this difficulty will no doubt be overcome. The Internationale Studiengesellschaft zur Erforschung der Arktis deserves encouragement in its endeavour to make use of new scientific applications in the solution of old problems.

A Frazer Anthology.

Man, God, and Immortality: Thoughts on Human Progress. Passages chosen from the Writings of Sir James George Frazer. Revised and edited by the Author. Pp. xvi + 437. (London: Macmillan and Co., Ltd., 1927.) 15*s.* net.

"ALL that I have attempted in the present volume is to crystallise, as it were, the results of my studies into an optic glass which may afford the reader some momentary glimpses of the long march of humanity on the upward road from savagery to civilisation." So with characteristic modesty, but not unfairly, Sir James Frazer defines the scope and object of this last published of his books. It is an anthology which is virtually a statement of his position as a philosopher and a student of certain phases of human evolution. It brings together within the compass of one volume the more general conclusions of his published works. Except for the slightest of revision, the change of a word here and there to fit the new setting, the original wording of the passages chosen remains unchanged. For their selection and the order in which they appear, M. Pierre Sayn has been responsible; but the compilation has been made under the direction of the author.

The contents have been classified into sections. The first deals with "The Study of Man," in which are embodied the author's pronouncements upon certain of the more general methodological problems of anthropological science. Part II. deals with "Man in Society"; Part III. with "Man and the Supernatural"; and the final section with "Man and Immortality." Few of the passages exceed three pages in length and each is complete in itself, except that in so far as it is the conclusion of an argument, or an inference from previously recited data, the evidence upon which it is based has been omitted. In a book of this character that is not to be imputed as a fault, but is merely an essential part of the general scheme. The reference to the source from which each extract is taken guards against any misunderstanding on the head of dogmatism or the nature of the premisses upon which the argument depends.

In publishing abridged editions of "The Golden Bough" and "The Folklore of the Old Testament," Sir James Frazer conferred a great boon upon his public. For while the complete works will always be indispensable to students and for use in reference, the abridged form, contrary to the general rule, conveys the greater pleasure to his readers. It contains proportionately more of Sir James Frazer. But this can be said even more emphatically of the present book. Here we have the author entirely to himself in extracts from the whole of his works and not from two only, and unadulterated with quotation from the work of others. For we venture to differ from the author when he expressed the opinion that if his work survives to posterity, it will be on account of his record of quaint and savage customs which will then have long passed away. If for no other reason, it will endure as a monument of pure, lucid, and flexible English of never-failing charm.

There is, however, little danger that Sir James Frazer's work will survive only as a storehouse of anthropological facts, or as a model of scholarly and graceful writing. In the course of his extensive studies there is scarcely a problem in social anthropology, in the comparative study of religion, in fact, in the whole range of the evolution of the mind of man, upon which he has not touched, and, it must be admitted, whether we agree with his conclusions or not, which he has not illuminated. In fact, so comprehensive in its scope is the present volume, and so versatile is the mind of which it is the offspring, that it might well serve as a guide, if not as a text-book, for the student in the mazes of what is admittedly one of the most difficult subjects of study.

It is not unfair to say that Sir James Frazer has sometimes been represented by those who do not accept his position, as if he wrote in the spirit of a partisan incapable of appreciating the force of an argument contrary to his own views. Nothing could be further from the truth, yet this imputation may have been made perhaps for the very reason of his essential fairness, and his aversion from anything that is controversial in tone. Yet if readers will turn to those passages in this volume which

deal with evolution and diffusion in culture, we venture to think they will find no clearer grasp of the problem, no more concise and well-balanced discussion of it, and no more logical conclusion free from prejudice in the whole of anthropological literature. It would be possible to cite instance after instance in the passages included here in which highly controversial problems are discussed in the same philosophical spirit, even if the conclusions are not always equally convincing.

It may be inferred from what has been said that this is a book that is of interest only to the anthropologist and the student. On the contrary, and perhaps even more than the works from which its material is drawn, it is essentially a book for the intelligent public, especially at the present moment. Questions relating to totemism, marriage, and the organisation of early forms of society may be passed over as more highly technical in interest. When Sir James Frazer deals with the form and history of religious beliefs, and the survival of primitive modes of thought in civilised communities, he is handling topics of vital interest to modern society. A study of his penetrating and logical examination of the development of man's attitude of mind in the past is a valuable preparation for clarity of thought in dealing with the problems of to-day.

This is not the occasion to enter upon a detailed and critical study of Frazer's work, although the issue of this compendious volume might seem a challenge. From the present writer, after reading and re-reading, it calls for nothing but respectful homage to a great work and a great thinker.

The Polychæta.

(1) *British Museum (Natural History). British Antarctic (Terra Nova) Expedition, 1910.* Natural History Report. Zoology, Vol. 7, No. 2: *Polychæta.* By Prof. William B. Benham. Pp. 47-182 + 6 plates. (London: British Museum (Natural History), 1927.) 12*s.* 6*d.*

(2) *Faune de France. 16: Polychètes sédentaires; addenda aux errantes, Archiannélides, Myzostomaires.* Par Prof. Pierre Fauvel. (Fédération française des Sociétés de Sciences naturelles: Office central de Faunistique.) Pp. 494. (Paris: Paul Lechevalier, 1927.) 75 francs.

(1) PROF. BENHAM'S memoir of the Polychæta of the Antarctic (*Terra Nova*) Expedition, and on those of New Zealand, is important not only for the number of species (88), but also from the novelty of many and the able treatment by the experienced author. As shown in a former paper, the most numerous species are Terebellids, closely followed by the Syllids, then the Phyllodocids, Aphroditids, Sabellids, and Ampharetids. Of the total number of species, 33 were obtained off the northern coast of the North Island of New Zealand during the work of the *Terra Nova* there.

Amongst the Antarctic Syllids, the author was fortunate in procuring the epigamous condition of the large band-like *Trypanosyllis gigantea*, and he combats Fauvel's view that this species is either *T. tæniæformis*, Haswell, or the *T. richardi* of Gravier. He adds the genus Eurysyllis to the fauna, with the 'polybostrichous' condition of *Autolytus maclearanus*. Of the Aphroditids, *Lætmonice producta*, Grube, a widely distributed species, is the only one met with; whilst amongst the Polynoids a new form, *Lepidasthenia antipathicola*, merits special mention, since it inhabits a latticed tunnel formed by the serrated branches of an antipatharian (*Parantipathes tenuispina*), the living tissues of which accommodate themselves to the tubular home of the annelid. The Polynoids and Phyllodocids are well represented; whilst the Lopadorhynchids embrace *Pelagobia viguieri* of Gravier, and *Maupasia cæca*, Viguier. The Nereids include the curious *Cheilonereis peristomialis* of the author, with the hood or collar. The Onuphids have a new sub-family, Aotearinæ, a group with the general facies of *Lumbriconereis*; but whilst the upper jaw-plates are of unequal number as in Eunice, the anterior series are in line as in Lumbriconereis. The Terebellids include the fine *Pista mirabilis* of the *Challenger* Expedition, which stretches from Valparaiso to Graham and Adelie Lands, Gravier's *Lanicides vayssierei*, *Lanice flabellum*, *Amphitrite kerguelensis* and various other members of the group. The author discusses at length his reasons for uniting the *Leæna wandelensis* of Gravier and the *L. arenilega* of Ehlers described two years later. The striking *Hauchiella tribullata* has a distribution ranging from European waters to New Zealand.

The author founds a new genus, Melinnoides, for a species—*M. nelsoni*—from McMurdo Sound. It has only two pairs of gills in a transverse row, and there are neither dorsal crest nor post-branchial hooks. He differs from Augener as regards the relationships of *Travisia oleus*, Ehlers, and *T. kerguelensis*, McIntosh, which the first-mentioned author united. Prof. Benham finds, after a careful survey of many examples, that these forms essentially differ.

The addition of a species of Euchone (*E. pallida*, Ehlers) to Antarctic waters is noteworthy, since

the genus is characteristically Arctic and northern. The finding of the tubes of the ubiquitous *Sepula vermicularis* L., broken into lengths of 1 in. to 2 in. 30 ft. above sea-level on the Drygalski glacier at Evans Cove, Victoria Land, is an interesting observation. Two new species of Vermilia, a new Zopyrus, and a new genus, Chitinopomoides, are described, the species *C. wilsoni* having an operculum approaching that of Mercierella and allied forms, and probably presenting similar blood-spaces on section. The author rightly groups the various varieties of Filograna under the single species, *F. implexa* of Berkeley—from *Protula Dysteri*, Huxley, to the Salmacinas of subsequent authors; and it may interest some to know that Prof. Huxley in July 1865 spontaneously admitted to the writer that his species was only *F. implexa*, a form which stretches over a wide area. The author met with an interesting case of a tube of this species budding at the tip into two tubes which he figures. Species of Protula and Apomatus from New Zealand complete the series.

Besides the intrinsic value of the memoir as an able contribution to the polychæts—to which it adds three new genera and sixteen new species—it affords another example of the extensive distribution of many of the group almost from pole to pole and from the Atlantic to the Pacific Ocean. It is illustrated by six quarto plates of carefully drawn figures by the author, which bring out striking features like the structure of the bristles and hooks, as well as such unique formations as the spiral ridges of sand-grains bristling with sponge-spicules on the tubes of *Leæna wandelensis*.

(2) Prof. Pierre Fauvel, whose wide experience of the group ranges over both European and distant waters, continues his task in this volume with the "Polychètes Sédentaires" of the shores of France, though under this head are included those of the Mediterranean, North Africa, and one or two other regions. Unlike Prof. Benham, who follows his own classification, he for the most part stands by that of Malmgren.

Each species is defined and its important parts figured with great care by the author or others, so that his successors will reap the benefit of his unwearied labours. The method of illustration adopted (apparently lithographic ink) is prone to make the long bristles somewhat uneven, but on the whole they are helpful outlines. Occasionally inferior figures, as in Magelona, have been selected instead of more accurate representations, but generally the author has given his own figures or those of competent workers. He has a table of the families and of the genera and species in each case, and as there are, for example, in Polydora no less than a dozen species, the author's task has been no light one.

Under the family of the Cirratulidæ are the curious *Ctenodrilus serratus* of O. Schmidt, so common in aquaria, Zeppelinia, which reproduces by scissiparity, and Raphidrilus. Prof. Ashworth's Ascleirochilus is mentioned under the Scalibregmidæ, and Ardwisson's work under the Maldanidæ. Under the Arenicolidæ he gives *Arenicola Claparedii*, an Atlantic and Pacific form, notwithstanding Prof. Ashworth's proof in the British Museum Catalogue that it is *A. pusilla*, De Quatref. Again, he adheres to Claparède's species *A. Grubei*, which, after careful study, Prof. Ashworth and the writer consider to be *A. branchialis*, Aud. and Ed. The Sabellariidæ are followed by the Sternaspididæ, a group formerly placed under the Gephyrea, and still open to controversy as to its place amongst the polychæts. Under the great family of the Terebellidæ, Prof. Fauvel follows the reviewer in considering that the proposal of Hessle to classify them chiefly on their nephridia is more or less impracticable, and he prefers the arrangement of Malmgren—giving six sub-families. Notwithstanding his objections, *Amphitrite gigantea*, Mont., stands, as also does the union of the two forms *Nicolea venustula* and *N. zostericola*, as well as the distinctions between *Chone Fauveli*, *C. Duneri*, and *C. Rayi* in the Ray Society's monograph.

The author gives a useful classification of the Serpulidæ, under which *Serpula concharum* Langerhans, and various species of Hydroides seem to be in want of further investigation. Moreover, he adheres to the old view in regard to Filograna and Salmacina, even citing Prof. Huxley's *S. Dysteri* as a species. An appendix contains a few additions to the errant group, besides the Archiannelids and the Myzostomes.

This volume forms an important contribution, by an able investigator of the polychæts, to the fauna of the shores of France, and will be welcomed elsewhere by all students of the subject. W. C. M.

Modern Organic Chemistry.

Lehrbuch der organischen Chemie. Von Prof. Dr. Paul Karrer. Pp. xxi + 884. (Leipzig: Georg Thieme, 1928.) 34 gold marks.

THIS is a comprehensive text-book planned on a somewhat rigid classificatory basis. The historical introduction is limited to three pages, and except for an equally brief note on the evolution

of organic chemical formulæ, most of the remaining historical allusions are confined to a bare mention, usually undated, of names of leading investigators in the various fields which come successively under review. The treatment of aliphatic compounds (including methods of molecular diagnosis) occupies the first 361 pages; of carbocyclic compounds (including pyrones, indigotin derivatives, and certain other heterocyclic types), 342 pages; and of heterocyclic compounds, 137 pages. In a series of tables, filling the final 17 pages, a good deal of information of statistical and scientific interest is summarised. Useful bibliographies are appended as footnotes to leading sections of the book.

The general plan has necessarily entailed a dispersion of matter which in British text-books is usually assembled under special headings. Thus, the student of stereochemistry, tautomeric change, or valency, will need to collect his information from divers sections of the book, which may often suggest themselves only to the sophisticated reader. His task will be rendered still more difficult by the nature of the index, which is essentially an alphabetical list of names of compounds; the absence of an index of authors is an additional handicap.

These are inconveniencies; but the work may be commended to teachers and advanced students of organic chemistry as affording an excellent and up-to-date German text, dealing with the subject from the viewpoint of molecular constitution. Questions of structure, synthesis, and interrelationships of structural types are handled in a clear and workmanlike manner, and due regard has been paid to the current biochemical trend of organic chemistry. On the whole, recent developments have been well covered, but in a book of this size one is surprised not to find adequate references to modern ideas and investigations on such important subjects as the genesis and transmission of orienting effects in the benzene ring, applications of electronics to organic chemistry, tautomerism, glutaconic acids, the constitution of urea, the menthone chemistry, carene, hydroxymethylenecamphor, squalene, insulin, the production of acetic acid from cellulose by anaerobic fermentation, lead tetraethyl, dichlorodiethyl sulphide and phenarsazine. However, a text-book of organic chemistry offers a broad target to the arrows of detailed criticism, and it is unnecessary to empty the quiver. Suffice it to say, in conclusion, that both author and publisher are to be congratulated on a useful and well-printed addition to the literature of this flourishing branch of science.

J. R.

Our Bookshelf.

The Flora of Oxfordshire: a Topographical and Historical Account of the Flowering Plants and Ferns found in the County; with Biographical Notices of the Botanists who have contributed to Oxfordshire Botany during the last Four Centuries. By George Claridge Druce. Second edition (rewritten). Pp. cxxxi + 538. (Oxford: Clarendon Press; London: Oxford University Press, 1927.) 30*s*. net.

WE congratulate Dr. Druce on this, the latest addition to the series of county floras to the preparation of which he has devoted so much time, study, and investigation in the intervals of a busy life, for more than forty years.

Compared with the original edition of 1886, the book has much increased in size. Both the form and number of pages are larger. The 'botanologia,' or biographical notices of botanists who have contributed to our knowledge of the flora, has more than doubled in extent, while the flora proper, now limited to the seed plants, ferns, and Characeæ, occupies 533 pages as compared with 366 in the 1886 edition. The appendix on mosses and Hepaticæ, supplied by Henry Boswell in 1886, and the lists of fungi and lichens, have been omitted.

The extensive introduction deals briefly with the topography, soils, elevation, and geology of the county, followed by a more detailed account of the characteristics of the botanical districts, of which seven are recognised based on river drainage (by some oversight, a map included in the former edition has been omitted), and a short section on meteorology (by F. A. Bellamy); the second half of the introduction is taken up mainly by the botanologia. The plan of the systematic portion is similar to that of other county floras by the same author,—references are given to the "Flora of Berkshire" for additional synonymy and bibliography.

From the summary we learn that the flora comprises 1061 species, including denizens and colonists, as compared with 1091 in Berkshire and 1027 in Buckinghamshire. Adventives (450), hybrids (79), and varieties and forms (781) bring the total up to 2371, and there are also eight species now regarded as extinct. Two species, *Orchis Simia* and *Stachys germanica*, appear now to be confined to the county. More than thirty species are mentioned as remarkable absences for which special search should be made.

A. B. R.

The Bread of our Forefathers: an Inquiry in Economic History. By Sir William Ashley. Pp. xii + 206 + 4 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1928.) 12*s*. 6*d*. net.

ALTHOUGH at first sight of purely antiquarian interest, the question of the kinds of grain our forefathers used for breadmaking proves on examination, to be "intimately bound up with some of the most fundamental problems of our economic

and social history." By the end of the eighteenth century, wheat was firmly established as the universal bread grain in England, at a time when the commoners of other northern races still ate rye.

The main transition to wheat took place during the eighteenth century, and though in earlier times, wheat, rye, barley, and oats were all used as bread corn to some extent, the chief competition always lay between the two former. It is clear from the old records, both civil and ecclesiastical, that wheat and rye bread early became the symbols of social position, rye being the staple food of the commoners, wheat that of the aristocracy or overlords. In some cases bread of different grades was used as currency in payment for services rendered, wheaten bread being given only in very special circumstances.

In England the change in the balance from rye to wheat was much influenced by the interest in the land taken by the lords of the manors. This led to such improvements in agricultural practices as marling and liming, which needed capital expenditure, and steadily improved the land and rendered it more fit for wheat growing. It took centuries, however, for wheat to become the ordinary food of the whole nation. In northern continental countries where the land remained largely in the hands of peasant proprietors, rye growing held its own, and even at the present day forms a staple part of the food of the community.

The rivalry between wheat and rye has always been entirely a question of supply rather than one of cost, because in the early days the price of bread did not affect the bulk of the nation to the degree it now does, as most bread was baked at home. With short supplies, wheat early became a mark of social distinction, and with increasing ambition among the populace, and increasing supplies, it gradually attained the position it now holds as the staple bread corn of Great Britain.

The Soils of Cuba. By H. H. Bennett and R. V. Allison. Pp. 409. (Washington, D.C.: Tropical Plant Research Foundation, 1928.) 6.25 dollars.

A COMPREHENSIVE survey of the soils of Cuba has been undertaken by H. H. Bennett and R. V. Allison, and the results published in book form. Cuba is still the greatest sugar-producing country of the world, and every effort is necessary to maintain this supremacy. The point of the survey was to investigate the possibility of lowering the cost of production of the raw material in the fields by the use of more modern agricultural methods and the better adaptation of the varieties to the soils on which they are grown.

A general description is given of the various soil series found throughout the island, with complete chemical analyses and physical measurements of some of the more representative types, followed by a detailed survey of middle, eastern, and western Cuba and the Isle of Pines. Some areas are handicapped by the presence of large amounts of soluble salt in the soil, which is so detrimental to sugar cane that the mortality and retarded growth is in some cases severe enough to cause the fields to be completely abandoned. Furthermore, the cane juices obtained from salty areas are of inferior quality for milling purposes. The opinion is expressed that better results would accrue from more intensive cultivation of sugar cane on smaller areas, the poorer and less suitable soils being put down to grass or timber.

The influence of soil is of paramount importance in the Cuba cane fields, and emphasis is laid on the importance of cultivators understanding their soils and learning how to treat them to get the best results, as the behaviour of the soil and subsoil has definite peculiarities in many cases. A large-scale annotated soil map is appended, with brief descriptions of the quality of the soil, the best methods of cultivation and treatment, together with the most suitable crops. W. E. B.

Die europäischen Schlangen: Kupferdrucktafeln nach Photographien der lebenden Tiere. Von Dr. Fritz Steinheil. Siebentes Heft. Herausgegeben von Prof. Lorenz Müller. Tafel 31: *Vipera berus berus* (L.); Tafel 32: *Vipera berus berus* (L.); Tafel 33: *Vipera berus berus* (L.); Tafel 34: *Vipera ursinii ursinii* (Bonap.); Tafel 35: *Vipera ursinii macrops* (Mehely). Pp. 17 + 5 Tafeln. (Jena: Gustav Fischer, 1927.) 6 gold marks.

AFTER an interval of more than twelve years, a further part of Dr. Steinheil's beautiful photographs of European snakes, with the appropriate letterpress, has been published. The issue of the work was interrupted, after the appearance of the sixth part, by the outbreak of the War, and favourable conditions for the continuance of publication did not present themselves until 1926. In the spring of that year, Dr. Steinheil resumed his work, but a return of an old malady necessitated an immediate operation, from which he died in April 1926. His friend, Prof. Lorenz Müller, has undertaken the completion of the work as an act of duty and esteem, and, in a foreword to the present part, pays an eloquent tribute to the memory of Dr. Steinheil and to the value of his work. Dr. Steinheil left behind all the photographs necessary for the completion of his book, and Prof. Müller will write the descriptive text. The seventh part, which is now published, deals with *Vipera berus berus*, *Vipera ursinii ursinii*, and *Vipera ursinii macrops*, and is accompanied by five beautiful copper-plate reproductions of excellent photographs of these forms. This part maintains the very high standard of its pre-War predecessors and, now that publication has been resumed, we shall look for a speedy completion of this valuable work, which Prof. Müller has undertaken as a memorial to his friend.

Introduction to the Calculus. By Prof. William F. Osgood. Pp. xi + 449. (New York: The Macmillan Co., 1926.) 12*s*. net.

IN this revision of the author's "First Course," the sets of examples have been improved by the addition of more difficult examples. Even these should be well within the reach of most serious students. The tendency in England in the past

has been to include too many examples of the problem type in the introductory course. Nowadays it is recognised that this is a mistake. Nevertheless, it may be doubted whether this course contains enough to extend the abler readers of it. One reason why many teachers are slow to introduce modern text-books is that the older books, however unsatisfactory they may be in some respects, usually have the merit of containing excellent collections of problems for the better students. This is the more necessary in small schools, where it is not possible to grade the real mathematicians into sets by themselves.

In this volume the emphasis is on the applications of the subject, and there is much material which does not usually occur in an English text-book on the calculus. Whether this material is really required depends on what other text-books are being used concurrently, but the book would certainly be suitable for certain classes of British students, for example, those whose main subject is not mathematics, but who wish to acquire some knowledge of the ideas and applications of the subject. A. R.

Manuel du tapissier décorateur. Par Prof. Lucien Coussirat. (Bibliothèque professionnelle.) Pp. 440. (Paris: J.-B. Baillière et fils, 1927.) 25 francs.

It is always a satisfaction to encounter a work giving evidence, not alone of the pleasure experienced in its preparation, but also of a thoroughness of knowledge and a completeness in execution, such as are too often absent. In writing about 'completeness' it is, of course, not suggested that the whole art and science of decorative upholstery can be embodied between the covers of a book (16mo) of 440 pages with the encroachment caused by 239 illustrations and diagrams. It is rather the completeness that takes a survey of all the *varia* that may be comprehended by the subject matter.

M. Coussirat might have done better to enter more into the class of upholstery that would suit the average purse of to-day; whereas, in fact, his attention is mainly devoted to 'period' furniture and furnishing; this is peculiarly noticeable in Chapter ix. A curious chronological *mélange* occurs early in the book (p. 19) concerning Catherine de Medici, upon which there is no need to enlarge. The chapter on colour is worthy of attention by the student, though there is some confusion created between spectrum colours and pigments. The chapters dealing specifically with upholstering and the cutting-out of fabrics are the most valuable in an interesting work. P. L. M.

The Story of the Roads. By Cyril Hughes Hartmann. With an Introduction by Lieut.-Col. Alfred Hacking. Pp. xx + 194 + 12 plates. (London: George Routledge and Sons, Ltd., 1927.) 7*s.* 6*d.* net.

Recently there appeared in these columns an article upon road formation, the *raison d'être* being two books, dealing in one case with the scientific aspect of roads, and in the other with the management and methods of concrete highway construction. A passing reference to Mr. Hartmann's "Story of the Roads" will form a fitting corollary. The lively style of diction, in which he displays the history of the island roads of Great Britain from Roman days onwards to the days of gyratory traffic, together with the quaint illustrations, provide a couple of hundred pages of very attractive material. Regarding highway bridges, one might deplore the loss of the original Blackfriars bridge in stone, when viewing the present iron structure.

Apparently the author differs from Mr. Macadam, by lauding the Scotch roads of the eighteenth century to the detriment of those in England. He properly stresses the fact that "the roads must be made to suit the traffic, and not the traffic to suit the roads." It is, of course, a case of pendulum-swinging respecting the former hegemony of the roads being restored after a period of eclipse by the railways. Has the final swing taken place? P. L. M.

Romance of the Sun. By Mary Proctor. Pp. xii + 266 + 13 plates. (New York and London: Harper and Bros., 1927.) 7*s.* 6*d.* net.

The contents of Miss Proctor's book are not quite so comprehensive as the title would suggest. The first few chapters include an account of the transit of Venus expeditions and Gill's observations of Mars made for the purpose of measuring the sun's distance. Chapters v.-viii. touch upon the sun itself, but almost exclusively on those phenomena—prominences and corona—which are seen at total eclipses of the sun. Chapter ix. gives the author's personal experiences at the eclipses of 1896, 1900, and 1905, whilst the final chapter describes the recent eclipse of June 29, 1927.

Miss Proctor quotes largely from her authorities; indeed, one-quarter of the text is made up of excerpts. Whether so excessive a use of quoted passages is wise in a book of this description is very questionable. But however that may be, an entertaining account is provided of astronomers and their friends in quest of observations which are only possible at rare intervals.

A Manual of Field Astronomy. By Prof. Andrew H. Holt. Second edition. Pp. xiv + 126. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1927.) 10*s.* net.

Prof. Holt's little book is intended for the instruction of those doing field work with theodolites. It contains a theoretical explanation of the heavenly motions sufficiently full to enable the student to follow the formulæ with intelligence. The practical directions are clear and explicit. There is a useful table of formulæ for solving spherical triangles, and some explanation of the solar attachments, which when used in conjunction with a theodolite enable the meridian to be found mechanically. There are tables at the end for the conversion of sidereal to mean time, refraction, azimuth of Polaris at elongation, etc. These tables indicate that the order of accuracy aimed at is the nearest second of arc. An error has been noticed on p. 82. In the equation just above (10) for cos *z* read cot *z*.

A. C. D. C.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Geological Features of the Sites of the Sligo Implements.

AT intervals from August 1927 to March 1928 there appeared in NATURE a series of letters relating to the discovery of chipped fragments of limestone by Mr. J. P. T. Burchell in the neighbourhood of Sligo. These were claimed by him to be evidence of Palæolithic man in Ireland. Apart from the arguable question of the human character of the flaking of the limestone, Mr. Burchell's statements regarding the geology were disputed by Prof. R. A. S. Macalister, Prof. J. K. Charlesworth, Dr. Lloyd Praeger, and Mr. A. W. Stelfox.

We were therefore requested to assess the geological evidence furnished by the sites, and for this purpose visited the Sligo district at the end of March. We were much assisted in finding the exact sites by the photographs in Messrs. Burchell and Moir's book, "The Early Mousterian Implements of Sligo, Ireland." We have to report as follows:

Photo] [R. J. Welch

FIG. 1.—Boulder clay at Ballyconnell, showing angular fragments of limestone.

At Ballyconnell, about ten miles north-west of Sligo, is a small bay with two horns, at each of which boulder clay rests upon limestone. There is a place on each of these horns where the boulder clay reaches about the height recorded by Mr. Burchell and where it can be seen lying upon limestone. The 'implements' were obtained from an 'implementiferous layer' a few inches above the base of the section. The boulder clay of the two promontories contains an astonishing number of angular limestone fragments of all shapes and sizes, and near the base the limestone beds can be traced breaking down into angular pieces, similar to those incorporated in the boulder clay (Fig. 1). The edges of the limestone visible just beneath the boulder clay have been flaked and shattered. We understand that Mr. Burchell devoted some weeks to seeking the 'implements' in this section, and we understand also that he found two or more 'implements,' of which the human workmanship is not so enthusiastically and generally accepted as in the case of the Rosses Point finds. Among such myriads of angular limestone fragments, it would be surprising if in the course of some weeks, two or even more pieces simulating human workmanship could not be found. If the 'implements' are *beyond question* of human origin, there is certainly a case for the existence of man before the boulder clay of the region was formed. If, however, there is any doubt about the workmanship, the 'implements' from Ballyconnell are of no value as evidence of Palæolithic man in Ireland.

At Rosses Point, Mr. Burchell claims to have discovered a rock-shelter of high antiquity, the roof of which was formerly in place but was broken down, as he suggests, under the load of the advancing ice which deposited the boulder clay. At the most, the rock-shelf (the 'shelter') was not higher than a table, and at present there is very little overhang of the 'roof' (Fig. 2). One would expect that if a rock-shelter collapsed under these conditions, the collapsed fragments would consist of roof-blocks, whereas in point of fact we counted 26 (out of a total of 36) large slabs, having an aggregate area of about 180 square feet lying above H.W.M. of ordinary summer tides, which were unmistakably derived from the 'floor,' being of limestone of different character from that of the 'roof,' and easily distinguished from it. These 26 blocks have been lifted to a height of at least 5 ft. above the level of the floor by the waves during storms. Whatever, therefore, may be the position as regards the human origin of the flakes found beneath the loose blocks, it is improbable that a 'shelter' could have existed there in Palæolithic times. It might even not have been there a hundred years ago.

The supposed raised beach is neither more nor less than sand and shells which have been blown up and plastered against the face of the boulder clay cliff behind. That boulder clay also is crammed full of angular fragments of limestone, which seems to be a feature of the boulder clay of the district. Mr. Burchell refers in one of his letters to the fact that he hurled blocks of rock about on the site "in the way in which some people imagine the sea to have done." It is easier to contrast than to compare the hurling of blocks by a human being and the action of the sea during winter storms on the Atlantic coasts. The fact that limestone blocks from the floor of the supposed shelter are now found in abundance above the level of that floor, and that one of them was, in fact, imbedded in the soil and grass well above H.W.M., proves conclusively that the storms on the very exposed coast near Sligo are capable of lifting and hurling at each other very large blocks of limestone.

Some of the transported slabs we measured were 4 ft. in length by 3 ft. in width. This piling-up of blocks is a feature of the whole coast-line where low-dipping limestones run out to sea. It is particularly well seen on the western side of Coney Island, where there are rows of blocks, fringing the low coast-line, the source of which can be traced to two or three ledges below H.W.M. which have been stripped to provide the blocks piled up above H.W.M.

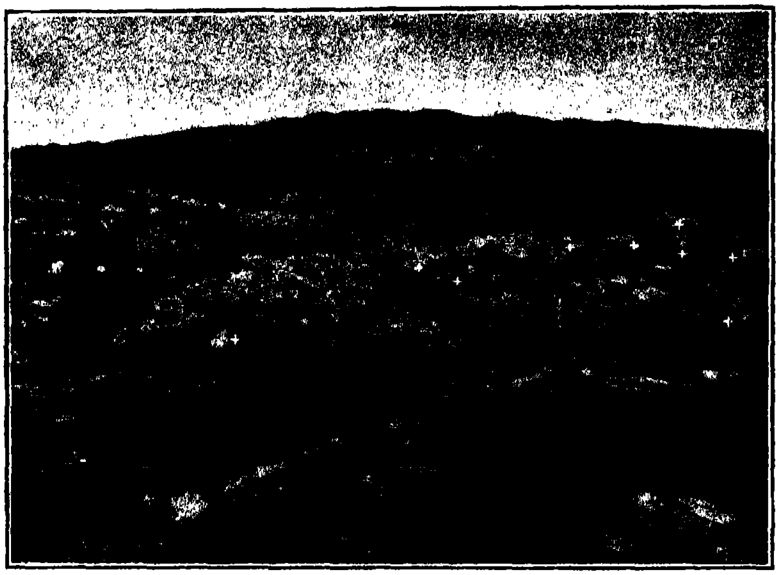
At the western end of the northern side of Coney Island, Mr. Burchell has described another rock-shelter or cave, out of which he supposes 'implements' to have been washed. This part of the coast again bears obvious traces of rapid erosion, due in that case partly to the exposed position, partly to the existence of well-bedded rocks with shaly limestone underlying more massive beds, and partly to the exceedingly well-marked joints, which run roughly parallel to that part of the coast. The cave which Mr. Burchell describes is interesting, because not long ago (? fifty years) a beacon was erected near the edge of the cliff (Fig. 3). The concrete base of the beacon has now been undermined by the collapse of the cliff over the cave, and the whole bed which formerly supported it has come away in one piece to a width of about 7 ft. and length of at least 30 ft. Since the beacon would certainly not be built on an unsupported overhanging concrete base, we may say that since it was erected the coast has receded not less than 7 ft. by erosion.

Photo] [R. J. Welch

FIG. 3.—Coney Island, Sligo, showing supposed 'shelter,' collapsed limestone and, above the figure, the old masonry foundation of the beacon.

Such low sea-caves, about 3 to 4 ft. in height and due to the undercutting action of the sea, in no way resemble inland shelters and caves in limestone districts, which are usually solution-phenomena.

Finally, we may perhaps be permitted to say that we went to Sligo unprejudiced and prepared to find that there was a real case to be considered. We are convinced that there is absolutely no case whatever



Photo] [R. J. Welch

FIG. 2.—The so-called 'shelter' at Rosses Point. The black cross marks the 'floor' of limestone and the white crosses blocks of the same rock which have been thrown up by wave-action.

for supposing that the sites concerned are of any antiquity, with the exception of Ballyconnell, the 'implements' from which, as we have said, are not enthusiastically accepted. Not having seen any of the 'implements' which were exhibited in London, we offer no opinion on them.

O. T. JONES.
University of Manchester.
P. G. H. BOSWELL.
University of Liverpool.
May 8.

Nova Pictoris.

THE article entitled "Nova Pictoris as a Double Star," in NATURE of April 7, attributes to me views which I do not hold. This is doubtless due to an incompletely cabled report of an interview which I gave to a reporter of the *Cape Times*, after the announcement from Johannesburg of the duplicity of the star, which was announced in the local press as a splitting of the star. In this interview I mentioned various theories which have been advanced as possible explanations of the outburst of a nova, including the theory of a grazing impact of two stars. I referred to the inherent improbability of the latter occurring, but added that as Nova Pictoris had behaved in such an exceptional manner from the time of its first discovery, it should not be left out of consideration in seeking an explanation of the star's behaviour, and that subsequent observation of the

star would doubtless throw further light on the matter. I do not, however, adopt the view that the outburst was definitely due to such a collision.

There has also been some misunderstanding in regard to the separation of the stars. The figure of one-fifth of a second was merely a hypothetical figure which I adopted for the sake of argument to show that if the companion was in reality a background star, previously hidden by the nova but afterwards uncovered, the proper motion required to render it visible in a large telescope was not excessive. I adopted the figure of one-fifth of a second as the minimum separation at which the duplicity would be certainly detected with the 26½-in. refractor at Johannesburg, as at that time I was not aware of the separation observed at Johannesburg. It is unfortunate that it has been interpreted as a measure of the separation made at this observatory. With the 18-in. visual refractor here, the duplicity has not been conclusively seen, though suspected. The most prominent feature of the star is the very strong nebulous envelope.

The Johannesburg observers are satisfied that there are three components, and suspect a fourth, thus still further adding to the mystery of this extraordinary star. The star is surrounded by rings which are probably due to matter ejected with high velocity at the outburst. The diameter of these rings suggests that the star is relatively near, much nearer than indicated by the spectroscopic parallax derived by Mr. Davidovich, and that the parallax should be easily measurable by direct methods. The star has therefore been placed upon the parallax observing list of the Cape Observatory.

H. SPENCER JONES.
(H.M. Astronomer.)

Royal Observatory,
Cape of Good Hope,
May 3.

Mechanical Production of Short Flashes of Light.

IN the study of phenomena which occur in a very short interval of time, it is usually necessary to have some kind of 'light shutter' that operates with extreme rapidity. An electro-optical shutter which lets through very short flashes of light has been previously described (Beams, *J.O.S.A. and R.S.I.*, **13**, 597; 1926; Lawrence and Beams, *Proc. N.A.S.*, **13**, 207; 1927), but in some experiments it is highly desirable that the shutter operate as many times per second as possible in order that enough intensity can be obtained to observe the phenomena accurately.

If one sends monochromatic light into an interferometer, say of the Michelson type, and projects approximately straight fringes upon a slit or slit system parallel to the fringes, and then changes the optical path in one arm of the interferometer with respect to the other, the fringes move perpendicular to their length. The slit then becomes a source of light flashes the duration of which depends upon the time required for a bright fringe to cross the slit. If, then, the optical path in one arm of the interferometer is changed rapidly enough with respect to the other, very short flashes of light can be produced. Thus, if light of 5000 A. is used, and the optical path changed at the rate of 1 cm./sec., then 2×10^4 flashes are produced per second, each flash lasting not longer than 5×10^{-5} sec.

There are, of course, several ways of changing the optical path with considerable rapidity, but the following device has been adopted because of its simplicity and the tremendous rate of change of optical path which it effects: two right angle prisms of identical material and dimensions are placed in one arm of the interferometer so that their hypotenuses are parallel, and so oriented that if the hypotenuses were in contact, the two prisms will form a rectangular block.

Light incident perpendicular to one of the sides is then undeviated as it passes through the prisms. If the two prisms are moved with respect to each other horizontally and parallel to the side upon which the light is incident, the optical path is changed and the fringes in the interferometer move. The rate of change in optical path depends upon the index of refraction of the glass, the angles of the prisms and the speed with which the prisms move, while the total difference in optical path at any time is limited only by the coherence length of the monochromatic light used.

In my preliminary experiments a single glass prism with a small vertical angle was mounted on a balanced steel arm, which was fastened to the shaft of an electric motor so that the prism moved approximately parallel to an identical fixed prism in the optical path. On the same shaft an opaque disc with a small slit in its edge revolved in front of a mercury arc source, so that light passed through the interferometer only while the optical path was being changed. A filter which permitted only the mercury green line to pass was used in front of the arc. The duration of each light flash was slightly less than 10^{-7} sec. These light flashes when sent back through the interferometer form two sets of fringe systems. These fringes are viewed by means of a mirror placed in front of the mercury arc in such a way as to avoid undesirable reflected light. One of these fringe systems is approximately stationary and serves to indicate when the apparatus is working properly. Although not used in this preliminary work, the instrument can be calibrated if desired in terms of the velocity of light by letting the light flashes pass over a measured distance before sending them back through the interferometer and observing the relative shift of this stationary fringe system. In fact, it is even possible to make this calibration with the slit removed.

One of the applications of this apparatus might be mentioned. If light flashes of the proper wave-length are focused on a bulb containing metallic vapour, and the resonance light from the bulb sent back through the interferometer, the resulting fringes will appear stationary, due to a sort of stroboscopic effect when the length of light flashes are constant, but will move or change their character when the flashes are shortened, depending upon the average time between excitation and emission for the vapour.

The present arrangement is not very satisfactory, because the two prisms twist slightly, and hence a very narrow slit in the opaque disc must be used, thereby sacrificing light intensity. However, a new apparatus is to be constructed in the near future that should eliminate these difficulties as well as give shorter light flashes. It should be easy to produce flashes of 10^{-8} sec. and possibly 10^{-9} sec. duration.

The writer desires to express his appreciation of the valuable suggestions made by Mr. Donald Cooksey with regard to the design of the mechanical parts of the apparatus.

J. W. BEAMS.

Yale University,
April 19.

The Band Spectrum of Mercury excited by a High Frequency Discharge.

A METHOD of exciting spectra by a high frequency discharge has been described by Wood and Loomis (NATURE, **120**, 510; 1927), Clarke (NATURE, **120**, 727; 1927), and others. The method consists of sending a high frequency current through a wire coiled around the tube in which the discharge is excited. While

experimenting with a low voltage Tesla coil in which the primary circuit power was supplied from a 110-volt buzzer, it was observed that when contact was made between one side of the secondary and a metal support on a diffusion pump, a brilliant green discharge was produced in the mercury circulating through the pump at a pressure of about 5 cm. The spectrum of this discharge showed a very intense emission of the green fluorescence band of mercury.

This observation suggested an experiment to study the conditions of excitation of the mercury bands. Accordingly, a quartz tube, 0·7 cm. in diameter and 15 cm. long, having a small bulb near each end, was evacuated and sealed off containing about 1 c.c. of mercury. A piece of wire was wrapped around one end to serve as a single external electrode, and the tube was supported by this wire in a vertical position. One side of the secondary of the Tesla coil was connected to this wire and the other earthed through the primary circuit.

When the mercury in the tube was heated to boiling by a Bunsen burner, the Tesla coil produced a bright discharge in the tube. The spectrum of this discharge showed the mercury arc lines and the mercury bands, the maxima of which come at λλ4850, 3300, 2540, and 2345. No trace of a band at 2650, observed by Houtermans (*Zeit. f. Phys.*, **41**, 140; 1927) and Rayleigh (*Proc. Roy. Soc. Lon.*, **114**, 620; 1927), was found. Light from the middle of the quartz tube was focused on the slit of the spectrograph. If the middle of the tube was heated by a blow torch, the spectrum showed that the 4850 band had disappeared, the 2345 band had been weakened, but the 3300 and 2540 bands were unchanged in intensity. As soon as the middle of the tube cooled to the same temperature as the upper part, the 4850 band appeared again, and the spectrum was the same as before heating. If the mercury is vigorously boiled, the 3300 band is weakened with respect to the 4850, 2540, and 2345 bands.

In order to find the effect of distillation of the mercury on these bands, the tube was suspended in a furnace so that stagnant vapour resulted, and the discharge studied at various pressures from that at room temperature to that at which the discharge ceased. The arc lines appeared at all pressures, and at the higher pressures there was a faint trace of the 2540 band, but there was no observable emission at any pressure of the other mercury bands.

This experiment shows that distilling vapour is necessary for the excitation of the mercury bands 4850, 3300, and 2345 in a high frequency discharge. It is well known that distilling is necessary in many cases for the excitation of the 4850 band in fluorescence. Wood (*Jour. Frank. Inst.*, **205**, 488; 1928) and Pringsheim and Terenin (*Zeit. f. Phys.*, **47**, 342; 1928) have explained this as due to the sweeping away of impurities by the vapour stream. The same explanation probably applies here. These impurities in stagnant vapour are supposed to destroy the excited molecules of mercury through collisions of the second kind before they have a chance to emit the mercury bands.

The destruction of *only* the 4850 band through local heating is hard to explain. The local heating prevented the formation of extra fresh vapour through condensation and evaporation at the point of observation, but there was still a stream of mercury vapour past this point. It may be that the excited molecules which emit the 4850 band have an energy which very nearly coincides with that which the impurities may absorb, and it is, therefore, more probable that collisions with impurities will be of the second kind. This may also account for the non-appearance of the 2650 band.

This experiment, and those of Houtermans and Rayleigh (*loc. cit.*), show that the 3300 and 4850 bands originate in different initial excited states. This experiment shows in addition that the initial excited state for the 4850 band is also different from that for the 2345 and 2540 bands. This disagrees with the association of the 2540 and 4850 bands made by Houtermans. The final states for the 2345 and 2540 bands must be the same, since both are obtained in absorption. The results of this experiment also indicate that the 3300, 2540, and 2345 bands are emitted from separate initial states.

J. G. WINANS.
(National Research Fellow.)
Princeton University,
New Jersey.

Active Nitrogen.

I REGRET having to request valuable space in NATURE, but it seems necessary to answer a criticism by E. J. B. Willey in the issue of Mar. 10. Quoting a single sentence from one's publication is generally unsatisfactory unless the correct meaning is carried with it. To one who reads my article in the *Journal of the American Chemical Society* (**50**, 27; 1928), it is evident that the statement does not, as Dr. Willey suggests, stultify a good deal of the work under consideration. It is meant merely to indicate that, besides the reactions studied by Willey, there are actions initiated by active nitrogen which require more than two volts, of which he is aware. One need only direct attention to the vast amount of literature on the excitation of spectra requiring up to 10 volts.

Aside from strictly spectroscopic data, which are themselves sufficient evidence for my original statement, I may point out that iodine is ionised by active nitrogen (Constantinides, *Phys. Rev.*, **30**, 95; 1927); 9·4 volts are required for this reaction. $CuCl \rightarrow Cu + Cl$ requires 3·3 volts. The Cu lines are also strongly excited (Mulliken, *Phys. Rev.*, **26**, 1-32; 1925), and should this occur simultaneously, the total energy requirement is more than 8 volts. Other energetic reactions occur in active nitrogen, but one hesitates to insist on the exact energy requirement since we are not sure of what is happening, that is, whether the nitrogen molecule or atom is effective. Admission of oxygen or water to active nitrogen gives nitric oxide spectra. Admission of carbon monoxide or carbon dioxide gives cyanogen and nitric oxide spectra. If a single atom does the work, as, for example, $CO + N = NO + C$, this requires about 8 volts. Although direct proof is lacking, it is not inconceivable that metastable nitrogen molecules in level *A* can actually dissociate oxygen (7·02 volts). The criterion for water formation by $H_2 + O = H_2O$ is considered ill-chosen, as it is problematical whether this reaction as given will take place (see "Photochemical Clustering," NATURE, May 19, p. 792). It is worthy of note that J. Kaplan has observed a green and red line in oxygen excited by active nitrogen (abstract in *Bull. Amer. Phys. Soc.*, April 7). In the case of hydrogen, it is well known that the molecule can possess electronic energy greatly in excess of that necessary for dissociation and can lose this energy in band spectrum emission. Dissociation also cannot be expected with carbon monoxide, as indeed Willey and others have found, since the energy required is larger than is available from the metastable nitrogen molecule in level *A*. (Heat of dissociation of carbon monoxide is 10·8 volts. Birge and Sponer, *Phys. Rev.*, **28**, 283; 1926.)

I regret the unfortunate wording which drew Dr. Willey's next criticism. I meant to convey that 2-volt nitrogen molecules do not issue only from the

discharge, but that spectroscopic data make it appear very probable that they may also be created outside the discharge by collisions of the second kind. I am well aware of Willey's work with an uncondensed discharge, where certain chemical actions occur in the absence of the afterglow. In this connexion it would be especially interesting to see whether there is sufficient energy in active nitrogen from an uncondensed discharge to bring out the band spectrum in cuprous iodide and the arc spectrum of copper.

As to the experiments with active hydrogen and ordinary nitrogen, my results are not extraordinary or new. The experiments are simple and were perfectly and easily reproducible. My negative results are, moreover, supported by several other investigators, including Bonhoeffer, who employed the same method (for literature see *J. Amer. Chem. Soc., loc. cit.*). It still remains, I believe, for Dr. Willey to explain the kind of active hydrogen with which he was dealing, for (1) at 10 mm. pressure and 150 cm. (corrected in private communication) from the discharge no atomic hydrogen can exist (Kaplan, *Phys. Rev.*, **30**, 639; 1927); (2) electronically excited atoms or ionised species are out of the question; (3) there is no real evidence for the existence of H_3, in fact, there is much evidence against it (see Urey and Smallwood's exhaustive attempts to prepare it with negative results, *J. Amer. Chem. Soc.*, **50**, 620; 1928; also Paneth and others, p. 29 of my paper).

The criticism is meaningless that since ammonia extinguishes the glow of active nitrogen (of which I am aware), that this constitutes a grave objection to my theory of ammonia formation—which by the way is not mine, since it has been expressed by Olsen (for reference see my paper, p. 33). My experimental procedure indicates that the pressures of nitrogen and hydrogen were low, down to 0·04 mm., and that a liquid air trap condensed out the ammonia immediately following the mixing chamber. It is certain that some of the ammonia formed, which would have otherwise reached the trap, was again decomposed. It is quite beyond the human eye to detect changes in the afterglow intensity at these low pressures, and it is rendered even more difficult due to stray light from the discharges. The results published in Table 1. are only a few of the numerous runs made.

I feel that private communication in controversial matters, once experimental data have been presented, is a far more satisfactory means of discussion.

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(National Research Fellow.)
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The Mechanism of Formation of the Latent Photographic Image.[1]

IN a communication to NATURE of Sept. 24, 1927 (vol. 120, p. 441), the preliminary results were described of experiments made in an attempt to correlate the mechanism of the latent image formation with that responsible for producing changes of conductivity on illumination. It was shown that the apparent absence of the photo-conductivity effect in the ultraviolet was due to two things: (1) the small penetration of that light, and (2) the use of thick layers of the silver halide. With thinner layers, of the order of 70μ, the ultra-violet ($\lambda 3650$) effect in silver bromide was found to be about twice as great as that produced by the blue ($\lambda 4358$), thus supporting the original prediction that in very thin layers of the order of $1{\cdot}5\mu$ the effect at $\lambda 3650$ would rise to nearer ten times that at $\lambda 4358$, which is the ratio of *photographic* effects in very thin layers of slow, pure silver bromide emulsions. It was further predicted that in very thin layers the 'hump' of maximum sensitivity at $\lambda 4600$ in the photo-conductivity–wave-length curve would disappear. How completely these conclusions have now been verified can be seen from the accompanying graph (Fig. 1). The inference is that in very thin layers of silver bromide the three curves representing

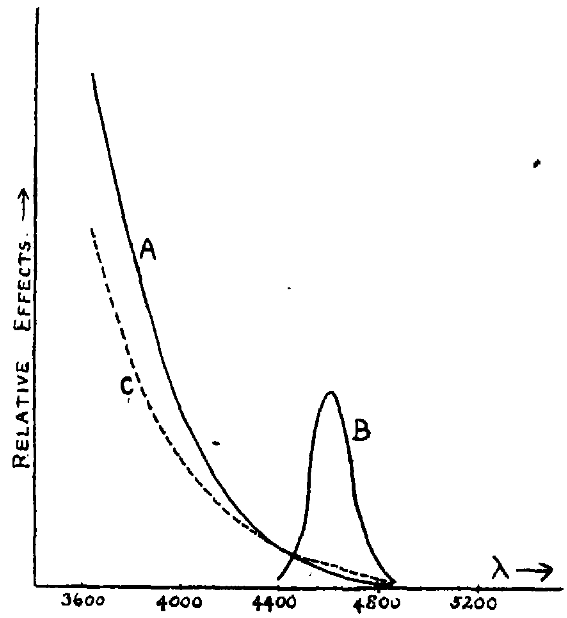

FIG. 1. Curve *A* represents the relative photographic effects in 'single layer' emulsions of silver bromide. It also closely represents the absorption curve of this halide. The relative effects at $\lambda 3650$ and $\lambda 4358$ are as 10 : 1.
Curve *B* represents the relative photo-conductivity effects in layers of silver bromide of the order of 0·7 mm. and upwards. As the thickness is decreased, this curve gradually changes and approaches the form of Curve *A*. The closest approach yet obtained experimentally is given in Curve *C*, where the ratio of effects at $\lambda 3650$ and $\lambda 4358$ has risen to 7 : 1. The thickness of layer in this case was roughly of the order of 20μ.

(1) the relative photo-conductivity effects, (2) the relative photographic effects, and (3) the relative light absorptions, each plotted against the wave-length for equal incident intensity, are closely the same, indicating that in all probability the primary stage of the photographic mechanism is intimately connected with that which produces conductivity changes on illumination.

It is hoped that these results will be presented in detail and discussed at the forthcoming International Congress of Photography to be held in London on July 9-14.

F. C. TOY.
Physics Department,
British Photographic Research Association.

Forestry and Agriculture in Great Britain.

ALL forest economists will agree with the writer of the leading article in NATURE of May 5 that national poverty greatly increases the difficulties of a scheme of State afforestation, and that periods when money can be borrowed cheaply are most suitable for afforestation development. Only those, however, who take a superficial view of our national forest problem are likely to be greatly influenced by this consideration.

For many decades those who were alive to the facts of the case have advocated a policy of national

[1] Communication No. 67 from the British Photographic Research Association Laboratories.

afforestation, and various Commissions have recommended in favour of it. It took a great war and the imminent danger of an alarming timber shortage, when we were cut off from foreign supplies, to rouse the public to action. The Forestry Commission was constituted immediately after the War, and now, at the end of its first ten-year period, there is a danger that national lassitude will allow the Commission to languish from lack of adequate funds.

Statistics of so many million trees planted on so many thousand acres are apt to be unconvincing, and we are liable to forget what lies behind these figures—an organised staff and a trained personnel which cannot be easily recruited and must not be lightly disbanded. Without continuity of administration, forests cannot be effectively managed and no efficient forest service can be built up, so that a gradual and systematic development is likely, in the long run, to be far more economic than sudden growths stimulated by war panic, unemployment, or cheap money, alternating with periods of decay due to apparent national security or financial stringency.

The benefits which may be derived from national afforestation are not confined to the timber, which, as the writer of the leading article says, can only be reaped after many years. Forestry helps to maintain the rural population, and when co-ordinated with the formation of small holdings, as in many of the Forestry Commission schemes, it stimulates agricultural and horticultural output. The agricultural depression is throwing a great deal of land out of cultivation, and it is very important that forestry should step in where possible and utilise the land and labour thus rendered unproductive. The present cheapness of land is also a direct incentive towards immediate afforestation.

W. E. HILEY.
(Editor, *Quarterly Journal of Forestry*.)

Imperial Forestry Institute,
University of Oxford,
May 9.

MR. HILEY misses the point of the article on "Forestry and Agriculture in Great Britain." No suggestion was put forward that the afforestation work now being undertaken should be discontinued. The view was expressed, however, that the Government should perhaps consider whether some of the heavy overhead charges which have little bearing on the actual planting of trees, that is, the afforestation work proper, could not be curtailed. The plea that forestry should step in and plant up land, which, owing to agricultural depression is being thrown out of cultivation, is surely unsound. The first axiom of scientific forestry is that no land which can be made to produce food should come under the ægis of the forester. The money Mr. Hiley would devote to afforesting such land would be more justifiably employed in assisting the agriculturist to bring it once more under crops or stock.

THE WRITER OF THE ARTICLE.

Salt Crystals as Nuclei of Sea Fog Particles.

I HAVE received from Dr. J. S. Owens a note of observations of a fog drifting from westward which he experienced recently on the Bay of Biscay. I cannot recall any observations exactly similar, so I append a copy of the note. It will interest readers of NATURE, and at the same time revive an old question as to the real meaning of an observation of the wet bulb in a sea fog, of which there are many thousands on record.

NAPIER SHAW.

May 17.

"On Sunday, April 29, 1928 (R.M.S.P. *Demerara*), we were a little south of Ushant, about 49 degrees north and 6 degrees west, when after a bright sunny morning a fog came on about 12·30 P.M. and remained till about 7 P.M. The sea was very smooth, no white caps or spray. A light breeze from west. The fog could be seen blowing in wisps across the ship. My cabin being on the west, the breeze was blowing into the port, and I placed a well-polished tumbler in the port hole so that fog particles blown in might hit it and stick. After about an hour visible spots were on the tumbler, and at about 5·30 P.M. the side facing the west was well covered with minute drops obviously liquid, when magnified. I removed the tumbler and filled it with hot water, when all drops disappeared, and in their place were whitish spots, such as one would expect if the droplets contained a soluble salt. On emptying the glass and allowing it to cool again, after about 10 minutes the whitish spots became converted into drops of liquid, evidently the soluble salt deliquescing. It seems, therefore, evident that the fog particles were formed round salt crystals, and that for such a fog to form the relative humidity need not rise much above 75 per cent, assuming, as is fairly certain, the salt present was sea salt, which deliquesces at 74 per cent or 75 per cent relative humidity.

J. S. OWENS."

Correlation.

FOR the determination of a linear function of X approximating to Y for a range of corresponding values (X, Y), a graphic method is desirable.

If the plotted values are divided into two classes by the median of X, in each class, the same number

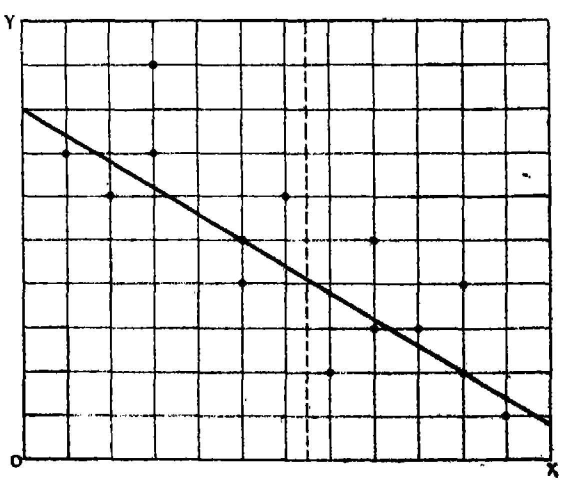

FIG. 1.

of points should lie on each side of the required line, which is thus found by inspection.

The method is much more expeditious than that of least squares. It appears, moreover, to be free from undue bias by outlying values.

For the values plotted in Fig. 1, the straight line is $Y = (40 - 3X)/5$, with a mean deviation of 1·00. The method of least squares gives $Y = (1940 - 137X)/236$, with a mean deviation of 1·05.

A. F. DUFTON.

Barns Green,
Horsham,
May 5.

The Centenary of the Institution of Civil Engineers.

By Engr.-Capt. EDGAR C. SMITH, O.B.E., R.N.

FOUNDED through the action of six young engineers, the first formal meeting together of whom took place at the Kendal Coffee House in Fleet Street on Jan. 2, 1818, the Institution of Civil Engineers on June 3-7 is celebrating the centenary of its incorporation by Royal Charter. It was in January 1820 that Telford was asked to become the first president of the new society, and it was largely through him its charter was obtained eight years later. The celebrations are to commence with a memorial service in Westminster Abbey at 3 P.M. on Sunday, June 3; on Monday, June 4, the president, Mr. E. F. C. Trench, and the council will receive the delegates, and Sir Alfred Ewing will deliver the thirty-fourth James Forrest Lecture on "A Century of Inventions"; during the three succeeding days there will be a conversazione, a banquet, a conference at which some thirty different problems in engineering will be discussed, and a series of visits to important engineering works and undertakings.

In the petition of a hundred years ago to the Attorney-General for the grant of a charter, it was laid down that "Civil Engineering is the art of directing the great sources of power in Nature for the use and convenience of man," an all-embracing phrase which covers almost all the manifold activities of the engineer, and it is not without interest to find that practically all the subjects to be dealt with at the conference—docks, harbours, shipbuilding, railways, fuels, gas, boilers, domestic lighting and heating, road traffic, tidal power, mining, water supply, and sewage—were all matters of vital interest to the engineer a hundred years ago, while even at the time of the incorporation of the Institution, the internal combustion engine was a subject of practical debate, and in the laboratory of Faraday was being laid the foundation of our electric power and lighting.

The birth of the Institution and its incorporation by charter are but two of many landmarks in the material progress of Great Britain. It was not the first society of its kind, neither did it mark the beginning of any new branch of engineering. Docks, harbours, bridges, viaducts, and aqueducts had been constructed for centuries; France many years before had founded a School and Corps of Civil Engineers, while in Great Britain we see the rise of the Smeatonian Society and the short-lived Society for the Improvement of Naval Architecture. These, however, were but the forerunners of the great modern engineering institutions of Great Britain which really had their foundations in the vast extension of the work of the engineer due to the widespread application of mechanical invention to manufacture and to transport during the eighteenth and the early part of the nineteenth century.

When the Institution was incorporated, Brindley, Smeaton, Arkwright, and Watt had long since passed away, but the movements they inaugurated gained in volume day by day. No one had added more to the roads of McAdam and the canals of Brindley than Telford himself, while as a bridge-builder he will always be remembered for that most graceful bridge which spans the Menai Straits. In 1828 the steamboat was a recognised factor in overseas transport, though both Bell and Symington still survived in undeserved poverty. Through David Napier the mails were regularly carried by steam vessels: in 1825 the little *Enterprize* had made her historic voyage to India, and in 1827 the British-built Dutch vessel *Curocoa* crossed the Atlantic to the West Indies. In 1828, steam vessels were included in the Official List of the Royal Navy, but another ten years had to pass before Brunel's famous *Great Western* inaugurated regular trans-Atlantic passages. The same period also saw the beginning of the railway systems of England. Blenkinsop's locomotives had been at work since 1812, passengers were carried on the Stockton and Darlington Railway in 1825, and in 1828 George Stephenson was engaged in the construction of the Liverpool and Manchester Railway, with which the epoch-making *Rocket* is associated. On the roads, too, steam carriages such as Goldsworthy Gurney's were seen, and had a more enlightened policy prevailed, the steam motor-car might well have been common eighty years ago.

With the increasing demand for engines and machinery arose a new type of engineer, known as the 'mechanical engineer,' devoted to the founding and fashioning of iron. Not only was he called upon to make steam engines in great numbers for factories, ships, and railways, but it was he who built the iron bridges and the iron ships. Thanks to the work of Cort, the iron masters of Great Britain were able to meet all demands, and the country came to boast of some thousands of puddling furnaces. With these things came the rise of the machine tool makers. From the shops of Boulton and Watt at Soho, the Butterley Iron Works, and Maudslay's shops at Lambeth, came a long line of successful pioneers, such as Roberts, Muir, Whitworth, and Nasmyth, who gave us the planing machine, the true plane surface, the standard screw thread, and the steam hammer.

Among the first members of the Institution of Civil Engineers were to be found men engaged in all the various branches of engineering, and the *Proceedings* of the Institution contain a progressive review of the great achievements of the engineering profession. In the early days of the Institution, however, engineering work was carried out mainly by practical men trained in the hard school of experience. Of scientific education for the engineer, in England at least, there was none, and scientific research was in its infancy. If there is one thing more than another which separates the present from the past, it is the attitude towards scientific discovery, but for many years now in matters of education and investigation the Institution of Civil Engineers has taken a leading part. In connexion with this it is perhaps worth recalling that when William Anderson inaugurated the

annual lectures which keep alive the memory of the most famous of the Secretaries of the Institution, James Forrest, he took for his subject "The Interdependence of Abstract Science and Engineering." That was in 1893. Since then many men famous both as engineers and as men of science have delivered the James Forrest Lecture, but the happy choice of the Council in selecting Sir Alfred Ewing to give the lecture which will mark the centenary of the incorporation of the Institution will not fail to gain general approval; his lecture on "A Century of Inventions" will be awaited with more than usual interest. In the voluminous publications of the Institution, which in themselves form a veritable engineering library, it may be there are few, if any, more valuable records than these James Forrest lectures, which have often rivalled in interest the famous presidential addresses of Sir John Rennie, Robert Stephenson, Sir William White, and others.

The Accuracy of Shortt Free Pendulum Clocks.

By Dr. J. JACKSON and W. BOWYER.

THE period of vibration of a simple pendulum, swinging in a vacuum through the small semi-arc α is given by $2\pi\sqrt{\frac{l}{g}}\left(1+\frac{1}{16}\alpha^2\right)$.

Variations in the rate of a pendulum clock are produced by variation in (1) the length of the pendulum; (2) the arc of vibration; and variation in several factors which produce a departure from the above formula; namely: (3) air resistance; (4) elasticity of the spring; (5) interference with the free motion of the pendulum by the escapement and impulsing mechanism.

We will consider these in turn.

(1) The principal cause of variation in the length of the pendulum is change of temperature. This can be overcome by keeping the pendulum at constant temperature. Attempts have also been made with more or less success to compensate the effect by the use of metals of different coefficients of expansion so as to make the effective length of the pendulum practically independent of the temperature. But the parts of such compound pendulums may not take up changes of temperature at the same rate, and those of the grid-iron type are apt to roll. The discovery of invar has greatly simplified the temperature question. But invar is a rather unstable substance and its growth produces slow secular change in the clock rate.

(2) If the bob moves in a cycloid instead of a circle the period is independent of the amplitude. Clocks have been constructed with 'cycloidal cheeks' to guide the pendulum, but these have not proved of value. When the semi-arc of vibration is 1° a change of 1′ in the amplitude affects the daily rate of a simple pendulum by only 0·05*s*. The change of arc in precision clocks is not great, and, moreover, as a result of the action of the suspension spring, the effect of change of arc in such clocks may easily be less than the theoretical amount given, so that this source of irregularity is not very serious.

(3) A change of 1 per cent. in the air pressure under ordinary conditions changes the daily rate of a standard type of pendulum by about 0·1*s*. This can be fairly accurately compensated in various ways, but for the most accurate clocks it is best to keep the pressure constant. For Riefler clocks this is usually about 600 mm. of mercury, but for the Shortt clocks it is of the order of 30 mm.

(4) The effect of the suspension spring does not appear to be very great, although various methods of supporting the pendulum have been invented. Change of elasticity with temperature and fatigue of the material from continuous bending, may produce variations of arc and so affect the rate of the clock.

(5) The most difficult problem in clock making has been in the escapement. In the usual type of clock the escapement serves a double purpose. It enables the number of vibrations to be counted, and through it the impulse is given which maintains the vibrations of the pendulum. The pendulum is in more or less continuous contact with the escape wheel, and although this is generally situated fairly near the point of suspension, it is clear that frictional forces and continuous interference by the escape wheel may easily produce considerable irregularity in the clock rate.

At the end of 1924 the clock Shortt 3, made by the Synchronome Co., Ltd., was installed at the Royal Observatory, Greenwich, and it proved so reliable that it was introduced as standard on Jan. 1, 1925. It consists of a 'free pendulum' and a 'slave clock.' The free pendulum is made of invar swinging in an air-tight case at a pressure of about 1 inch of mercury. The free pendulum has no escapement. On a bar about one-fifth of the way from the top it carries a very light wheel about 6 mm. in diameter. At every fifteenth swing to the left (30 seconds) a gravity lever carrying a weight of ⅓ gm. and released by the slave clock, falls on the wheel, giving it an impulse. As this lever gets clear of the wheel a tail-piece releases mechanism which resets the impulse lever and also causes an electric contact to be made which synchronises the slave clock. An action of the synchroniser on the slave clock advances its phase by approximately 0·004*s*. The slave clock is rated to lose about 5*s*. a day, or 0·002*s*. per 30*s*. Under these conditions the synchronising action on the slave pendulum occurs at alternate half minutes with considerable regularity. The slave clock does all the work of counting the vibrations and releasing the impulse lever. Consequently, the only interference with the free pendulum is the impulsing during a fraction of a second every thirty seconds. The great advantage which the Shortt clock has shown over all other types of clock is undoubtedly due to the relative freedom of the pendulum from mechanical interference.

This clock was started at a practically zero rate

at the beginning of 1925, but it acquired a losing rate at about 0·04*s*. per day per month. By the autumn of that year the rate of change of rate had fallen to about 0·012*s*. per day per month. It remained at approximately this value until June 1926, when the clock stopped as a result of the failure of the release of the lever which resets the impulse arm of the free pendulum. This failure was caused by two steel surfaces jamming, and to avoid a recurrence of the fault a jewel was introduced at the locking surface.

The clock was restarted in July 1926, since which time its performance has been remarkable. The rate showed the previous change of about 0·012*s*. per day per month, but apart from this the going appeared nearly uniform. During October and November 1926, when special time determinations were being made for longitude purposes, the temperature was subject to unusually large fluctuations, and it appeared that there might be a temperature term of the order of 0·003*s*. per day per 1° F. Consequently thermostatic control was introduced, and the clock rate became very steady. This continued until May 1927, when the clock error commenced to depart from the predicted value, but this was traced to an irregularity in sidereal time and not in the clock rate. For those not acquainted with the exact definition of sidereal time, we may state that sidereal time is defined by the hour angle of the first point of Aries measured westward from the meridian. The motion of the first point of Aries is for convenience divided into two parts, the uniform part called precession and the non-uniform part called nutation. The principal part of the latter is given by the formula

$$-1{\cdot}06s. \sin \Omega - 0{\cdot}08s. \sin 2L.$$

The period of the first of these terms is 18·6 years, and this term can with sufficient accuracy be expressed in the form $\alpha + \beta t + \gamma t^2$ for an interval of a year or two. The second term, though of much smaller amplitude, runs through its period in six months, and this term cannot be expressed in quadratic form for more than four or five months. The clock error was therefore analysed in the form $\alpha + \beta t + \gamma t^2 +$ nutation, and this satisfactorily explained all the observations while the temperature was approximately constant. The temperature of the clock room had been maintained near 55° F., but in the summer of 1927 it rose to about 62° F., and by comparison of the observed clock error with the formula, it was found that there was a temperature term of very nearly 0·0030*s*. per day per 1° F. When this effect was allowed for, a formula was obtained which fitted all the observations from March 1927 to December within 0·1*s*. The formula was extrapolated backwards and found to leave residuals of about three-quarters of a second in the autumn of 1926 and to fit the observations again in July 1926. Extrapolation forwards fits the observations to 0·1*s*. at the end of March 1928.

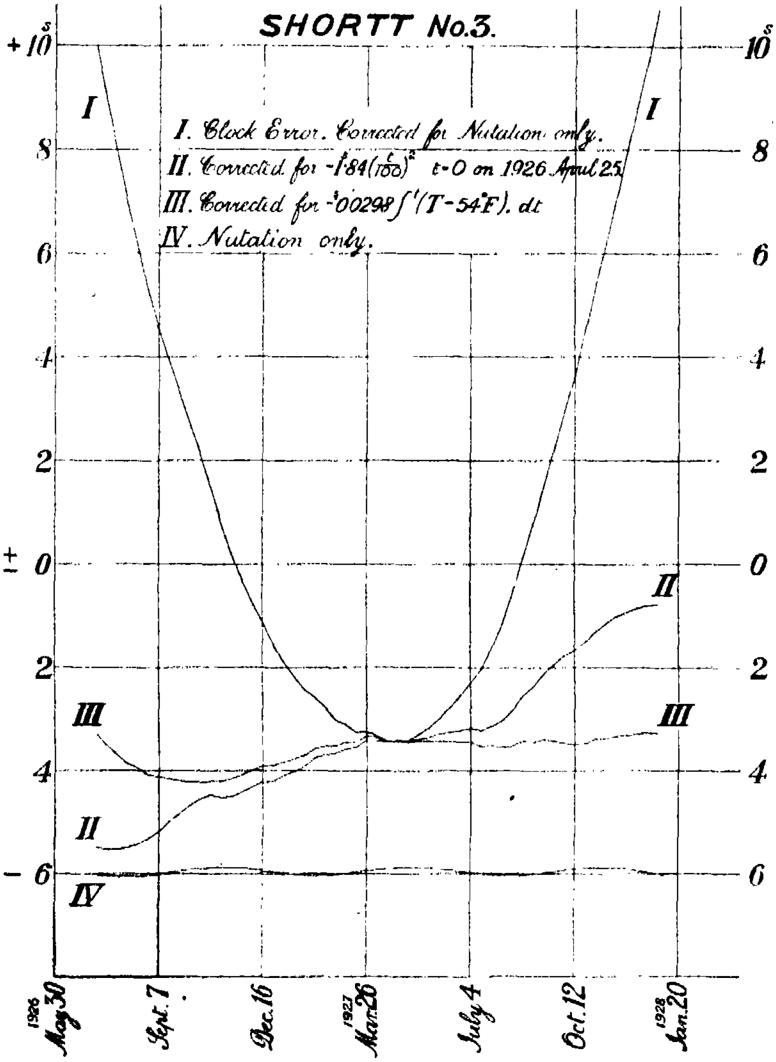

FIG. 1.

It should be stated that although the temperatures were not known with great accuracy in 1926, the residuals must be due to change in γ or some other irregularity.

The two diagrams (Figs. 1 and 2) show how closely the observed clock errors can be explained when the irregularities are allowed for. The points in the diagrams are based on curves drawn

through all the errors determined with the transit circle. A more detailed comparison of the observed and computed clock errors is given in the *Monthly Notices of the Royal Astronomical Society* for March 1928.

The temperature term of 0·0030*s*. per day per 1° F., or 1·1*s*. per year per 1° F., is much smaller than that for most high-grade clocks, but it was not expected to exist. It is said by the makers to be larger than would arise from uncertainty in the coefficients of expansion of the materials used in the construction of the pendulum. The second Shortt clock which was erected in the same clock room in May 1926 shows a temperature coefficient of similar amount.

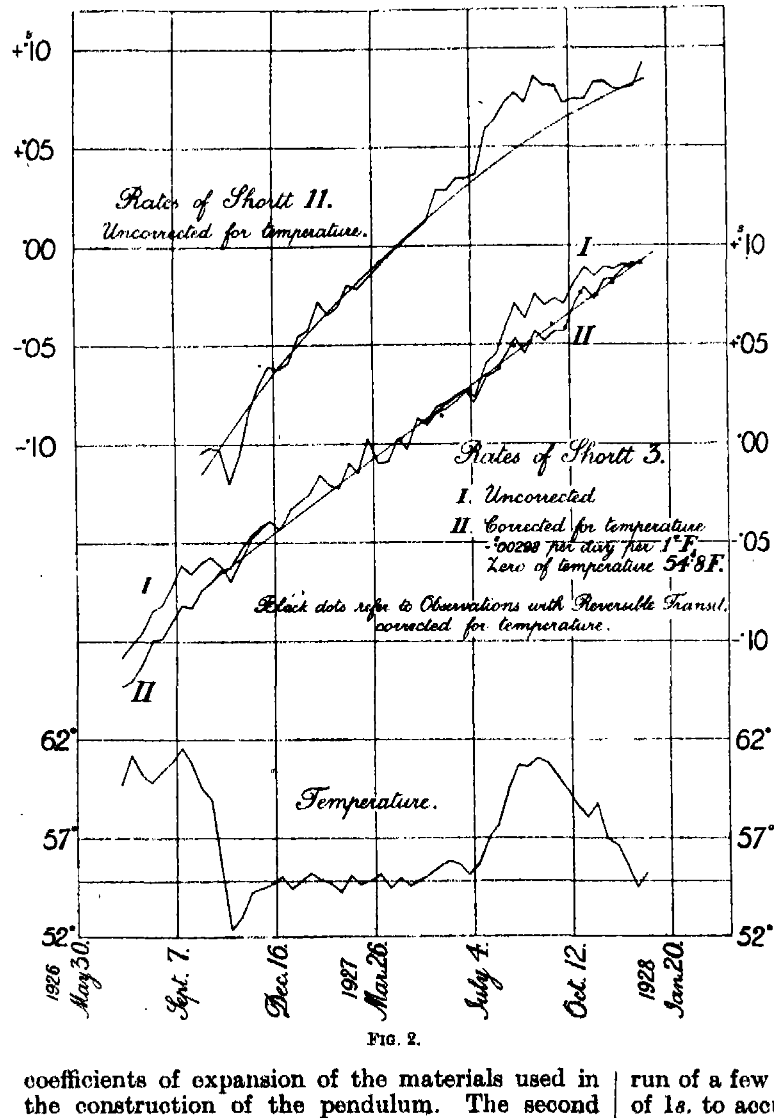

FIG. 2.

The temperature term in the clock error is, however, of comparatively small importance. The important term for long-distance forecasting of the clock error is γt^2, γ being 1·84*s*. when t is in units of 100 days. This term will amount to more than three minutes in 3 years. There can be little doubt that it is due to growth in the length of the pendulum. It is known that invar grows for years after its manufacture, and that the growth may be irregular. To explain the above coefficient the growth in the length of the pendulum (994 mm.) is 0·001 mm. in 118 days. Changes in the rate of growth of the pendulum do not affect the prediction of clock errors for a month or so, but may become serious when a formula fitting the observations for a year or more is considered.

Possible changes in the rate of rotation of the earth have recently attracted the attention of astronomers. Observations of the positions of the moon, supported fairly well by observations of more slowly moving bodies in the solar system, indicate that the rotation of the earth may be subject to variation amounting in extreme cases to about 1*s*. per year. One second a year is only 1 part in 30 millions, and if residuals of this order in the relative times shown by the earth and the free pendulum are demonstrated, the question will arise as to whether they are caused by:

(*a*) Residual secular change in the length of the pendulum.

(*b*) Variation of gravity.

(*c*) Variation in the actual rate of rotation of the earth.

(*d*) Seismic disturbances.

(*b*) and (*c*) may be inseparable, as changes in the earth's moment of inertia may be accompanied by changes in gravity as well as in the earth's angular velocity.

The real difficulty in the clocks is (*a*). It appears that the principle of their construction is such that they could be used to check the uniformity of the earth's rotation if only material stable for several years to 1 part in 100 millions could be obtained for the manufacture of the pendulums. At present the two sidereal Shortt clocks at Greenwich have been running continuously for 20 months, and a run of a few years would possibly suffice for errors of 1*s*. to accumulate in the earth's rotation, but a variation of 1 per cent. in the rate of growth of the pendulums would introduce greater irregularity in the clock error. It appears impossible to be certain that any piece of material has the required degree of stability, and until pendulums of different materials in different parts of the earth agree in supporting the motion of the moon and planets against the earth's rotation, clocks will not play an important part in checking the uniformity of the earth's rotation.

Cruise VII. of the *Carnegie*, 1928–1931.

By Dr. J. A. FLEMING and Capt. J. P. AULT,
Department of Terrestrial Magnetism, Carnegie Institution of Washington.

AFTER an interval of more than six years, the *Carnegie* began again on May 1, 1928, a world-wide cruise planned to continue to September 1931. This will be the seventh cruise of the vessel and, as indicated by the tentative route shown in Fig. 1, will add 110,000 statute miles to the total of nearly 290,000 miles traversed in all oceans during Cruises I. to VI. (1909–1921). Thus the plans for the magnetic and electric survey of the oceans envisioned in 1904, under the enthusiastic and energetic directorship of Dr. Louis A. Bauer, will be further realised and the results already obtained will be greatly enhanced.

The survey of the oceans of the world was begun during 1905–8 on the chartered brigantine *Galilee* in the then magnetically unexplored Pacific under the command, respectively, of J. P. Pratt for the first cruise, and W. J. Peters for the second and third cruises. Upon completion of the specially designed yacht *Carnegie* in 1909, the survey was continued with greater efficiency, because of non-magnetic construction of the vessel and the steady evolution of suitable instruments and observational methods, in all oceans during 1909–21 under the command, respectively, of W. J. Peters for Cruises I. and II., of Capt. J. P. Ault for Cruises III., IV., and VI., and of H. M. W. Edmonds for Cruise V.

The practical and theoretical value of the magnetic work already done on the *Carnegie* is attested by the principal hydrographic establishments of the world and by individual investigators. While magnetic data are needed for practical navigators, yet future magnetic work at sea is far more necessary for the advancement of theoretical studies. Accumulated data indicate that the accelerations in the secular variation changes may not be extrapolated safely over periods so long as five years. Observations will be repeated in localities previously surveyed by the *Galilee* and the *Carnegie*, and additional information will be obtained regarding the distribution of the magnetic elements in some large areas not already covered.

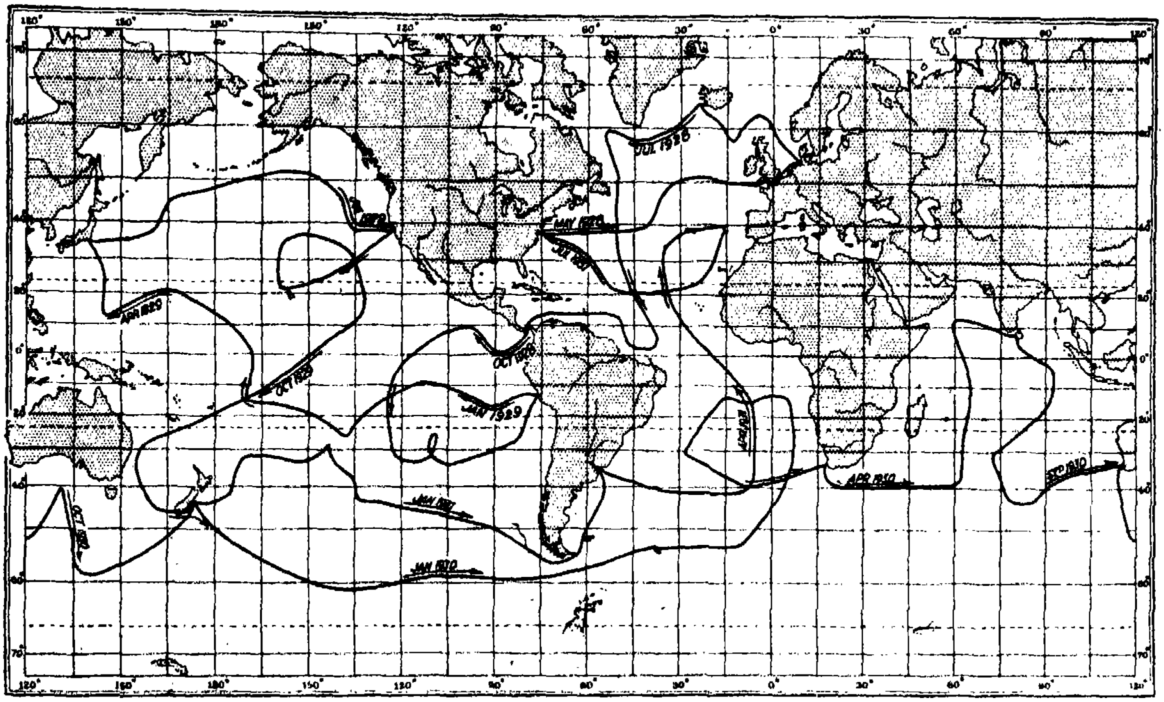

FIG. 1.—Tentative route for Cruise VII. of the *Carnegie*, 1928–1931.

Experience during previous cruises has shown that results with certain magnetic methods and instruments are more trustworthy than with others, so that the duplication of instruments and methods need not be continued. Thus the magnetic declination will be determined by use of the marine collimating-compass, omitting the deflector; the horizontal intensity will be determined by the deflector, omitting the dip circle method; the magnetic inclination will be determined with the earth inductor, omitting the dip circle. Some improvements have been made in the magnetic instruments, chief among which is the addition of a constant speed apparatus and drive for rotating the coil of the earth inductor, with amplifier and micro-

ammeter to determine inclination electromagnetically. Electromagnetic methods are also to be attempted with the earth inductor for the measurement of the horizontal intensity, thus replacing the more laborious deflector method by a more rapid and accurate electric method.

For the further investigations on the origin and maintenance of the earth's electric charge and of their relation to the earth's magnetic condition, determinations of changes in the values of the atmospheric electric elements with geographic position are needed in addition to those already made. A photographic recorder will be used to record variations in atmospheric potential gradient continuously; it will be mounted near the top of the mainmast and will be controlled by the apparatus for eye-readings mounted on the quarter-deck railing as heretofore. A motor has replaced the spring and clock-work mechanism in the ionic-content apparatus for drawing the air through the instrument.

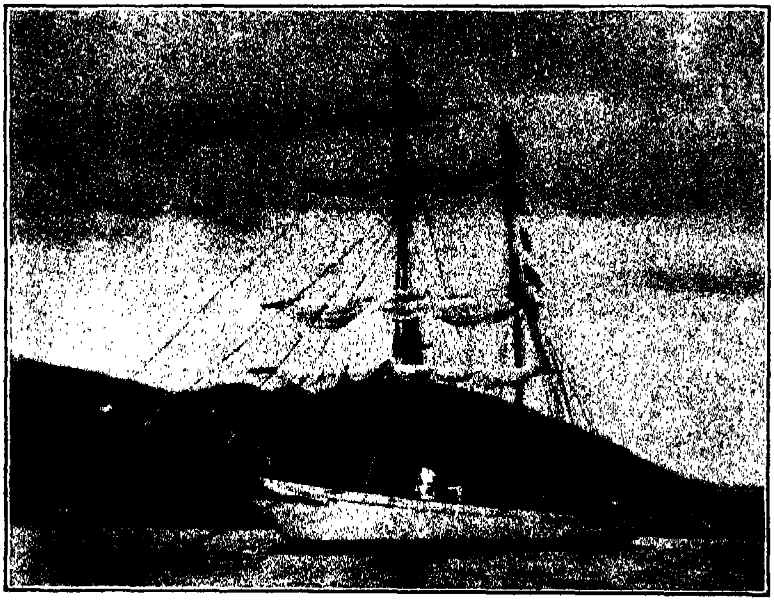

FIG. 2.—Non-magnetic yacht *Carnegie* off Port Lyttelton, New Zealand. During six cruises in all oceans (1909–21), the vessel has sailed about 290,000 miles.

Some improvements have been made in the instruments and methods used for measuring the penetrating radiation and the radioactive content, and more frequent series of observations extending over a period of twenty-four hours are planned. In addition to the programme previously followed for observations of the penetrating radiation, parallel observations will be made with a Kolhörster instrument which Dr. Kolhörster is testing thoroughly and comparing with his 'standard' instrument. It is planned to observe especially for variations with time, with geographical position, and with depth. Dust-count observations, using an Aitken dust-counter, will be made for correlative studies with atmospheric electricity. The measurement of marine electric currents will be attempted by trailing electrodes on cables from the stern of the vessel.

The important contributions to the study of various geophysical problems, which are being made by investigations of the Heaviside conducting layer and of radio transmission and variations with changing magnetic and electric conditions, greatly enhance the value of the atmospheric electric data already collected on the *Carnegie* over the ocean areas, and indicate co-operative investigations along similar lines for the coming cruise.

The omission of duplicate magnetic methods and instruments previously mentioned, and addition of two men to the scientific personnel, make possible a substantial programme in physical and biological oceanography. In physical oceanography it is planned to investigate the topography and configuration of the ocean depths by the sonic depth-finder; to study the causes of movements of vast bodies of water relatively to one another, the dynamics of the sea, by measuring differences in temperature and salinity over the surface and at various levels down to a maximum of 20,000 feet; to secure information regarding the nature and derivation of inorganic marine deposits by sampling the bottom muds and sediments; and to increase our knowledge of the physical interchange between the surface of the ocean and the air above it by measuring the temperature and humidity lapse-rates of the air in the first 100 feet above the surface, and by observing the variations in the amount of solar radiation received at the ocean surface.

Work in marine biology will be confined to microbiology, to determine the abundance and distribution of plankton and other small organisms. Most of the collecting will be done by tow-nets and dip-nets. A special boom-walk, similar to the one used by Beebe, has been installed on the starboard forward side of the vessel, where the collector may walk 30 feet out from the side of the ship on a plank suspended by a netting of rope from two boat-booms and about three feet below them. The booms are hinged at the rail and are suspended from the mast by a pendant with preventer stays both forward and aft. Shallow-water dredging will be undertaken to secure diatoms and foraminifera, and specimens of porpoises, dolphins, birds, and other creatures will be collected from special regions.

To carry out this programme of oceanographic investigations and to provide for new equipment required many changes in the *Carnegie*. The

structural changes were made during the summer of 1927, when the vessel was completely overhauled and reconditioned at Hoboken, New Jersey. The two lifeboats were removed from the quarter-deck to overhead platforms amidships, thus leaving the quarter-deck free for the operation of the winch, sounding wire, water-bottles, deep-sea reversing thermometers, tow-nets, bottom-samplers, and earth-current cables. Two new laboratories were constructed on the main-deck, one designed for oceanographic investigations, and one for radio and sound work. In the oceanographic laboratory are mounted the Wenner electric salinity apparatus, the Negretti and Zambra distant-recording surface temperature thermograph operating on a 24-hour rate, and the various equipment and apparatus for the study of plankton and of the chemistry of the air and of sea water.

In the radio and sound laboratory is mounted the depth-finder loaned by the United States Navy Department for measuring rapidly and accurately the depths of the sea. The short-wave transmitting and receiving radio equipment made after the design of the United States Naval Research Laboratory, for the investigation of variations in transmitting and receiving conditions and on skip distances and signal intensity, is installed in this laboratory.

In a new galvanometer house on the port side of the quarter-deck aft of the radio laboratory, are mounted the Einthoven type string galvanometer for the earth inductor and for the earth-current apparatus, the control portion of the constant speed apparatus, amplifying unit, microammeter, special inductance coils, and appurtenances for the earth inductor work, the recording apparatus for six resistance thermometers located at various places from the masthead to near the ocean surface, and the roll-and-pitch recorder.

The oceanographic equipment includes a Wenner electrical salinity apparatus made in the Department's shop, Richter and Wiese thermometers and water-bottles, Nansen water-bottles, special non-magnetic winch with 6800-foot and 20,000-foot aluminum-bronze cables for depth-work, sonic depth-finder loaned by the United States Navy Department, chemical and biological apparatus, silk metre and half-metre plankton nets, various types of bottom-samplers, and necessary appurtenances.

The meteorological instruments are in general of the recording type, and a special programme of observation and control has been arranged. At Plymouth and at Hamburg, additional recording wet- and dry-bulb thermograph and wet- and dry-bulb resistance thermometer equipment with recording galvanometer for three stations at masthead, cross-tree, and meteorological screen are to be installed. It is hoped that, despite the difficulties of such work on a sailing vessel, data on the general upper-air circulation may be obtained by pilot-balloon flights, for which equipment is provided.

The members of the scientific personnel and their special fields of activity are: Capt. J. P. Ault, commander and chief of scientific staff; Wilfred C. Parkinson, senior scientific officer, atmospheric electricity and photography; Oscar W. Torreson, navigator and executive officer, magnetism, navigation, and meteorology; F. M. Soule, observer and electrical expert, magnetism and physical oceanography; H. R. Seiwell, chemist and biologist, oceanography; J. H. Paul, surgeon and observer, medical work, meteorology, and oceanography; W. E. Scott, observer, navigation and commissary; Lawrence A. Jones, radio operator and observer, radio investigation and communication. The sailing staff will consist of 17 men, making the total number of men on board 25; of the sailing staff, A. Erickson, first watch-officer, C. E. Leyer, engineer, and F. Lyngdorf, steward, occupied similar positions during the entire two years of the *Carnegie's* last cruise.

The first leg of the cruise will be to Plymouth, England, where the vessel was due to arrive at the end of May. After a call at Hamburg, the next ports of call will be at Iceland, at Barbados, and at the Panama Canal Zone (about the end of October 1928). The remainder of the cruise (see Fig. 1) will cover the North Pacific, South Pacific, South Atlantic, Indian, and North Atlantic oceans. Among the ports of call will be Easter Island, Callao, Papeete, Apia, Guam, Yokohama, San Francisco, Honolulu, Lyttelton, South Georgia, St. Helena, Cape Town, Colombo, St. Paul, Fremantle, Rapa Island, Buenos Aires, Ponta Delgada, and Madeira.

The preparations for this cruise have had generous co-operation and expert advice on all sides from interested governmental and private organisations and individuals both in America and Europe, who have also either loaned or presented much of the special oceanographic equipment and many books for the reference library on board. Among these the Carnegie Institution of Washington is indebted to the following: United States Navy Department, including particularly its Hydrographic Office, Naval Research Laboratory, Signal Corps and Air Corps of the War Department, Coast Guard, National Museum, Bureau of Fisheries, Weather Bureau, and Coast and Geodetic Survey; Scripps Institution of Oceanography of the University of California; Museum of Comparative Zoology of Harvard University; School of Geography of Clark University; American Radio Relay League; Geophysical Institute, Bergen, Norway; Marine Biological Association of the United Kingdom, Plymouth, England; German Atlantic Expedition of the *Meteor*; Institut für Meereskunde, Berlin, Germany; British Admiralty, London; Carlsberg Laboratorium, Bureau International pour l'Exploration de la Mer, and Laboratoire Hydrographique, Copenhagen, Denmark; and many others. Dr. H. U. Sverdrup, of the Geophysical Institute at Bergen, Norway, research associate of the Carnegie Institution of Washington, is consulting oceanographer and physicist.

Obituary.

DR. H. F. GADOW, F.R.S.

DR. HANS FRIEDRICH GADOW died suddenly on May 16, aged seventy-three years. He was born in Pomerania, the eldest son of the Inspector of the Prussian Royal Forests. He was a Wend by birth, and he was deeply interested in the languages and aspirations of all the peoples of East Prussia. He was being trained for a commission during the Franco-German war. Afterwards he was educated at Frankfurt, Berlin, Jena, and Heidelberg, and he regarded himself as a pupil both of Haeckel and of Gegenbaur. For the former he edited "The Last Link," and he suggested his striking and picturesque comparison of past evolution with the spectrum. In his morphological work he always remained a pupil of Gegenbaur, who suggested his employment by the British Museum in 1880. Here he remained until 1882, when he was appointed Strickland curator of birds at Cambridge, in 1884 becoming lecturer on the advanced morphology of vertebrates as well; he also became naturalised. He remained in these same posts until 1920, when his lectureship was changed into a readership. During all these years he was responsible for the advanced teaching in the comparative anatomy of vertebrates at Cambridge, but on becoming reader he undertook at his own desire for some years the elementary teaching as well. He also lectured at times on the history of zoology and on geographical distribution. He was elected a fellow of the Royal Society in 1892.

Dr. Gadow's early researches were largely concerned with the musculature of reptiles and birds, in much of which he broke a new field. His volume in Bronn's "Klassen und Ordnungen des Thier-Reichs" on the anatomy of birds, more than 1000 pages and 59 plates, 1884–91, will always remain classical, and this was followed by a systematic volume in 1893. He was also responsible for all the anatomical parts in Newton's "Dictionary of Birds." His two papers (1895–6) on the vertebral column were a great attempt to bring into line the anatomy of different groups. He established the existence in each vertebra of four pieces, but the whole question is still very involved. He examined his material directly and by sections cut at all sorts of angles, and above all he made pilgrimages, wherein he saw practically all the fossil material of Europe. His lectures on the cloaca, on ear ossicles, and on other organs, were largely founded on his own researches, and in all his work on the hard parts he treated fossil with living forms in a single story.

With further discoveries in palæontology and embryology much of this work has been superseded, but Gadow's method undoubtedly exercised a stimulating influence on all zoology. In 1898 he published his "Classification of Vertebrata," which most of the critics of that time judged severely for its division of suctorial and jawed forms and for the placings of many fossil groups, most of which are now accepted. The volume on amphibia and reptiles (1901) in the "Cambridge Natural History," next occupied his attention. He personally examined practically every beast that he mentioned, and he made himself acquainted with very many by keeping them alive, by studying them in Nature or in zoological gardens. He started *de novo*, and the result is seen in unquestionably one of the greatest works in zoological science.

Dr. Gadow's explorations led him to caves and mountains in northern Spain and in Mexico among other places. He visited the latter on several occasions, being always warmly welcomed by President Diaz. He camped when and where he liked and at all elevations in complete safety in that land of brigands, for he had the gift of friendship with such wild peoples. His results are seen in two travel books and many papers, of which perhaps the most remarkable were on the colorations of lizards, snakes, and birds. His presidential address to Section D of the British Association (1913) was on the necessity for the study of structure and function taken together.

In many respects the late Dr. Gadow was a man of strong personality. He was always ready to fight any- and everyone over any zoological research or teaching matter. He seemed to us to enjoy it, and for the time being it entirely dominated his life, his opponent for the moment in all his works and characteristics being a villain. Yet this never lasted long, and he made no enemies and many friends, for his very faults were all lovable. His ideas of research were Teutonic—a professor and an obedient school, a system unsuited to England—and consequently he had few direct pupils, though all zoologists appreciate his potent and excellent influence on the development of their science in the last fifty years. All Cambridge men in particular will deeply regret his death, but he has left a good name and a fine record. J. S. G.

PROF. J. V. DANEŠ.

THE Charles' University of Prague has lost one of its leading professors, Prof. Jiří Václav Daneš, who died on April 13 in Los Angeles in his forty-eighth year, having been run over by a motor-car. This disaster happened when he was on a scientific tour through the United States, where he had been invited by several universities to lecture on geographical problems.

Daneš was our professor of general geography at Prague, and his aim was to make his subject a truly scientific one. He studied under Palacký in Prague and under Penck in Berlin. In the year 1919 he was nominated ordinary professor of the Charles' University, but soon afterwards accepted the post of a general consul in Sydney. Daneš worked especially in the domain of geomorphology and anthropogeography in the Czechoslovak Republic, in Yugoslavia, together with its famous geographer, Cvijić, in the United States, Mexico, Jamaica, Java, Australia, and Oceania, where he spent some time in travelling with his colleague, Prof. Karel Domin, professor of botany, and after

his return to Australia he worked there and on some of the islands for the Australian Government. The results of these scientific travels were published, jointly with Domin, in a volume, "Through the Double Paradise," and his further work was "Three Years in the Pacific."

Daneš published a series of papers in the *Proceedings of the Bohemian Academy of Prague* (with summaries in English), and the following further papers: "Physiography of some Limestone Areas in Queensland" (*Proc. Roy. Soc. Queensl.*, 1910); "On the Physiography of North-eastern Australia (*Roy. Soc. Prague*, 1911); "Absence des traces glaciaires dans la Californie méridionale" (*La Géographie*); "La région des rivières Barrow et Russell (Queensland)" (*Annales de Géographie*, 1912); "Further Kars-Studies in Jamaica" (1914); "Glacial Studies in territory of Ljuma" (*Bull. Soc. Serbe de Géographie*, 1914); and many others. Daneš was in 1925–26 dean of the Faculty of Natural Sciences in the Charles' University; he was honorary, ordinary or corresponding member of many scientific societies, among them being—the Royal Society of Science and the Bohemian Academy of Science in Prague, the Royal Society of Queensland and the Royal Geographical Society of Australasia (Queensland branch, Brisbane), the Serbian Geographical Society in Beograd, the Royal Academy in Beograd, the Polish Geographical Society in Warszawa, and the Commission Internationale de l'Atlas photographique des Formes du Relief Terrestre. BOHUSLAV BRAUNER.

PROF. EDGAR F. SMITH.

BY the death of Prof. Edgar Fahs Smith on May 3, the United States loses a distinguished and versatile chemist who had many friends in England. Prof. Smith was born at York, Pennsylvania, on May 23, 1856. He graduated at Pennsylvania College in 1874 and proceeded to Germany, where he obtained his Ph.D. (Göttingen) in 1876. He was awarded the D.Sc. of Pennsylvania in 1899, and was afterwards honoured by many American universities and societies both in the United States and outside. He took up his duties as professor at Philadelphia in 1888 and continued there until his death.

Prof. Smith contributed to the advance of chemical knowledge in many fields, having carried out investigations in organic, inorganic, and physical chemistry. His earliest publications described the preparation and properties of the derivatives of certain aromatic acids and bases, and in this branch he claimed attention by translating Richter's "Chemistry of the Carbon Compounds," the first English edition appearing in 1886. Before this Smith had already turned his attention to the advantages to be gained by the application of electrical methods in analytical chemistry, and he worked out a number of procedures for separating and estimating metals by electro-deposition methods. So early as 1878 he published a book on "Electrochemical Analysis," which was favourably received and reached its sixth edition in 1917.

Most of Prof. Smith's researches, however, were concerned with tungsten and the tungstates, and although he carried out much painstaking work, this does not seem to have attracted the attention it merited. Indeed, Prof. Smith is best known as a biographer of American and other chemists and as a writer upon the history of science. His essays on the early American chemists, such as Martin Hans Boyé (1610–1686), Jacob Green (1790–1841), Robert Hare, J. Cutbush, Charles Baskerville (whose obituary he wrote for the *Journal of the Chemical Society*), and others, have done much to stimulate an interest in the achievements of these pioneers. In 1918 he published a "Life of James Woodhouse" (1770–1809), and last year there appeared his "Old Chemistries," in which he presented to "interested readers a hint of the vast stores of early literature relating to chemistry."

J. G. F. D.

THE issue of the *Physikalische Zeitschrift* for April 1 contains an obituary notice of Prof. Eilhard Weidemann from the pen of his former colleague and assistant, Dr. G. C. Smith. The son of the physicist Gustav Weidemann, he was born in Berlin on Aug. 1, 1852. He was educated at the high schools of various university towns, and at eighteen years of age entered the University of Heidelberg to study under Helmholtz, Bunsen, and Kirchhoff. He got his doctor's degree under his father at Leipzig in 1876 for a research on the elliptic polarisation of light. Two years later he received the title of extra-professor, and in 1886 was appointed professor of physics at Darmstadt, and a few months later at Erlangen. Here he spent the rest of his days and did his best work. In conjunction with his father he founded the *Beiblätter* to the *Annalen der Physik* and edited it for twenty-four years. He could speak with fluency several languages, and his studies in the history of science in Arabia are well known. He resigned his professorship in 1926 and died on Jan. 7 last. His principal researches dealt with specific heats and vacuum tube discharges. He was a fluent and clear lecturer.

WE regret to announce the following deaths:

Dr. Edward S. Burgess, for thirty years professor and head of the department of biological sciences at Hunter College, New York City, an authority on the asters of North America, on Feb. 23, aged seventy-three years.

Dr. Thomas Bruce Freas, professor of chemistry at Columbia University, to which he had been attached since 1911, who was known for his work on thermodynamics in chemistry, on Mar. 15, aged fifty-nine years.

Dr. F. M. Perkin, C.B.E., past-president of the Paint and Varnish Society and of the Oil and Colour Chemists' Association and one of the founders of the Faraday Society, on May 24.

Dr. C. G. J. Petersen, Director of the Danish Biological Station, Copenhagen, distinguished for his work on animal associations on the sea-bed.

Mr. W. E. Plummer, Director of the Liverpool Observatory at Bidston, Birkenhead, on May 22, aged seventy-nine years.

News and Views.

THE airship *Italia*, under the direction of General Nobile, has made two long flights from its base in King's Bay, Spitsbergen. The first was eastward past Franz Josef Land to Northern (Nicholas) Land. Details are awaited, but apparently no new land was discovered. The second flight was to the Pole, which was reached about midnight on May 23. Wireless messages report that it was impossible, as had been hoped, to lower anyone on to the pack-ice. Before returning, an attempt to reach the site of Peary's Crocker Land seems to have been made. A course was then set for Spitsbergen, against strong winds which reduced the speed of the *Italia* to 25 miles an hour. Fog was encountered, which led to ice accumulating on the envelope and added greatly to the weight. The airship was said to have ninety hours' fuel on board, and in case of forced descent a month's provisions. On Friday, May 25, the *Italia* was north-east of Spitsbergen, and apparently at no great distance from land. A north-westerly wind was blowing. On May 28 no further news had been received. Great anxiety as to the safety of the *Italia* and her crew was felt in Spitsbergen, and search parties had been sent out.

THE Friday evening discourse delivered by Mr. A. C. Egerton at the Royal Institution on May 25 dealt with engine knock and related problems. 'Knocking' is a sound which comes from the cylinder of an internal combustion engine during the abnormal explosion of the charge. It limits the compression of the charge and therefore the efficiency of the engine. The efficiency can be improved by suitable engine design, by the admixture with the petrol fuel of large percentages of non-knocking fuel, such as benzene, or by the addition to the petrol of small quantities of 'antiknocks,' such as lead tetra-ethyl or iron carbonyl. Thus the function of an antiknock is to make possible the use of higher compressions in the engine, thereby increasing the efficiency and preventing the unnecessary wastage of large quantities of petrol fuel. It was Sir Humphry Davy who, at the Royal Institution, first directed attention to the influence of small quantities of combustible substances on the combustion of other mixtures. The remarkable features of antiknocks, such as lead tetra-ethyl or iron carbonyl, are the small quantities needed to be effective—one part in 200,000 of the fuel and air mixture—and, secondly, the fact that although they deaden down explosion they themselves in the pure state are highly inflammable and explosive substances.

MR. EGERTON stated that antiknocks do not impede the progress of a detonating gaseous explosion, which makes their action in preventing 'knocking' still more obscure. They inhibit the processes of oxidation which occur prior to ignition of the gaseous mixtures. Metallic vapours—for example, of thallium, lead, and potassium—were found to be effective in delaying the ignition of petrol. A general theory of the combustion of hydrocarbons was set out, depending on the formation of chains of reacting molecules; centres of high energy are formed wherein ignition can be set up. Antiknocks act by interfering with these chains and delaying the setting up of ignition. 'Knocking' is accounted for by enhanced vibratory combustion in the neighbourhood of the walls towards the end of the travel of the explosion in the cylinder, favoured by regions of high energy; compression waves may thereby be set up which give rise to the 'knocking' sound.

THE Committee on Immigration and Naturalisation of the United States House of Representatives has published a statement, submitted by Dr. Harry H. Laughlin, dealing with the eugenical aspects of deportation, which embodies the results of a detailed investigation of the statistics and other data bearing upon the evidence of defects among immigrants and native-born Americans. One point upon which stress is laid is that of differential fecundity. While the upper levels tend to maintain themselves when there is racial contact owing to the purity of their women, there is a tendency for the lower race to breed up by the 'pure sire' method, the men of higher level mating, legitimately or illegitimately, with the women of the lower. On the other hand, the upper classes tend to have smaller families. While, therefore, controlled immigration could be used in promoting race conservation, a family standard, that is, an examination of the stock from which an individual sprang, might be made the basis of admission. In a large number of institutions from which particulars were obtained, the overwhelming proportion of defectives were native born, and very few were legally deportable. In dealing with distribution, defectives are low in number in agricultural areas, as they tend to gravitate to the commercial and industrial districts or to the poorer land of the hills. The so-called Ishmaels or American gypsies, of Indiana, who migrate north in summer and south in winter, are traceable historically through Kentucky back to Virginia. It is thought, though not proved, that they may be descended from exiles dumped from Great Britain in Virginia in the early days, as undesirables were dumped in Botany Bay. In these degenerate families increase is very rapid.

FOLLOWING the work of Whipple and his collaborators on the favourable influence of feeding with liver on blood regeneration in dogs made anæmic by repeated hæmorrhages, Minot and Murphy showed that the administration of at least half a pound daily to patients suffering from pernicious anæmia resulted in a marked amelioration of the symptoms, with permanent benefit in most cases provided that the diet was continued. This advance in the treatment of a disease of obscure etiology has been confirmed by other workers, and the dietetic treatment appears to have obtained a permanent place in therapeutics. The only drawback to it is the difficulty some patients have in consuming the necessary amount of liver daily; numerous recipes have been published with the aim of tempting the most fastidious palate. A

further step forward has, however, recently been made by Cohn, Minot, and Murphy and their co-workers, when they found that an extract of liver has the same effect as the liver itself. This work leads in the direction of the discovery of the actual substance which produces the beneficial effect and at the same time improves the treatment of the disease, since the extract is much less bulky and more palatable than the original liver. We have received from Messrs. The British Drug Houses, Ltd., a sample of their liver extract, B.D.H., which has been made by a process adapted from that described by Cohn. The results of clinical trials, already published, show that the extract exerts a marked effect in pernicious anæmia; a month's treatment may restore the number of red blood cells to normal. The extract is a dry powder, and is administered in the same manner as meat extract. It is put up in glass tubes, each containing one daily dose, the equivalent of half a pound of fresh raw liver.

IN *L'Europe Nouvelle* for Mar. 17, M. Genissieu, the transport engineer to the French Government, discusses the novel problems which will arise when electrical energy on a large scale is imported and exported between European countries. In 1923 the League of Nations suggested that transmission of electrical energy should take place freely between States, and in 1927 it recommended that all frontier dues in this connexion should be abolished. In Italy a law forbids the import and export of energy except when specially authorised. It also taxes this electrical energy at a rate which averages about $\frac{1}{4}d.$ per unit. Switzerland sells to other countries about a fifth of its power production, but permission for export must be obtained from the Federal Council. The difference between the transport of energy and the transport of goods is whether the former could have been produced in the country being traversed. When Westphalian coal wagons cross Switzerland, the Federal Railways find it profitable and do not grudge this foreign product passing. They would not regard with equanimity, however, a high voltage line crossing Switzerland and delivering energy produced in the Ruhr to Milan. The electric energy, whether flowing north or south, could have been produced from its own water power, and custom payments would not compensate for the loss. M. Genissieu thinks that with the possible exception of Denmark, every European country would oppose the transmission of electric power over it. He thinks that the evolution of technique will gradually solve the problems. Perhaps energy will be transmitted across seas and frontiers by Hertzian waves. Power lines of greater and greater length will continually be made. The prodigious power of the Congo cataracts may be transmitted to Europe, and then solutions to these international problems will have to be found.

EVERY teacher of electricity, when lecturing, attributes to Oersted the discovery that when a wire carrying an electric current produced by a battery is brought near to a poised electric needle, the needle is deflected. It generally happens that a few members of his class wonder who Oersted was, and some possibly think that no great credit is due to the discoverer of such an obvious phenomenon. Mr. Rollo Appleyard, in *Electrical Communication* for April, has done well to write a careful biography of this great physicist and show why great credit is rightly his due. H. C. Oersted was born in 1777 and was educated at the University of Copenhagen. His bent at first was towards literature and philosophy, and in his early writings it is easy to trace the influence of the great German metaphysicians. In 1800 he gained a money prize which enabled him to travel for a few years. He found that Germany was a realm of theory, but that Paris was the home of experimental philosophy. His great discovery was made in 1820, after he had been appointed a professor at Copenhagen. For some years he had a suspicion that just as an electric current can produce heat and light, so it might be able to exert magnetic influence. He was convinced by his experiments that every voltaic circuit had a magnetic field, and that the direction of the movement of the needle was determined by that field. He sent an account of his investigations to societies in all the capitals of Europe, and honours were bestowed on him by practically all of them. The Royal Society sent him a Copley medal and the Institut de France gave him a prize of 3000 francs. Faraday describes the discovery well. Oersted discovered "a fact of which not a single person beside himself had the slightest suspicion, but which, when once known, instantly drew the attention of all who were able to appreciate its importance and value." Mr. Appleyard gives many novel and interesting biographical details.

WE have received the fifth Annual Report of the Benzole Research Committee, issued by the National Benzole Association. Much useful and fundamental work has been done during the past year, particularly on the cause and prevention of resin formation in motor spirit of the benzole type derived from coal. The use of ultra-violet light in indicating tendency to resin formation was studied in the previous year and this work has been continued. The conclusion is drawn that the test, although useful, is not altogether satisfactory, since resin formation may occur in the test but not in actual storage. Another test, depending on an examination of oxidation whilst the benzole is refluxed under exposure to oxidising conditions, has been examined. The use of inhibitors, particularly aniline and tricresol, has been investigated. There is also an account of the comparative efficiency of wash oils for benzole recovery, one of the materials examined being tetralin. It will be seen that the report contains much valuable and interesting information, and is of importance at the moment, when the possibility of increasing the yields of motor fuel from coal is prominent in the minds of all users of internal combustion engines.

THE annual publication of the Edinburgh University Forestry Society, *Sylva*, is now in its eighth year. This Society comprises the students following the forestry courses within the University and their

predecessors, now serving in every part of the Empire where forest conservation is in progress. The major part of the articles in the magazine come from the pens of present students and their predecessors, now in the services. A yearly record is published of the names, appointments held, and addresses of all forestry graduates. In the present number this information has been summarised in an article, "The E. U. Forestry Department and the Empire," where it is shown that between 1919 and 1927 one hundred and seventy-seven men qualified and are now serving in almost every corner of the British Empire overseas, as well as in Great Britain and Ireland. Lord Clinton, chairman of the Forestry Commission, was the honorary president of the Society during the year 1926–27. In his presidential address he traced the history of British forestry from early times, and then dealt with the present position of afforestation work in the country and the various aspects of research work being undertaken under the auspices of the Commission. In the latter connexion an interesting paper deals with 'Powder Post Beetles,' based on investigation work initiated by an Edinburgh graduate at the Forests Products laboratory. The work carried out shows that serious damage is committed in timber yards by this type of beetle, and these species of *Lyctus* have been, and still are being, brought into the country in American oak and ash lumber of low grade. A far too brief paper of considerable interest deals with the low-level conifers of Sarawak, in which it is shown that two species, *Dacrydium elatum* and *Agathis alba*, which are found in Sarawak and elsewhere in the Malaya region on the higher hills, occur in the former country in utilisable stands practically at sea-level. *Dacrydium* occurs with a slight admixture of *Casuarina sumatrana* on low swampy lands in the north. The *Agathis* is found on light soils in mixture with various broad-leaved species. The timber of both has a commercial value.

The publication by the Cambridge University Press of the second volume of abstracts of theses for the Ph.D., M.Sc., and M.Litt. degrees at Cambridge contains an interesting statement in the preface suggesting the establishment in the near future of a complete university research intelligence service. One gain that such a service might bring to workers in a subject would be the rendering accessible of degree theses which do not reappear in the pages of some generally accessible scientific (or literary) journal. As it is, something might perhaps be done if these summaries, and similar summaries from other universities, reappeared in such a publication as *Science Abstracts* or in specialised bibliographies, in cases where the main work of the paper is not published elsewhere.

As these special research degrees are still quite a modern feature in Cambridge, it is not without interest to examine some of the statistics of the present volume. Out of the 55 research degrees granted in the year 1926–27, no fewer than 41 were for scientific investigations. The large excess of scientific degrees may represent the fact that more emoluments are available for scientific than for literary research by young graduates, and that more encouragement is given by the teaching staff of scientific departments at Cambridge and elsewhere to young graduates to continue with research work after taking their degrees. It is perhaps significant that 12 of the 14 literary graduates came from other universities to do post-graduate work at Cambridge; while of the 41 science graduates, 26 came from outside and 15 were purely Cambridge students. The unequal distribution in subjects is reflected in an unequal distribution among the colleges. Trinity with 10, Caius and Emmanuel with 9 each, and St. John's with 7 account for two-thirds of the students, while six colleges are unrepresented in the list. Physics heads the list of subjects with 10 names, followed by mathematics, 6; biochemistry, 5; physiology and botany, 4 each. It may be mentioned that 6 of the 55 graduates are now fellows of colleges.

The Report of the National Physical Laboratory for 1927 is a quarto volume of 264 pages, 200 of which are devoted to detailed accounts of the work done in the various departments of the Laboratory. These are well illustrated, and enable the reader to follow the advances which are being made towards the solution of the problems which at present confront science and industry. The staff consists of about 560, 72 of whom are engaged in administrative and clerical work. About 43,000 tests have been carried out during the year as against about 46,000 in the previous year, the decrease being mainly in the Metrology Department. A considerable amount of work is done for Government departments and for the numerous industrial research associations which have been formed under the auspices of the Department of Scientific and Industrial Research. The equipment of the high voltage research building is proceeding, but nothing has been done towards the new physics building which has been urgently needed for more than six years and for which funds were provided by Parliament in 1925 and then withdrawn. To meet the requirements of aeronautics a compressed air wind tunnel is under consideration. There have been few changes in the senior staff, but the Superintendent of the Engineering Department has been knighted for his long and distinguished services to the country.

The Mining Institute of Scotland has issued a tastefully got up pamphlet to commemorate the jubilee of its foundation. This dates from Jan. 24, 1878, when a number of gentlemen interested in mining met in Hamilton and decided to form an Association called the West of Scotland Mining Institute. The direct cause of the formation of this Association may be said to have been a disastrous explosion which took place at Blantyre Colliery in 1877. Not long after its formation the title was changed to that which it holds at present, namely, the Mining Institute of Scotland; and not many years afterwards its headquarters were transferred from Hamilton to Glasgow. The pamphlet gives a full and interesting account of the work of the Insti-

tute, including a long list of special committees, amongst the objects of which the problems of increased safety in coal-mining operations take a prominent place. A list of the principal presidents of the Institute, together with their photographs, form an interesting feature of the pamphlet.

THE following prize awards have recently been announced by the Belgian Royal Academy of Sciences: Maurice Nuyens (1500 francs), for his memoir on the resolution of problems with axial symmetry in general relativity; A. Monoyer (1500 francs), for anatomical and ethological researches on one or more plant species interesting through their mode of life; Théophile Gluge Prize (1300 francs), to L. Dautrebande for his work on the study of gaseous metabolism in man in health and disease; P. J. and Ed. van Bereden Prize (3400 francs), to Hans de Winiwarter for his work published during 1924–26; Adjutant H. Lefévre Prize (1500 francs), to Hélène Massart for her researches on the phenomena of secretion in plants: Ad. Wetrems Prize (7500 francs), to Louis Verlaine for; his studies on instinct and intelligence in Hymenoptera Agathon de Potter Foundation. The following grants have been made: W. Conrad (2000 francs), for the continuation of his researches on the lower organisms, particularly on the Belgian fresh-water flagellates; J. Pasteels (500 francs), to continue at Wimereux his researches on the cyto-physiological action of the dilution of sea water on the eggs of lamellibranchs; the Jean Mascart experimental garden (5000 francs), to continue a series of experiments on plant physiology commenced by the late Jean Mascart; E. Zunz (6000 francs), for the purchase of instruments necessary to the continuation of his researches on glycæmia; Th. De Donder (7500 francs), for the publication of his "Théorie des invariants intégraux"; Gilta (1000 francs), for the publication of plates of chemical crystallography; E. De Wildemann (3000 francs), for assisting the publication of parts of vol. 4 of "Plantæ Bequærtianæ"; Comité national de Géodésie (5000 francs), to enable it to print the reports of 1920–25 and 1926, on the geodesic work done by the Institute cartographique militaire since the War; Beeli (500 francs), for the execution of plates relating to the mycological flora of the Congo. Jean Servais Stas Prizes to Lucie De Brouckère, Léon Navez, Louis Henry; the Decennial Prize of the mineralogical sciences to Armand Renier.

Two exhibitions of special interest to students of South African archæology and ethnology will be held at the rooms of the Royal Anthropological Institute early in the month of June. A collection of copies of Bushman drawings will be on view on June 4–12. The collection is of exceptional interest, as some of the drawings are said to be of a type not hitherto recorded. Col. S. P. Impey, the author of a recently published work on the origin of the Bushman drawings and paintings, by whom this collection is exhibited, will give a demonstration of the drawings on Tuesday, June 5, at 4 P.M. Tickets of admission to the demonstration may be obtained from the Secretary of the Institute, 52 Upper Bedford Place; admission to the exhibition only on presentation of a visiting card. On June 11-19 a collection of stone implements from South Africa, belonging to Col. W. E. Hardy, will be on view at the Institute preparatory to the reading of communications on the South African Stone Age by the Rev. Neville Jones and Col. Hardy, on Tuesday, June 19, at 8.30 P.M., when specimens of South African stone implements of special interest and exceptional type, collected by the Rev. Neville Jones, will also be exhibited. The collection to be shown by Col. Hardy is noteworthy for the examples showing affinities with Sahara types which it includes. Admission to the exhibition and evening lecture may be obtained on presentation of a visiting card.

THE Huxley Memorial Lecture next year will be delivered by Prof. F. O. Bower in the Royal College of Science, London, on Friday May 3, at 5.30 P.M.

THE President of the French Republic has conferred the Cross of Officier de la Légion d'Honneur on Dr. George H. F. Nuttall, Quick professor of biology in the University of Cambridge.

PROF. D'ARCY W. THOMPSON, professor of natural history, University of St. Andrews, has been elected a foreign honorary member of the American Academy of Arts and Sciences, Boston, Massachusetts. The list of honorary foreign members of the Academy is limited to seventy-five, and among the distinguished zoologists in the section of zoology and physiology are Sir E. Ray Lankester and Prof. G. H. F. Nuttall.

ONE of the houses occupied by Newton when living in London stood on the corner site between St. Martin's Street and Orange Street, where the Westminster City Council is now erecting a new public library. The Council has decided to commemorate Newton's connexion with the site by cutting an inscription on the stone face of the building to read as follows: "Sir Isaac Newton lived in a house on this site, 1710–1727."

THE May meeting of the Royal Society of Canada was held at Winnipeg on May 21–24, under the presidency of Prof. A. H. Reginald Buller, professor of botany in the University of Manitoba, who delivered an address on "The Plants of Canada, Past and Present." A popular lecture on "The Air we breathe" was delivered by Prof. J. J. R. Macleod. The programme of the meeting includes abstracts of a very large number of papers contributed to the sections. Most of the meetings were thrown open to the public.

AT the anniversary meeting of the Linnean Society of London, held on Thursday, May 24, the following were elected officers for the year 1928–29: *President*, Sir Sidney F. Harmer; *Vice-Presidents*, Dr. W. T. Calman, Mr. H. N. Dixon, Mr. Horace W. Monckton, Dr. E. J. Salisbury; *Treasurer*, Mr. Horace W. Monckton; *Secretaries*, Dr. G. P. Bidder (Zoology) and Mr. John Ramsbottom (Botany).

THE following have been elected officers of the British Institute of Radiology for the session 1928–29:

President, Dr. G. W. C. Kaye; *Vice-Presidents*, Sir William Bragg, Dr. Robert Knox, Mr. L. A. Rowden; *Honorary Treasurer*, Mr. Geoffrey Pearce; *Honorary Secretaries*, Dr. Stanley Melville and Dr. G. Shearer; *Honorary Editors*, Dr. Robert Knox and Dr. G. W. C. Kaye.

THE annual general meeting of the Faraday Society was held on Wednesday, May 16, when the report of the Council was presented and the members of the Council for the session 1928-9 elected. The new president is Prof. T. M. Lowry. The retiring president, Prof. C. H. Desch, delivered an address entitled "Diffusion in Solids." During the past session the Faraday Society has held seven meetings, eighty-two papers being presented. Three of the meetings were general discussions on the following subjects: Atmospheric corosion; the theory of strong electrolytes; and cohesion and related problems. In future, the *Transactions* of the Society will be published in monthly, instead of bi-monthly, parts.

"NATIONAL Baby Week" is again being celebrated in Great Britain this year during the first week of July (July 1-7). Full particulars and suggestions for the celebration may be obtained from the secretary, National Baby Week Council, 117 Piccadilly, London, W.1. While all aspects of the maternity and child welfare problems are regarded as suitable subjects for propaganda, it is especially desired this year to focus attention on three subjects: (1) immunisation as a means of protecting young children against disease, (2) prevention of maternal mortality, and (3) new developments in child welfare work. A conference on infant welfare will also take place on July 4, 5, and 6, followed by an International Child Welfare Conference in Paris, July 8-12.

A RECENT *Daily Science News Bulletin*, issued by Science Service of Washington, D.C., reports the discovery by Mr. J. H. Sinclair, of the American Geographical Society's expedition, of a new volcano in eastern Ecuador in lat. 0° 8′ S., long. 77° 32′ W. It lies in a heavily forested uninhabited region and rises from a base elevation of about 4000 ft. to nearly 7000 ft. The crater appears to be very large. Activity of the volcano is reported to have begun in 1925 with a violent explosion that carried away the entire top of the mountain. Ash is said to have fallen in appreciable quantities as far away as a hundred miles. The expedition was surveying in that little-known region and made other important discoveries before its recent return to the United States.

THE second International Conference on Light and Heat in Medicine, Surgery, and Public Health, organised by the *British Journal of Actinotherapy* (17 Featherstone Buildings, London, W.C.1), will be held on Oct. 29–Nov. 1, at the University of London, South Kensington, S.W.7. There will be discussions on both therapeutic and scientific aspects, and it is hoped to arrange visits to representative clinics, where the most modern methods of utilising light and heat for therapeutic purposes will be seen. Simultaneously with the Conference, an exhibition of apparatus for ultra-violet, radiant heat, and allied forms of therapy, will be held in the Great Hall of the University, adjoining the conference hall. Reduced railway fares will be obtainable in England and Scotland for those attending the Conference.

AT the anniversary meeting of the Royal Society of South Africa, held on Mar. 21, Dr. W. A. Jolly, professor of physiology in the University of Cape Town, was elected president for the year 1928. Dr. A. Ogg, professor of physics in the University of Cape Town and retiring president of the Society, was elected honorary general secretary, and Dr. L. Crawford, professor of pure mathematics in the University of Cape Town, honorary treasurer. Dr. Ogg delivered his presidential address on "Some Aspects of Modern Physics," in which he discussed the origin of relativity and the quantum theory, passing on to Bohr's work on spectrum analysis and its modifications by Sommerfeld and others, and to Schrödinger's wave mechanics, and dealing in conclusion with Sir Ernest Rutherford's picture of the nuclear structure of radioactive elements.

THE Council of the Institute of Metals has issued a preliminary programme of the four-day annual autumn meeting of the Institute, which is to be held this year in Liverpool. This is the first time that the Institute has visited Liverpool. The proceedings will begin on Sept. 4 with a lecture on "Non-Ferrous Metals in the Shipping Industry," by Mr. F. G. Martin. The mornings of Sept. 5 and 6 will be devoted to the reading and discussion of papers, and the afternoons to visiting works of interest in the neighbourhood, the Gladstone Dock, and a large liner. In the evening of Sept. 6 there will be a reception at the Town Hall by the Lord Mayor (Miss Margaret Beavan). The meeting will conclude on Sept. 7 with an all-day motor trip to North Wales, during the course of which it is expected that an electric power station and aluminium works will be visited. Full particulars of the meeting can be obtained from the honorary local secretary, Mr. H. F. Richards, 42 Bedford Street, Liverpool, or from the secretary of the Institute of Metals, Mr. G. Shaw Scott, 36 Victoria Street, London, S.W.1.

UNDER the auspices of the National Association of Olive Growers of Spain (Alcalá 87, mod°. Madrid), a competition is being promoted with the object of simplifying and standardising the analytical and physico-chemical examination of olive oils and of mixtures in which they occur. It is hoped also to advance the olive-oil industry by gaining new information upon such fundamental problems as the mode of elaboration of the oil in the plant and the variations in its composition during the period of ripening. Moreover, an examination is required of the associated essential oils, colouring matters, and ferments, and of the products of enzymatic hydrolysis; while "as to the vitamins in olive oils, a brief study should be made to ascertain the quantities present, their class and their beneficial influence upon the human organism." In addition, competitors are asked to report upon the practicability of applying 'cracking' processes to

olive oils, with the aim of producing petrol and related materials from it. The details of the competition, which closes on July 30, are laid down in a circular issued by the Association through the Spanish Ambassador in London, and prizes of 20,000 pesetas (about £700) and 5000 pesetas are offered.

MESSRS. Dulau and Co., Ltd., 32 Old Bond Street, W.1, have just issued a useful catalogue (No. 159) of a thousand works on geology, ornithology, and general natural history, including conchology, entomology, fishes, mammalia, etc. Many long runs of serials are included. The catalogue can be had free upon application.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—Teachers of electrical engineering and of engineering drawing at the East Ham Technical College evening classes—The Secretary, Education Office, Town Hall, East Ham, E.6 (June 7). An assistant curator in the Royal Botanic Gardens, Kew, in charge of the Herbaceous and Alpine Department—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (June 9). A head of the mechanical and civil engineering department of the Sunderland Technical College—The Chief Education Officer, Education Offices, Sunderland (June 12). A full-time teacher of mining subjects in Rotherham and South Yorkshire—The Secretary for Education, Education Offices, Rotherham (June 15). A teacher in mechanical engineering at the Birmingham Central Technical College—The Principal, Central Technical College, Suffolk Street, Birmingham (June 16). A full-time itinerant poultry instructor for the County of Essex—The Clerk of the Essex County Council, Shire Hall, Chelmsford (June 18). A demonstrator of chemistry at St. Bartholomew's Medical College—The Dean, St. Bartholomew's Hospital Medical College, E.C.1 (June 19). An assistant lecturer in agricultural economics in the department of agriculture, The University, Leeds—The Registrar, The University, Leeds (June 21). A leather research chemist for the New Zealand Tanners' Research Association—The High Commissioner for New Zealand, 415 Strand, W.C.2 (June 30). A full-time engineering workshop instructor at the Borough Polytechnic Institute—The Principal, Borough Polytechnic Institute, Borough Road, S.E.1. Instructor lieutenants in the Royal Navy with a university training and an honours degree in mathematics, science, or engineering—The Advisor on Education, Admiralty, S.W.1. A lecture assistant and laboratory steward for the chemistry department of the Royal Technical College, Salford—The Secretary for Education, Education Office, Salford. A head teacher in the electrical engineering and physics department of the Rochdale Technical School—J. E. Holden, Education Office, Rochdale. Two assistants in the department of geography of University College, London—The Secretary, University College, Gower Street, W.C.1. A lecturer in dairy accountancy and economics at University College, Cork—The Secretary, University College, Cork.

Our Astronomical Column.

A PROBABLE METEORIC DISPLAY.—Mr. Issei Yamamoto, of the Tokyo Observatory, has pointed out in the *Mon. Not. R.A.S.* that the orbit of Skjellerup's bright comet, seen last December, lies near the earth's orbit on about June 7 next, and that as the distance separating the orbits is only three millions of miles, there may probably ensue a meteoric shower. The radiant point has been computed as at 42°·3 + 41°·4. Dr. Crommelin has also calculated the place of radiation and gives the point a few degrees west of that given by Yamamoto.

It will be desirable to watch the heavens on June 7 in order to witness the shower should it occur. The distance of three millions of miles between the orbits need not negative the prospective display, for Halley's comet is responsible for a shower early in May though its orbital distance from us is greater than that separating us from Skjellerup's comet. There are a few other instances where meteors are seen from comets the orbital distance of which exceeds three millions of miles. At 10 P.M., the computed radiant will be unfavourably placed a few degrees above the northern horizon. The gibbous moon will rise on June 7 a few minutes before midnight.

THE SYSTEM OF PROCYON.—This is a difficult system to study owing to the extreme faintness of the companion, which was discovered by Schaeberle in 1896, but has not been satisfactorily observed since 1913. It is of interest owing to the fact that its mass seems to be too low for its bolometric magnitude according to the Eddington curve. Dr. Spencer Jones makes a very exhaustive study of the system in *Mon. Not. R.A.S.* for March, using meridian observations of the bright star from 1755 onwards, also micrometric observations of the companion, and spectroscopic determinations of the radial motion of the bright star made at the Cape between 1909 and 1924. The adopted orbit for the bright star about the centre of gravity is Periastron 1886·50, period 40·23 years, inclination 30°·6, omega 65°·7, node 307°·8, e 0·310, a 1″·020. For the faint star about the bright one a is 4″·26, node 127°·8, the other elements being the same as above. The bright star is taken as 3·18 times the mass of the faint one, the masses in terms of the sun being 1·24 and 0·39. The mass of the bright star according to Eddington's curve would be 1·46. This could be obtained by changing the adopted parallax from 0″·308 to 0″·292, but that is considered an improbably large reduction. In any case this research has made the discordance less than it was before.

COMETS.—*Lick Observ. Bull.*, No. 398, contains an investigation by N. T. Bobrovnikoff on the outward motion of matter in the tail of Morehouse's comet 1908 III. This comet was well situated for such examination, owing to its high north declination and the activity manifest in the tail. The repulsive force from the sun for three different condensations was found to be 154, 148 and 88 respectively in terms of gravitation at the same distance ; the probable error of each is about 8 units. The projected condensations travelled in hyperbolæ that were nearly parabolic, the average eccentricity being 1·01. The sun of course was outside the branch described. The acceleration was observed to diminish at a distance from the comet's head ; this is accounted for by dissipation of the cloudlike masses, and increase of resistance from slower-moving matter in the tail ; others have suggested the gradual leakage of electrical charges.

Research Items.

MUMMIES FROM COLOMBIA.—In *Man* for May, Mr. Warren R. Dawson publishes the results of a recent examination of two mummies now in the British Museum. Of these the first is that of an adult female in the sitting position, which is labelled as having been given by W. Turner, Esq., and found in a cave near Leiva, northern Grenada. The arms of the mummy are placed across the chest, the forearms nearly parallel. The head is slightly bent forward and inclined to the left. The knees are vertical, and the left foot over the right. All the nails of the toes are missing, and apparently those of the fingers as well, though this cannot be ascertained with certainty owing to the position of the hands. Part of the scalp is missing, and the condition of the sutures suggests middle age. Impressions of woven cloth show the body was wrapped up. Round the neck is a necklace of thirteen objects, and there are traces of red pigment on thighs, cheeks, knees, and elsewhere, which may be derived from the wrapping. The mouth is packed with wool which has distended the cheeks. The nose is broken away but the septum is intact, and there is no trace of a forced passage into the cranial cavity through the nose. The perineum is incised and the anus and vulva united into a single widely distended opening, probably due to the evisceration. The mummy was probably smoke dried. The second mummy is an adult male in poor condition from Gachansipa, northern Grenada. It is in the contracted posture with the head inclined forward. Wherever the integuments remain they are of a dark red colour, almost black in parts, suggesting the application of a resinous stain. The anterior part of the abdominal wall is broken away, exposing an empty cavity. There are no traces of the thoracic viscera, so the body was almost certainly eviscerated through an incision which appears in the left flank. The condition of this mummy suggests that it also has been smoke dried.

THE EXTINCTION OF THE PASSENGER PIGEON.—A letter written in March 1838 from Camp Gaugh, New Jersey, by J. T. Waterhouse to his parents in London, emphasises once again the former abundance of the passenger pigeon, and the great slaughter which took place during the migration (*Condor*, vol. 29, p. 273; 1927): "For the last fortnight the air has been almost black with wild pigeons emigrating from the Carolina swamps to more northerly latitudes, making their summer quarters in the lake countries. Within ten miles square during the last fortnight I suppose they have shot or netted twenty thousand. They fix up a kind of hut in a field made of the limbs of trees and buckwheat stubble. They have one or two fliers which they throw out every time a flock passes; the fliers are of the wild pigeon breed usually wintered over, or sometimes they take them direct from the flocks, tie their legs to a small piece of twine and throw them up." The writer then describes the operation of the fall net, and says that sometimes at one haul as many as three or four hundred pigeons were taken. "Whilst I am writing they are in the adjoining room picking seven pigeons for our breakfast. They were shot this morning at one fire of the gun."

UNUSUAL GESTATION OF ROE DEER.—The breeding of the roe deer is anomalous in respect of the period which elapses between the pairing season and the birth of the calf. Mating takes place during July and August and the young appear in the following May or June. This, however, does not represent the true gestation period, since there is evidence that germinal development does not actually begin until December, the probability being that fertilisation of the egg may then take place by sperms which have lain quiescent since the mating season six months earlier. The true gestation period—December to May or June—is therefore about six months. Dr. James Ritchie records and comments upon an interesting departure from this sequence (*Scottish Naturalist*, 1928, p. 49). In December 1927 an early roe calf was found with its mother on the hills near Kingussie. The calf apparently was born about six months after the pairing season, and the suggestion is made that the six-months dormant period was omitted from this life-cycle, and that fertilisation and development of the egg took place immediately upon pairing, "an abnormal reversion to a normal occurrence." The fact that the new-born calf had to face the rigours of winter and spring, suggests how valuable the normal staving off of the gestation period must have been for the survival of roe deer.

INSECT TYPES.—In his Report for 1926–27 on the Hunterian Collections, University of Glasgow, Prof. Graham Kerr refers to the completion by Mr. P. A. Staig of Part 1 of a monograph of the Fabrician types of insects contained in that museum. Dr. William Hunter afforded Fabricius ready facilities for studying the insects in his extensive collections and, as a result, Fabricius described many new species which he recorded in his classific works on systematic entomology. These 'antique' types constitute the standard by which it is possible to determine finally to what particular species a particular scientific name properly belongs. Fortunately, the Fabrician types contained in the Hunterian Collections are in a wonderful state of preservation, which has enabled Mr. Staig to prepare detailed descriptions, which should serve to assure entomologists as to which of the now well-known insects are rightfully assigned to the various Fabrician species. Part 1 of this monograph is now ready for publication, and deals with 55 out of a total of 250 of these early types.

RUSSIAN FISHERIES RESEARCH IN THE PACIFIC OCEAN.—The Pacific Ocean Scientific Fishery Research Station, recently established near Vladivostok (see NATURE, Aug. 6, 1927, p. 198), has issued the first volume of its *Bulletins*, of 328 pages, well produced with numerous illustrations. Apart from two papers by the Director of the Station, Prof. K. M. Derjugin, on the organisation and activities of the Station, the volume contains a number of papers based on original observations of its members. Of special interest is a description of the West Kamtchatkan fishing industry by J. T. Pravdin, containing detailed data on the economically most important species of fish, their bionomics, methods of rising, statistics of catches, labour problems in the industry, etc. Several papers deal with the chemical analyses of local fishes (*Oncorhynchus keta*, *O. gorbusha*, *Clupea melanosticta*), and of the sea-cabbage (*Laminaria*) and other sea-weeds of industrial value, of oysters (*Ostrea laperousi* Schrenk), meedies (*Mytilus dunkeri*), and of edible medusa (*Rhizostoma sp.*). G. U. Lindberg gives a description of the Kamtchatka grayling (*Thimallus arcticus pallasi* Val.), which was hitherto very imperfectly known. A detailed biometric study of Pacific herrings is presented by A. I. Rabinerson.

FRUIT-ROT OF CULTIVATED CUCURBITACEÆ.—For the past few years in Pusa, India, during the monsoon season, a fruit-rot disease of various members of the Cucurbitaceæ has been doing considerable damage to the fruit, both in the field and in storage. The etiology of the disease has been determined by Mitra

and Subramaniam (*Mem. Dept. of Agri. of India*, Bot. Series, vol. 15, No. 3). The causal organism is *Pythium aphanidermatum* (Eds.) Fitz., which has also been reported recently by Drechshler as doing considerable damage to cucumber and egg-plant fruits in the United States of America. This fungus forms a woolly mycelial weft over the surface of the affected fruits, and penetrating inside causes the interior to become soft and watery; decay rapidly follows. It is very common in the field during and after the rains, and most of the fruits lying on the soil or hanging near the ground are attacked. Microscopic examination reveals unseptate mycelium, both in the interior and on the surfaces of the fruits, with large numbers of oogonia, antheridia, and oospores. All the strains grow very well in cultures of different kinds, especially in oatmeal agar, in which sexual reproduction takes place freely. Sporangia and zoospores are not formed in any medium, but can be obtained within six hours, if a little of a culture is placed in a vessel containing water to which has been added some ants killed by boiling water.

DRYING SULTANA GRAPES.—The standard methods for drying sultana grapes are described by A. V. Lyon (Australian Council for Scientific and Industrial Research, Pamphlet No. 6). The fruit is treated by one of three processes prior to the drying, the method chosen depending chiefly on the class of fruit, local climatic conditions, and the capacity of the drying plant. In general, the cold dip and modified temperature caustic dip give the best results in early and mid-harvest periods with good quality fruit. The berries are picked directly on to perforated tins, which are immersed in the desired solution. Since the concentration of the liquid and the duration of the treatment are important factors, preliminary trials are made with the dip to ensure the correct conditions. Details for the adjustment of the concentration according to the condition of the fruit are given. The *boiling dip* consists of a caustic soda solution (approximately 3 lb. in 100 gallons) in which the berries are immersed for 1½ seconds, the bloom being thereby removed and the rate of drying increased. Only slight cracking of the berries results if the conditions are well managed. The *modified temperature caustic dip* closely resembles the boiling dip, except that it is used at 190°-196° F., and at a slightly higher concentration. It is imperative that the proper temperature should be maintained if the browning action of the soda is to be avoided. The *cold dip* consists of a solution of potassium carbonate (approximately 1 lb. in 2 gallons) to which an olive oil emulsion (1½ pints in 50 gallons) is added. The fruit must be immersed for 4 minutes in this case. After dipping, the fruit is drained and immediately spread thinly on drying racks; spraying with the cold dip solution, though not always essential, is recommended, as it hastens the drying and thereby increases the quality of the final product. Cold dipped fruit, in contrast to that treated with the caustic dips, retains its natural colour, and exposure to the sun after treatment is necessary to destroy the pigments. When bleached, a wash is given before the final drying. Care must be taken to avoid bundling partially dried fruit or thick spreading during drying, as uniformity in the sample is essential for good value.

BIOLOGICAL FUNCTIONS OF THE PROTEINS.—In a recent paper Dr. Dorothy Jordan Lloyd defines two biological functions of the proteins (*Biological Reviews*, vol. 3, No. 2). In the first place the amphoteric and colloidal properties of the proteins make them highly sensitive to changes in composition or condition of the cell fluids, thus establishing a relation between the proteins of different cells, and between those cells and the external environment. The inertia of the colloidal particles also gives stability to the system and protects its general equilibrium. Proteins play no part in the metabolic cycle of the living cell, but exist associated with chemically active groupings which play a direct part in the cycle of chemical change, whilst the physical condition of the proteins affects the chemical activity of the complex. A second function attributed to the proteins is that they form the chemical basis of differentiation of species. The various ratios in which the large numbers of amino-acid molecules condense to form protein molecules make possible a multiplicity of detailed structure combined with uniformity of fundamental structure. Dakin and Dale showed that albumins from the blood of hens and ducks, although closely similar in chemical composition, are actually different proteins in the two species. Working along similar lines, Dudley and Woodman pointed out that the casein from sheep's milk is not the same substance as the casein from cow's milk. This biologically specific character of the different proteins is sharply contrasted with the wide distribution of certain chemically active cell constituents such as glutathione, insulin, and cytochrome. Even in the cell nuclei the active chemical groupings seem to be non-specific in character. It is not suggested, however, that the same chemical cycles of metabolism are found universally in the animal and plant kingdoms, for there is plenty of evidence to show that different chemical cycles serving the same end have been produced in the course of evolution. In the animal world various respiratory pigments have been evolved independently and at different times. Proteins in the plant world are found only as intra-cellular substances or as food reserves in the seeds, the protective and supporting tissues being built up from carbohydrates. In animals, on the other hand, protein materials are also used for extra-cellular structures such as the keratins of the epidermis or the supporting fibres of connecting tissue.

THE PROBLEM OF CROCKER LAND.—The publication of the full report of the Crocker Land expedition, led by Dr. D. B. Macmillan in 1913–17 (*Bulletin of the American Museum of Natural History*, **56**, 6; 1928), throws interesting light on the possibility of non-existent lands being reported. In 1906, R. E. Peary reported Crocker Land to lie about a hundred and twenty miles north-west of his position on Cape Thomas Hubbard (Heiberg Island). As he sledged towards that site in 1914, Dr. Macmillan on two consecutive days saw 'land' to the west, a hilly, ice-capped land extending through 150°. Its appearance changed very slowly, and it gradually faded in the evening. On the site of Crocker Land in 82° 30′ N., 108° 22′ W., there was no sign of land within the range of view in any direction. But on his return, Dr. Macmillan, from Peary's view-point on Cape Thomas Hubbard, again saw extensive 'land' from south-west to north-north-east. These were obviously mirages, but their persistence in that area may indicate land farther west, though this is improbable. Yet the pack ice on the site showed a much broken appearance, indicating the existence of cross-currents which occur only in the vicinity of land. Recent transpolar flights have given no indication of land in that area. Low and snow-covered land might, however, be indistinguishable from pack ice.

MARSHALL ISLANDERS' CHARTS.—In a lecture before the Royal Geographical Society on May 14, Sir Henry Lyons directed attention to five examples of sailing

charts made by the Marshall Islanders, lent to the Science Museum by the Royal Colonial Institute. Only a few of these charts are known, and the present collection supplements the accounts of similar charts published in 1898 by Capt. Winkler and in 1902 by A. Schück. Narrow strips of the mid rib of a palm leaf are tied in certain positions by lengths of palm fibre. The relation of the strips to one another gives the information which the chart is designed to provide. The strips represent the wave front of the swell caused by prevalent winds. Curved rods indicate that the swell movement is checked in the neighbourhood of an island; where two swell fronts meet, rough water may be expected. Currents near islands are sometimes shown by short straight strips. Islands are marked, but only approximately, by small shells tied to the frame-work. Some of the simpler charts were made only for instructional purposes. The more complicated ones are not drawn to scale and are difficult to decipher with any degree of accuracy, but they are so frail that they can scarcely have been used on canoe voyages. The construction of these charts was kept a secret by the chiefs, and consequently it is difficult to be certain as to their full meaning and use.

Electrical Conductivity.—The principles of the wave mechanics appear very clearly in an application of it by W. V. Houston to the problem of electrical conductivity. His work, which appears in the *Zeitschrift für Physik* of May 7, is an extension of Prof. Sommerfeld's revived electron theory of metals, already widely applied since its announcement last October. Each electron is treated as a system of waves occupying the whole of the metal, and its motion is supposed to be determined by the diffraction of the waves in the crystal lattice of the positive ions, conduction being thus referred to an interference phenomenon. The effect of increase in temperature is to make the thermal vibration of the positive ions more violent, and so permit of greater diffraction in the distorted lattice, most of the electrons being unaffected at low temperatures, because their wavelength exceeds the grating constant. Impurities in the metal are equivalent to a more or less periodic fault in the normal lattice, and the effect of this upon the motion of the electrons is the analogue of the production of 'ghosts' by errors in a ruled grating. The mathematical development of these ideas leads without further assumptions to a very satisfactory account of the temperature coefficient of resistance, except in the region of super-conductivity. The weak point of the theory appears to be that in other applications a definite form has to be assumed for the electric field of an ion, but even then the agreement with experiment is remarkably good.

Platinum Alloys in Thermionic Valves.—The American Telegraph and Telephone Company, which manages the long-distance communication arrangements of the United States, is very busy this year. It has to erect nearly a million poles, and the lengths of the underground and aerial systems to be installed amount to about three and a half million miles. It will soon complete a second cable route between New York and Chicago. For much of the success the company has achieved it is indebted to the thermionic valve repeater. In the *Bell Laboratories Record* for April, J. E. Harris describes the manufacture of the platinum alloys used in manufacturing the valves. It appears that a platinum alloy is used because there is no chemical action between it and the barium and strontium oxides with which it has to be coated. It is found that chemical reaction weakens the thermionic activity of the coating when metals such as tungsten are used. The platinum used in the alloy has a purity of not less than 99·98 per cent. The purity can be determined at once by the thermal electromotive force developed between the sample and a standard piece of metal. Frequent use is also made of the spectroscope to detect minute impurities. The platinum and alloying metals are melted in a high frequency induction furnace, the temperature attained being about 1750° C. The final diameter of the wires from which the wire ribbon required for the repeater is rolled vary from one to thirteen thousandths of an inch. Although platinum is twenty times heavier than water, an ounce of the metal can be drawn into a mile and three-quarters of the finest wire used in this work. Within recent years, improvements in the core and the coating and pumping processes have increased many fold the life of the thermionic repeaters. This enables the service to be improved and has effected considerable economies.

The Equilibrium between Alcohols and Salts.—The *Journal of the Chemical Society* for March contains an account of an investigation by E. Lloyd, C. Brown, D. Bonnell, and W. J. Jones of the equilibrium between alcohols and salts. They have determined the solubilities of a large number of salts in methyl and ethyl alcohols, and of a few salts in higher alcohols. A number of alcoholates have been isolated and their dissociation pressures at various temperatures measured. This paper includes a discussion of the variation of alcohol vapour–air mixtures from the ideal gas equation, and the Van der Waals' equation. The authors also point out that in many cases of alcohols and salts, solvation, ionisation, and alcoholysis are not the only reactions which take place. Thus, above 50° C., ferric chloride solutions in methyl or ethyl alcohol evolve chloroform and deposit a red precipitate.

The Synthesis of Ammonia by Alpha Rays.—The *Journal of the American Chemical Society* for March contains an account by S. C. Lind and D. C. Bardwell of the effect of the α-radiation of radon on a mixture of nitrogen and hydrogen in the proportion of 1 to 3 by volume. The gas flowed through a glass bulb at the centre of which was mounted a thin α-ray bulb and the ammonia formed was absorbed by water. The rate of synthesis of ammonia was determined by titration with acid and the yield was found to be 0·2 to 0·3 molecule of ammonia for every pair of ions produced in the gas. In comparison with other gas reactions taking place under α-radiation, the ionic efficiency is low and it is difficult to derive the mechanism of the reaction. The possibility that *ions* of both gases are involved is interesting, in view of the fact that B. Lewis has recently found that for the synthesis of ammonia both the nitrogen and the hydrogen require activation.

A New Device for Reading Burettes.—We have received from Messrs. Andrew H. Baird, of Edinburgh, a simple device, named Hyman's burette-reader, which will be very serviceable to those who are constantly using burettes. A strip of transparent celluloid is firmly fixed by two pins upon a larger strip of opaque celluloid, which is divided into an upper white and a lower black portion by a sharp straight edge. The upper edge of the transparent slip is made to coincide exactly with this division, and the burette is pushed between the strips. The device, which costs ninepence, greatly facilitates the reading of the meniscus and, with the aid of a lens, the estimation of fractions of the intervals engraved on the burette. Since the edge of the transparent cover is viewed against the sharp dividing line there is no danger of any parallax error.

The Elements of Wave Mechanics.[1]

THE path of a material particle of mass m moving in a conservative field of force in which the potential energy V is a function of position (x, y, z) only is determined by Hamilton's Principle. If E is the constant total energy and A and B the points of departure and arrival, this may be expressed in the form

$$\delta\int_A^B \sqrt{2m(E-V)}\,ds = 0. \quad . \quad . \quad (1)$$

Consider a group of light waves emitted at A in a suitably dispersive medium. The path of the light which reaches B is determined by Fermat's Principle

$$\delta\int_A^B \frac{1}{u}\,ds = 0,$$

where u is the wave velocity. If in this relation we put $u = \dfrac{E}{\sqrt{2m(E-V)}}$, thereby determining the character of the medium, Fermat's Principle gives for the path of the light the condition

$$\delta\int_A^B \frac{\sqrt{2m(E-V)}}{E}\,ds = 0, \quad . \quad . \quad (2)$$

which is exactly equivalent to (1), and hence the path of the light given by (2) is in this case the same as the path of the particle given by (1). If we now determine the frequency ν of the light waves by the relation

$$\nu = \frac{E}{h}, \quad . \quad . \quad . \quad . \quad (3)$$

where h is Planck's constant, the *group* velocity g of the waves is given by

$$\frac{1}{g} = \frac{d}{d\nu}\left(\frac{\nu}{u}\right) = \frac{d}{dE}\left(\frac{E}{u}\right) = \frac{m}{\sqrt{2m(E-V)}},$$

so that g is equal to the velocity of the particle. It follows that under the above conditions the motion of a group of light waves not only follows the same path as the particle, but also that the group velocity is the same as that of the particle at each point of the path. It would therefore be possible to predict the velocity and position of the particle by considering the velocity and position of the corresponding group of light waves. This principle may be regarded as a method of inferring from a problem in geometrical optics the solution of a problem in dynamics.

Now the methods of geometrical optics suffice only when the wave-length is small compared with the obstacles encountered. If this condition is not fulfilled, the wave theory of light must be used. The question then naturally arises as to whether the solution of a small scale optical problem by means of the wave theory can be made to yield the solution of a corresponding small scale mechanical problem. In other words, does there exist a theory of 'wave mechanics' which should be applied to small mechanical systems in a way similar to the application of 'wave optics' to small optical systems? Schrödinger answers this question in the affirmative.

The equation of wave propagation is

$$\nabla^2\phi = \frac{1}{u^2}\frac{\partial^2\phi}{\partial t^2}.$$

To search for periodic solutions of frequency ν put $\phi = \psi(x, y, z)e^{2\pi i\nu t}$ and use the value of u given above,

$$u = \frac{E}{\sqrt{2m(E-V)}} = \frac{h\nu}{\sqrt{2m(E-V)}}.$$

The equation for ψ then becomes

$$\nabla^2\psi + \frac{8\pi^2 m}{h^2}(E-V)\psi = 0. \quad . \quad . \quad (4)$$

This is Schrödinger's Amplitude Equation, ψ being the amplitude of the periodic function $\psi e^{2\pi i\nu t}$. Solutions of this equation are sought which shall be (i) finite, (ii) single-valued. In the case of the hydrogen atom, the potential energy is $V_0 - \dfrac{e^2}{r}$, where V_0 is a constant chosen to make V positive and e is the charge on the electron. It may be shown[2] that solutions satisfying conditions (i) and (ii) only exist in two sets of cases:

(*a*) $E = E_n = V_0 - \dfrac{2\pi^2 me^4}{h^2 n^2}$, $n = 1, 2, 3 \ldots$

(*b*) $E > V_0$.

(*a*) corresponds to Bohr's elliptic orbits, each of which has its appropriate energy E_n. Transference from one orbit to another implies a definite quantum emitted or absorbed. The values E_n are called *eigen* values.

(*b*) corresponds to the hyperbolic orbits which are not quantised. The frequency in the nth elliptic orbit is given by $\nu_n = E_n/h$. If in the fundamental equation (4) we put $E = E_n$, we get n^2 independent values of ψ called *eigen* functions. The n^2 *eigen* functions appropriate to E_n correspond to the multiplicity of orbits in Bohr's model, the phenomenon known as degeneracy. If, however, as in the Stark effect, an electric field is applied, E_n is split up into n^2 slightly different *eigen* values to each of which corresponds a (now) definite *eigen* function. The combinations of the transitions between the $n_1{}^2$ energy levels corresponding to E_{n_1} and the $n_2{}^2$ energy levels corresponding to E_{n_2} give lines which are theoretically possible. Not all these lines are observed, but the theory accounts for this by yielding zero intensity for the absent lines. A magnetic field has an analogous effect and in this way the results of Stark and Zeeman are accounted for. Thus by the application of an electric or magnetic field the system is rendered non-degenerate and experimental control can be applied to numerical calculations.

If we suppose the system rendered non-degenerate in this way, to E_k there corresponds an *eigen* frequency $\nu_k = E_k/h$ and an *eigen* function ψ_k. It is possible to choose the ψ_k in such a way that they form a complete orthogonal system; *i.e.* so that

$$\iiint \psi_k\psi_l\,dxdydz = \delta_{kl},$$

where $\quad \delta_{kl} = 1$ if $k = l$, $\delta_{kl} = 0$ if $k \neq l$.

Schrödinger considers the function

$$\psi = \sum_k c_k\psi_k e^{2\pi i(\nu_k t + \theta_k)}, \quad . \quad . \quad . \quad (5)$$

where $\Sigma c_k{}^2 = 1$ and interprets $|\psi|^2$ as the electric density ρ. With this assumption an atom in which the only vibrations excited correspond to elliptic orbits will emit like an infinitesimal dipole of moment (M_x, M_y, M_z), where

$$M_z = \iiint \rho z\,dxdydz = -\sum_k c_k{}^2 a_{kk} - 2\sum_k\sum_l c_k c_l a_{kl}\cos(\nu_{kl}t + \theta_k - \theta_l),$$

$$a_{kl} = \iiint ez\psi_k\psi_l\,dxdydz, \quad \nu_{kl} = \nu_k - \nu_l.$$

It follows that a_{kl} depends only on the nature of the system and not on its state.

[1] Based on lectures delivered by Prof. Erwin Schrödinger at the Royal Institution of Great Britain on Mar. 5, 7, 12, and 14.

[2] Cf. A. S. Eddington, NATURE, July 23, 1927, p. 117.

Moreover, $\nu_{kl} = \nu_k - \nu_l$, so that the frequencies of the emitted radiation are the differences of the frequencies of the various orbits. This leads to Bohr's Selection Rule, for the lines not emitted are found by calculation to be just those for which $a_{kl} = b_{kl} = c_{kl} = 0$. For linear polarisation parallel to z, say, $a_{kl} \neq 0$, $b_{kl} = c_{kl} = 0$. For circular polarisation $a_{kl} = 0$, $b_{kl} = c_{kl}$, and the phases differ by $\pi/2$. These results are obtainable by actual numerical computation.

Returning to the amplitude equation (4), we see that the value of ψ given by (5) is not a solution of the amplitude equation, but that it is the sum of solutions of the various amplitude equations obtained by giving E the values E_1, E_2, E_3 . . .

Since $$\frac{\partial}{\partial t}\left(\psi_k e^{\frac{2\pi i E_k t}{h}}\right) = \frac{2\pi i E_k}{h}\left(\psi_k e^{\frac{2\pi i E_k t}{h}}\right)$$

we can eliminate E_k between this and the equation of type (4) in which $E = E_k$. The resulting equation,

$$\nabla^2\psi - \frac{4\pi m i}{h}\frac{\partial\psi}{\partial t} - \frac{8\pi^2 m}{h^2}V\psi = 0, \quad . \quad . \quad (6)$$

where ψ is now written for $\psi_k e^{\frac{2\pi i E_k t}{h}}$, is Schrödinger's Wave Equation and is satisfied by all the $\psi_k e^{\frac{2\pi i E_k t}{h}}$ and therefore by the function ψ of (5). Hitherto V has been considered as a function of x,y,z only. The further assumption is now made that V may also be a function of the time. This enables us to discuss the effect of an alternating field on the atom and leads to Schrödinger's theory of dispersion, that is, the alteration in a primary wave incident on a body of atoms, caused by the disturbance due to the secondary wavelets emitted by the atom under the excitation of the incident primary radiation.

Suppose then that an alternating field $F = A \cos 2\pi\nu t$ is applied in the z direction. We put

$$V = V_1 + Aez \cos 2\pi\nu t,$$

where V_1 is the potential energy when $A = 0$, the case which has just been discussed, the solution being given by (5). We take A to be small and suppose the c_k of (5) to be now slowly varying functions of the time. If we substitute from (5) in (6), multiply by ψ_l, and integrate throughout space we get, on account of the orthogonal property of the ψ_k,

$$\frac{dc_l}{dt} = \frac{\pi i A}{h}\sum_k a_{kl}c_k\left[e^{2\pi i(\nu_k - \nu_l + \nu)t} + e^{2\pi i(\nu_k - \nu_l - \nu)t}\right], \quad (7)$$

an infinite set of linear equations of the first order.

If $\nu_k - \nu_l \pm \nu$ is large compared with Aa_{kl}/h, resonance is excluded, the frequencies are large and we can suppose the c_k to remain approximately constant. If only the k level is excited, $c_k = 1$, and all the others are zero. The z component of the electric moment is found to be

$$M_z = \iiint ez\rho dxdydz = -a_{kk} + \frac{2}{h}A \cos 2\pi\nu t \sum_l \frac{(\nu_l - \nu_k)a^2_{kl}}{(\nu_l - \nu_k)^2 - \nu^2}.$$

The first term is a spontaneous emission coefficient, the second shows that whether the vibrations are in or out of phase depends not only on the sign of $(\nu_l - \nu_k)^2 - \nu^2$ but also[3] on that of $\nu_k - \nu_l$. It is also seen that the secondary waves have the same frequency as the incident waves. If two levels, say c_k and c_l, are excited, it is found that the secondary waves are not all of frequency ν, but that some of the secondary radiation is of frequency $\nu \pm (\nu_k - \nu_l)$.

The case of resonance is fundamental. If $\nu_k - \nu_l + \nu = \epsilon/2\pi$, where ϵ is infinitesimal, and if we retain only those terms which contain ϵ in the exponent, the system (7) reduces to

$$\dot{c}_l = i\sigma c_k e^{i\epsilon t}, \quad \dot{c}_k = i\sigma c_l e^{-i\epsilon t}, \quad \sigma = \pi A a_{kl}/h.$$

To solve these put

$$c_l = xe^{i\epsilon t/2}, \quad c_k = ye^{-i\epsilon t/2},$$

so that $$\dot{x} = i\sigma y - \frac{i\epsilon}{2}.x, \quad \dot{y} = \frac{i\epsilon}{2}.y + i\sigma x.$$

If the l level is initially unexcited, $x = 0$ when $t = 0$, and we obtain, denoting $\sigma^2 + \epsilon^2/4$ by p^2,

$$|x|^2 = 4B^2 \sin^2 pt, \quad |y|^2 = 4B^2 \cos^2 pt + B^2\epsilon^2/\sigma^2.$$

Thus the total intensity is

$$|x|^2 + |y|^2 = 4B^2 + B^2\epsilon^2/\sigma^2,$$

and the total oscillating intensity is

$$4B^2 \sin^2 pt + 4B^2 \cos^2 pt = 4B^2.$$

Hence $$\frac{\text{Oscillating intensity}}{\text{Total intensity}} = \frac{\sigma^2}{\sigma^2 + \epsilon^2/4}.$$

If then $\epsilon = 0$, the resonance is complete and the total intensity oscillates continually between the k level and the l level. Thus Bohr's orbital jumps may be interpreted as a resonance phenomenon between the exciting frequency and the natural frequencies.

In generalised co-ordinates, the motion of a mass point can be represented by a trajectory AB in space of n dimensions, the co-ordinates of a point on AB being the n quantities required to specify the position and motion. By using a generalised Laplacian ∇^2 appropriate to these co-ordinates the amplitude equation (4) retains the same form. In this way the motion of the nucleus may be taken into account. In the case of the single electron problem, let m_1 be the mass of the electron (co-ordinates x_1, y_1, z_1) and m_2 be the mass of the nucleus (co-ordinates x_2, y_2, z_2). The generalised equation (4) is then

$$\frac{1}{m_1}\nabla_1^2\psi + \frac{1}{m_2}\nabla_2^2\psi + \frac{8\pi^2}{h^2}\left(E + \frac{e^2}{\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2}} - V_0\right)\psi = 0.$$

Now in the Keplerian problem of two bodies, we may regard m_2, say, as fixed and m_1 moving about it, provided that we replace m_1 by the 'combined mass' μ given by $\frac{1}{\mu} = \frac{1}{m_1} + \frac{1}{m_2}$. In the previous discussion m_2 has been regarded as infinite. It has been found that certain hydrogen lines would coincide with certain He^+ lines if the Rydberg constant $R = 2\pi^2 m_1 e^4/ch^3$ were replaced by $4R$ on the assumption that m_2 is infinite. Sommerfeld has shown, however, that a modified Rydberg constant must be used to obtain exact agreement, got by replacing m_1 by μ. To explain this put

$\psi = \phi$ (co-ordinates of G)

$\times \chi$ (relative co-ordinates with respect to G),

G being the mass centre of the system. The generalised amplitude equation above is now equivalent to the two equations

$$\frac{1}{m_1 + m_2}\nabla^2\phi + \frac{8\pi^2}{h^2}E_T.\phi = 0 \quad \text{(co-ordinates of } G\text{)}, \quad (8)$$

$$\frac{1}{\mu}\nabla^2\chi + \frac{8\pi^2}{h^2}(E - E_T - V)\chi = 0 \quad \text{(relative co-ordinates)}, \quad (9)$$

E_T being the constant energy of translation of G.

(8) refers to the motion of G, while (9) shows that only the energy relative to G is quantised. Schrödinger's method gives *eigen* values for the relative energy $E - E_T$ in terms of the combined mass μ. Thus Sommerfeld's results are retained in the new theory.

L. M. MILNE-THOMSON.

[3] Cf. H. A. Kramers, NATURE, May 10, 1924, p. 673.

Fisheries of Madras.

RECENT work done by the Madras Fisheries Department is detailed in the administration report for the year 1925–26 by the Director, Dr. B. Sundara Raj (*Madras Fisheries Bulletin*, vol. 21, pp. 1-94. Madras. 2 rupees, 4 annas. 1927). This report deals mainly with the commercial development of the department as applied to fish, pearl, and chank (a gastropod, *Turbinella pyrum*) fisheries. The fish cannery at Chaliyam was not a success, but it is hoped that with the help of Sir F. A. Nicholson in the management of its experimental and manufacturing operations, the cannery will improve. At Tanur, researches were continued in the methods of curing fish for sale in the interior markets, of avoiding saline excrescences in semi-dried prawns, of manufacturing paint oil, and of refining sardine oil to take the place of cod-liver oil. Attempts in preparing fish-meal from sardines with a low fat content had to be abandoned for want of material. Investigations for improving the resources of edible fish in inland waters have been continued. It has been observed that the fish gourami (*Osphromenus sp.*) feeds voraciously on certain common garden shrubs, and that the tench and the English carp can be acclimatised.

In 1926, after a lapse of more than a quarter of a century, a pearl fishery was commenced on Feb. 17 at Tuticorin. The time-honoured method of fishing and of disposing of the oysters was in vogue, except for the fact that the lots for sale were not counted, but weighed out according to the average weight of 1000 oysters worked out every morning. Considerable success attended the fishery, yet the fishing operations had to be closed on Mar. 27 on account of an outbreak of cholera in the camp. In spite of the short period of fishing, the Government made a net profit of Rs. 136,417. The chank fishery was an improvement on the previous year, though the best chank diving season coincided with the pearl fishery.

The marine aquarium continued to be popular. It is proposed that if the suggested biological station at Krusadai Island is established, other aquaria at Rameswaram and at Vizagapatam should be established with facilities for conducting scientific research and for popularising natural history among the Indians. It is very gratifying to note that the Fisheries Department is endeavouring to introduce elementary education to the children of the fishing population, to organise and to spread the co-operative movement, and to promote temperance and the social and economic advancement of the country.

University and Educational Intelligence.

CAMBRIDGE.—Sir Archibald Denny, Bart., has offered to endow an annual prize of £15 for the student who does best in the theory of structures in the Mechanical Sciences Tripos.

LEEDS.—By the will of the late Mr. F. C. Clayton, a sum of £2000 has been provided to establish a scholarship of £100 a year, to be called the "Richard Reynolds Scholarship," tenable in the University by a student qualified to benefit by the same in the study of chemistry or pharmacy. Miss Florence Watts and her sister have presented a collection of photographs, scientific apparatus and specimens, in memory of their uncle, the late Sir Edward Thorpe.

With the object of assisting the further development of the research work of the Textile Industries Department, the Clothworkers' Company is making an additional grant to the University at the rate of £3000 a year for the next four years. Since the foundation of the Yorkshire College, donations and annual grants of more than a quarter of a million pounds have been received from the Company. The new building will be officially opened in October. It will allow of extension of the Textile Museum, improved laboratories for the Silk Research Association, and the extension of the mechanical and scientific equipment of the Textile Industries Department. The new grant of £3000 a year will allow of additions to the research staff, and of the award of a number of post-graduate fellowships or scholarships for research in both the Textile Industries and the Dyeing Departments.

THE following lectures in metallurgy have been arranged for by the Armourers and Brasiers' Company: At the Royal School of Mines, at 5.15, on June 4, 11, and 18, by Mr. G. Mortimer, "The Founding of Aluminium and its Light Alloys." At the Battersea Polytechnic, at 7, on June 5, 12, and 19, by Dr. J. M. Robertson, "The Heat Treatment of Steel." Admission will be free, and no tickets will be required.

APPLICATIONS are invited for the Dickinson Research Travelling Scholarship in Medicine, value £300, and tenable for one year. Candidates must be university graduates who have taken the full course of clinical instruction required by their examining bodies in the Manchester Royal Infirmary and the University of Manchester, and have earned distinction in so doing. Applications (in each case six in number) should be sent not later than June 14 to Mr. F. G. Hazell, Secretary to the Trustees, Manchester Royal Infirmary.

A COURSE of three advanced lectures in anthropology will be given at the London School of Economics on June 4, 5, and 6, at 5 P.M., when Dr. Marcel Mauss, Director of the École des Hautes Études (Sorbonne) and professor at the Institut d'Ethnologie of the University of Paris, will lecture on "The Theory of the Elementary Forms of Prayer (Australia)." The course will cover the definition of prayer, the general characteristics of prayer formulæ, the formulæ of religion, totemic and initiation cults, and dramatic, magic and negative ritual. The chair will be taken at the first lecture by Dr. E. Westermarck, Martin White professor of sociology in the University of London. Admission is free without ticket.

UNIVERSITY College, London, announces in its recently issued annual report that the total number of its students in 1926–27 was 3218, showing a decrease of ten. Excluding evening (456) and vacation-course students (290) the figures show an increase of 46. Students from parts of the Empire outside the British Isles numbered 287; those from other countries in Europe, 417 (including 212, chiefly vacation-course students, from Germany); and those from foreign countries outside Europe, 152, of whom 60 were from the United States of America. There were 1376 students in different stages of the degree course, and 534 post-graduate and research students. The College has for many years taken an active part in promoting adult education by providing public lectures open without fee. More than 8000 persons attended these lectures during 1926–27, the approximate aggregate number of attendances being 18,678. The report contains a record of the centenary celebrations, including the most important speeches and addresses. The centenary fund amounted, at the time the report was printed, to £173,445, and has since risen to above £200,000. The appeal was for £500,000.

Calendar of Customs and Festivals.

(Addendum to May) May 17.

In Morocco, the first day of summer, known as *Mût l-arḍ*, "the death of the ground." No one may sleep on this day under penalty of losing his courage, while a wife is in danger of losing her husband's affections. Among the Tsûl, to avert evil influences everyone rises at daybreak and has a bath; this is said to strengthen the body, as the water this morning, coming from the well Zemzem, has special virtue. The magic of the death of the earth is used in various ways, especially in connexion with preparations of barley, for charms and magical purposes. But it is also the commencement of a new season. Therefore the women of the Aiṭ Sáddĕn fill their handmills with wheat and cover them up; the men of the Aṭ Ubáḫṭi buy new clothes for themselves and their women.

June 3.

TRINITY SUNDAY.—That Trinity Sunday, said to have been instituted by Beckett, was also a popular festival of older standing is suggested by the number of fairs held about this date, and also by the processions with garlands of flowers and ribbons which took place in many localities on this day. Aubrey, in his "Miscellanies," describes a garland ceremony at Newnton when, after prayers had been read, an exchange of a garland and a money gift took place between a maid and a bachelor of another parish.

In Carnarvonshire an offering was made of calves and lambs bearing the mark of St. Beuno, a natural mark on the ear, in the church of Clynnok Vaur. The beasts were sold and the proceeds used for the benefit of the poor or for repairs. At Paignton Fair, held at Exeter, as described in an account of 1809, an immense plum pudding decorated with ribbons and evergreens was drawn through the town by eight oxen, and then distributed among the people.

June 4.

TRINITY MONDAY. An annual fair, lasting until Wednesday, was held at Southampton. This was declared open by the Mayor, who erected a pole on which was a glove. A bailiff held the jurisdiction of the fair, and no one might be arrested within its precincts. At the close of the fair the glove was shot down by the young men. A fair was also held at Deptford on this day, when the Master and Brethren paid their annual visit to Trinity House.

June 6.

EVE OF CORPUS CHRISTI.—In Wales this was specially regarded as a health-restoring time, when it was customary for those suffering from any ailment to kneel before the altar and pray for recovery. In North Wales, at Llanasaph, green herbs and flowers, and at Caerwis ferns, were strewn before the doors of the houses.

June 7.

CORPUS CHRISTI.—Instituted by Pope Urban in 1264 to celebrate the doctrine of Transubstantiation. In England it became in a special sense a community festival, in which the civic authorities took part, and the guilds were required to provide a pageant. Although the religious element declined in importance at the Reformation, the civil celebration continued for some time. Thus it is recorded that down to Queen Mary's day, the Skinners' Company went in procession on this day, with two hundred clerks, the officers of the Company, the Mayor and Aldermen in scarlet, and then the Skinners in their livery. At Norwich the crafts or companies, each with its banner, marched from the Common Hall around the market and back.

It is, however, on account of the performance of religious or 'mystery' plays, that the celebration of Corpus Christi is best known. A record at Newcastle-on-Tyne, dated 1426, mentions the Merchant Adventurers as concerned in the production of five plays, and no doubt other companies, drapers, mercers, etc., each one responsible for at least one. One of the most celebrated of the Corpus Christi performances was at York, but the Chester and Coventry plays were almost, if not quite, as important. Every trade in the city was obliged to furnish a pageant at its own expense—each individual had to personify some particular passage in the Old or New Testament. The part played by the miracle as well as the mystery in the development of the drama is too well known to call for comment; but here again it must be noted that the Church had adapted a popular custom to its own uses, as it had adopted the pagan dance, and had brought its performance, at least in the case of the miracle play, within the church walls.

The mystery play at Corpus Christi and the miracle play at Christmas, like the great classical drama of Greece, which itself was attached to a religious festival, grew out of, or was an adaptation of, a rustic performance which survived in Greece in the satyric drama, and in England in the folk-drama. This, as played by itinerant mummers, lasted in the north of England to within living memory, and has now been revived in a number of localities. That this popular English folk-drama was originally of a ritual character is shown by its uniformity in structure and motive—a combat in which one of the characters is slain and brought to life again by the 'doctor'; in other words, a dramatic representation of a ritual death and resuscitation.

June 8.

On the first Friday after Trinity, Coventry Fair opened, lasting for a week. It was one of the most famous of the English fairs, in which was represented the ride of Lady Godiva through the city, by which it was freed from the exactions of her husband Leofric.

June 9.

ST. COLUMBKILLE or COLUMBA, Abbot of Iona and Apostle of Caledonia, A.D. 597, next to St. Patrick the most famous of Irish saints. He was of royal family, belonging to the Dal Ariadha, said to be of Pictish extraction. His birth was foretold long before Christian times in a vision to his royal ancestor, Fedhlimidh Reachtmhar, and also by the renowned Finn Mac Cumhaill.

St. Columbkille is associated both with holy wells and with holy stones. The stone on which he was born of his mother Ethnea from that time seemed marked with a cross, and to another reddish-coloured stone, called Cloch Ruadh, long preserved in a gold and silver case at Rathen, great efficacy was attributed when it was borne to houses in which were infirm persons in danger of death, and also in cases of difficult parturition. A flat slab is still said to be the bed of his birth, four indentations in the surface having been made at the time by his mother. It was once the object of the peasants' pilgrimage, and stations are still made there on the saint's festival.

At the parish of Clonmany, Co. Donegal, of which St. Columbkill is titular saint, it was the custom on his festival day to drive cattle down to the beach and swim them where the water of St. Columb's well runs into the sea.

Societies and Academies.

LONDON.

Geological Society, May 9.—**W. B. R. King**: The geology of the district around Meifod (Montgomeryshire). The general succession is summarised as Salopian, Valentian, (unconformity), Ashgillian, Caradocian. The Caradocian can be divided into six subdivisions, each characterised by a special fauna, probably controlled by the type of sedimentation and food-supply rather than by time. The evidence of marked unconformity at the base of the Silurian is striking at certain localities, and in conjunction with the ground on the east shows that the base of the Lower Valentian gradually transgresses the Ashgillian until some 1200 feet of strata are cut out. The fact that the whole of the Gala, from the zone of *Monograptus turriculatus* to that of *M. crenulatus* inclusive, is represented by some 300 feet of fine grey and maroon shales, is in striking contrast with the developments in Shropshire and central Wales.

EDINBURGH.

Royal Society, May 7.—**G. S. Carter**: A zoological expedition to Brazil and Paraguay in 1926–27 (Address). A year was spent on zoological investigations by the author and Mr. L. C. Beadle. On the way to the Paraguayan Chaco, where most of the work was done, six weeks were devoted to collecting zoological material along the line of the new railway from São Paulo to Porto Esperanza on the Paraguay. The aim of the expedition was (1) to collect and bring home young larvæ of Lepidosiren with the intention of breeding them to maturity at Glasgow; this was accomplished without difficulty; (2) to study the conditions of life in the swamps of the Chaco. As a result of investigations of several physical and chemical characteristics of the water of these swamps, it was found that, of the characteristics studied, the oxygen-content of the water was the condition of greatest bionomic importance. It was very low, and the fauna, especially the fishes and the oligochætes, showed adaptations to the satisfying of this need. The shortage of oxygen in these waters is due to several conditions which must occur in many other tropical waters, but not in those outside the tropics.—**D. A. Allan**: The geology of the Highland border from Tayside to Noranside. The rocks of the serpentine belt are of pre-Old Red Sandstone age, and are bounded to the south by the Highland Boundary Fault, the course of which has now been determined, and further evidence of its reversed nature found. A new exposure of Highland Boundary rocks has been found in the valley of the Prosen. A sequence of Lower Old Red Sandstone lava flows and sediments, the latter mainly conglomerates, has been proved throughout the area, an important new datum line being the Lintrathen porphyry, hitherto regarded as intrusive, but now demonstrated to be a dacite lava flow of wide extent and constant stratigraphical horizon. Contemporaneous erosion of considerable importance occurred during Lower Old Red Sandstone times. An interesting series of normal faults was mapped in the vicinity of the Highland Boundary reversed fault, and it is suggested that they correspond to the phase of relief of pressure immediately following upon the compression, fracture, and over-riding of the Lower Old Red Sandstone strata.—**F. Walker** and **J. Irving**: Igneous intrusions between St. Andrews and Loch Leven. The intrusions between St. Andrews and Loch Leven are mainly sills, and include olivine-dolerites, teschenites, nepheline-basanites, monchiquites, and quartz-dolerites, the first four types being probably consanguineous. The quartz-dolerites, which are very abundant, occasionally contain analcite. At several localities the published maps have been modified, the most important alteration being the inclusion of the twin Lomond peaks amongst the volcanic necks of the district. All the igneous rocks under consideration are probably of Carboniferous age.

PARIS.

Academy of Sciences, April 30.—The president announced the death of Félix Lagrange, *correspondant* for the Section of Medicine and Surgery. **Charles Moureu, Charles Dufraisse**, and **Louis Girard**: Researches on rubrene (7). The dissociation pressure of rubrene peroxide at the ordinary temperature. The peroxidation of rubrene in solution by free oxygen under the influence of light is a reversible phenomenon and the dissociation pressure of the peroxide is appreciable at the ordinary temperature (of the order of 5 mm. of mercury). Attention is directed to the analogy between the peroxidation of rubrene and of hæmoglobin.—**Pierre Termier** and **Eugène Maury**: New geological observations in eastern Corsica: the upper Jurassic: the primary strata prior to the granite.—**Gabriel Bertrand** and **Georges Nitzberg**: The ketonic function of α-glucoheptulose. From the colour reactions with orcinol and phloroglucinol in dilute hydrochloric acid, stability towards bromine water, and the reduction products with sodium amalgam, the new reducing sugar obtained by the action of the sorbose bacterium on α-glucoheptite was shown to be ketonic.—**H. Vincent**: Some non-colloidal substances with cryptotoxic properties. It has been proved in earlier publications that various colloidal substances, many of them soaps, possess the property of neutralising microbial toxins, such as the toxin of tetanus. It has now been found that other substances, not colloidal, possess a similar property, although generally to a less extent. Sodium salicylate has proved to possess the most marked activity in this respect. After the addition of 5 per cent or less of a saturated solution of sodium salicylate to a solution of tetanotoxin, a quantity representing from 200 to 400 fatal doses can be injected into a guinea-pig without inconvenience, and with further doses the animal can be immunised. Experiments with rabbits gave similar results.—**Léon Guillet**: The applications of the addition of nitrogen to certain special steels. The extreme hardness obtained by nitriding certain steels suggests interesting applications in motor-car construction.—**J. Favard**: Algebraic numbers.—**P. Vincensini**: Congruences of normals in their relations with certain rectilinear congruences.—**Bertrand Gambier**: Geodesic lines, lines of zero length, lines of constant total curvature.—**W. Břečka** and **J. Gueronimus**: The monotone polynomials deviating least from zero. —**Georges Valiron**: Circles of *remplissage* of meromorph functions.—**Arnaud Denjoy**: Series of rational fractions.—**J. Haag**: The calculation of certain elastic deformations, with application to the plane spiral.—**E. Carafoli**: The general movement round a contour.—**F. Wolfers**: Remarks on the theory of light. Energy, coherence, and supplementary fringes. —**J. Cabannes**: A new optical phenomenon. The beats which are produced when anisotropic molecules in rotation and vibration diffuse visible or ultraviolet light.—**F. Holweck**: The production and absorption of the K-rays of aluminium.—**Maurice François**: The preparation of mercurammonium iodide, $Hg_2N_4I_6$, in the crystallised state.—**Édouard Urbain** and **Victor Henri**: The formation of ammonia in the preparation of phosphorus. Charcoal impreg-

nated with phosphoric acid is heated to 900° C. in a quartz tube in a current of nitrogen. Under these conditions the nitrogen is converted into ammonia.—**Charles Prévost**: Erythrene and its dibromides.—**Bourguel**: The phenylpropines.—**André Meyer**: The products of condensation of homophthalimide with aromatic aldehydes.—**J. Bougault** and **L. Daniel**: The sulphoxytriazines.—**Maurice Nicloux**: The oxidation of glucose in alkaline solution by oxygen or by atmospheric air. The formation of carbon monoxide. The oxidation of glucose in alkaline solution by gaseous oxygen gives carbon monoxide, carbon dioxide, and other oxidation products. The optimum conditions as regards alkalinity and temperature for the maximum production of carbon monoxide have been worked out. —**J. F. Durand**: A synthesis of quinone (rectification). Correction of a note in the *Comptes rendus*, 192, 1927. The experiment described in the previous note cannot be repeated, and the author concludes that a mixture of acetylene and carbon monoxide acting on solutions of cuprous chloride in pyridine does not give quinone.—**Louis Barrabé**: The Callovian at Madagascar between Cape Saint-André and Betsiboka.—**J. Jung** and **P. Geoffroy**: The efficacity of the method of magnetic prospecting for the detection of faults in the Oligocene of Alsace. The instrument generally used for the determination in absolute measure of the horizontal component was used for this survey and was found to be very useful in detecting the directions of certain faults affecting the Oligocene. It may prove to be of use in prospecting for petroleum in Alsace.—**Léon Bertrand**: The general metamorphism of the secondary strata in certain parts of the Pyrenees.—**H. Besairie**: The existence of *Syringopora* limestones in the south-west of Madagascar.—**H. Buisson**: Measurements of the ozone in the upper atmosphere during the year 1927. The method used was based on the use of a spectrograph with quartz prisms and measurement of the ozone bands. There is a large annual variation with a maximum of about 400 in the spring and a minimum of 200 in the autumn. The results are in general agreement with those of Dobson and Harrison and of Gotz.—**L. Lutz**: The influence exerted by the support on the morphological characters of the birch *Polyporus*. Contribution to the study of the antioxygen rôle of tannin. Oak wood is normally invulnerable to this fungus, but the removal of the tannins by systematic washing with water renders it liable to attack.—**G. Ollivier**: The *bromuques* of certain Ceramiaceæ. *Bromuque* is the name given by C. Sauvageau to certain plant cells, which redden under the influence of fluorescin, a reaction attributed to free bromine. The application of Sauvageau's reaction to fresh specimens of *Ceramium* has proved the presence of these cells in seven species, *C. byssoideum* showing them in the greatest abundance.—**B. Ganossis**: The deflocculation and plasmolysis of soil coatings.—**E. Roubaud**: The maternal influence in the determinism of acyclic asthenobiosis.—**L. Léger** and **C. Motas**: Parasitism and the phenomenon of transport of a Hydrocarian in *Cricotopus biformis*. —**Maurice Piettre** and **André Chrétien**: Application of the acetone method to the study of the distribution of the antibodies in agglutinating sera in the course of immunisation.—**Y. Manouélian** and **J. Viala**: Lesions of the walls of the mouth and tongue in mad dogs.

CAPE TOWN.

Royal Society of South Africa, Mar. 21.—**A. Ogg**: Some aspects of modern physics (Presidential address). —**J. L. B. Smith** and **K. A. C. Elliott**: The essential oil of *Agathosma Microphylla*. *Agathosma Microphylla* or 'Stembok Buchu' is a short stunted shrub which grows in patches on the seaward side of the coastal hills, being found fairly extensively about Knysna and in neighbouring districts. It gives off a strong aniseed-like odour which is very noticeable in the still valleys where it flourishes. The oil content of the dried leaves appears to vary with the season, from 2 to 3 per cent of volatile oil when collected in summer, and as much as 5 per cent when collected in winter. Air-dried leaves yielded by distillation in steam a clear yellow oil of powerful odour, the chief constituent of which is methyl chavicol.—**Sir Thomas Muir**: Note on $(n-1)$-by-n arrays whose primary minors have a common factor.—**Theodora B. Auret**: Observations on the reproduction and fungal endophytism of *Lunularia Cruciata* (L) Dumortier. Female plants of this species are found in South Africa on slightly alkaline soil. Male plants and the sporophyte generation are not known. The gametophyte harbours a fungus which is confined to a definite zone below the assimilating tissue. The fungus has been identified as a species of Phoma. The association between the liverwort and the fungus is not a case of true symbiosis, but rather one of harmless parasitism.—**F. E. Fritsch** and **Florence Rich**: Contributions to our knowledge of the freshwater algæ of Africa. (7) Freshwater algæ (exclusive of diatoms) from Griqualand West. 183 species are recorded, 33 of which are new or represented by new varieties, and the total number of genera represented is 69, of which one is new (*Raphidiopsis*, a member of the Rivulariaceæ). Particular interest attaches to the discovery of two new species of *Sphæroplea*. There is another species of the hitherto monotypic genus *Centritractus*, and a highly peculiar new *Phacus*, *P. anomala*.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 14, No. 3. March).—**W. L. Ayres**: On the separation of points of a continuous curve by arcs and simple closed curves. —**H. Hopf**: On some properties of one-valued transformations of manifolds.—**G. A. Miller**: Harmony as a principle of mathematical development. Throughout mathematics, progress has implied greater intellectual harmony and is seen, for example, in the way in which the equation has steadily displaced the proportion. Increase in accuracy of knowledge generally discloses new elements of discord; hence the principle of harmony is a source of inspiration and also a guide to the novelty of the results obtained.— **Einar Hille**: Note on the behaviour of certain power series on the circle of convergence with application to a problem of Carleman.—**H. S. Reed**: Intra-seasonal cycles of growth. Lemon shoots generally show three distinct cycles of growth during a single season. The growth curves suggest a series of autocatalytic actions due to the periodic activity of a growth-promoting substance.—**Sophia Satina** and **A. F. Blakeslee**: Studies on the biochemical differences between sexes in Mucors. (4) Enzymes which act upon carbohydrates and their derivatives. It has been suggested that sucrase is present in one sex and not in the other. Mucors of varying habit were grown in different nutrient media, each containing a carbohydrate attacked by a specific enzyme. No enzyme tested for was found to be limited to one sex. Trehalose, maltose, and salicin were found to be the best carbohydrates for growth.—**Dontcho Kostoff**: Induced immunity in plants.—**Selig Hecht**: On the binocular fusion of colours and its relation to theories of colour vision. With a red filter before one eye and a green filter transmitting light of about the same brightness before the other (for example, Wratten 29

and 58), a brightly illuminated white surface on a black background appears yellow; similarly, yellow and blue filters make a binocular white. Thus the red (or yellow) sensation in one retina and the green (or blue) sensation on the corresponding retinal area of the other eye results in a yellow (or white) sensation, which arises in the brain. No special receptors in the retina for yellow or white are therefore necessary and the uniqueness of yellow and white as sensations is not opposed to Young's three-receptor mechanism of colour vision.—**Willem J. Luyten**: On the motion of the Magellanic Clouds. Only a very speculative computation is possible, and this indicates that the path of the clouds with respect to the Galactic System may deviate appreciably from a straight line and that they are permanent members of our galaxy.—**Albert Titlebaum**: Artificial production of Janus embryos of *Chætopterus*. Double embryos were obtained by compressing the eggs between slide and coverslip; pressure applied shortly after the extrusion of the second polar body gives the best results. It appears to be correlated with the equal distribution of the 'polar lobe' substance between the two blastomeres in the first cleavage.—**Carl Barus**: Anode and cathode sparks differentiated by the mucronate electrode.—**R. C. Gibbs** and **C. V. Shapiro**: A spectroscopic criterion for the benzenoid structure in some types of triphenylmethane derivatives. The absorption spectra of compounds of benzenoid or lactoid structure in neutral alcoholic solution include a pair of bands with average separation of about 100 mm.$^{-1}$ in the region 3500–3700 mm.$^{-1}$; both are relatively weak but of the same intensity, and the average molecular absorption coefficient is always of the same order of magnitude.—**Boris Podolsky**: The dispersion by hydrogen-like atoms in undulatory mechanics. Terms of the order of relativistic correction are neglected.—**Joseph Kaplan**: The production of active nitrogen. The discharge tube contained air at 5 mm. pressure; the discharge was condensed and a spark gap connected in series with tube and condenser. The glow was blue, changing to yellow-green with continuous spectrum when the spark gap was excluded. Second and fourth positive bands of nitrogen were identified.—**J. R. Oppenheimer**: On the quantum theory of the Ramsauer effect.—**Norbert Wiener** and **D. J. Struik**: The fifth dimension in relativistic quantum theory. The fifth dimension is introduced to account for the phenomena of incoherency and the atomicity of electricity.—**Richard C. Tolman**: On the extension of thermodynamics to general relativity. Two principles expressed in equations true for all sets of co-ordinates, which are the analogues of the first and second laws of thermodynamics, are discussed.—**William Rule**: On the variation of the electromotive force in a photoactive cell, containing a fluorescent electrolyte, with the intensity of illumination. Two quartz 'boxes' containing fluorescein solution, connected by a quartz capillary and with central platinum wire electrodes, are used, enclosed in an air-tight case, and one cell is illuminated. This method is considered to eliminate diffusion effects. The electromotive force generated increases with increase of intensity of illumination for a given time, tending to a maximum, and its variation with intensity is roughly paralleled by the variation with exposure. The results support the view that photochemical changes take place in the fluorescent electrolyte.—**A. W. Simon**: A note on corona at high humidity. Parallel copper wires were hung parallel to and equidistant from two parallel steel plates near an open window. Ordinarily, on applying a high voltage (plates positive), heavy visual corona appeared and persisted until an arc struck. On very wet days no corona was visible, the current to the plates was much reduced, and intermittent sparking occurred, possibly due to reduced mobility of the negative ions.—**H. N. Russell**, **K. T. Compton**, and **J. C. Boyce**: The spark spectrum of neon (*v.* NATURE, Mar. 10, p. 357).—**Edwin B. Wilson**: On hierarchical correlation systems.

Official Publications Received.

BRITISH.

The Journal of the Imperial College Chemical Society. Vol. 7: containing Papers read during the Session 1927–1928. Pp. 68. (London.)

Report of the Kodaikanal Observatory for the Year 1927. Pp. 6. (Calcutta: Government of India Central Publication Branch.) 6 annas.

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 34: The Biological Control of Prickly Pear in Australia. By A. P. Dodd. Pp. 44+9 plates. Pamphlet No. 7: The Export of Oranges. By W. Ranger and Prof. W. J. Young. Pp. 12+8 plates. (Melbourne: H. J. Green.)

Transactions of the Royal Society of Edinburgh Vol. 55, Part 3, No. 30: Pollination and Seed Production in the Rye-Grasses (*Lolium perenne* and *Lolium italicum*). By Dr. J. W. Gregor. Pp. 773-794. 2*s.* 0*d.* Vol. 55, Part 3, No. 31: Sporangial Variation in the Osmundaceæ. By Dr. S. Williams. Pp. 795-805. 1*s.* 6*d.* (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Archæological Survey of India. New Imperial Series, Vol. 43, Parts 1 and 2: The Bakhshālī Manuscript; a Study in Mediæval Mathematics. By G. R. Kaye. Pp. iv+156+48 plates. (Calcutta: Government of India Central Publication Branch.) 28 rupees; 43*s.* 6*d.*

Manchester Municipal College of Technology. Prospectus of Short Courses of Lectures and Laboratory Work to be given during the Summer 1928. Pp. 27. (Manchester.)

Annual Report of the Zoological Society of Scotland for the Year ending 31st March 1928. Pp. 62+6 plates. (Edinburgh.)

FOREIGN.

Building the American Museum, 1869-1927: Fifty-ninth Annual Report of the Trustees for the Year 1927. Pp. xxviii+308+16 plates. (New York City.)

Japanese Journal of Botany: Transactions and Abstracts. Vol. 4, No. 1. Pp. iv+112+29+15 plates. (Tokyo: National Research Council of Japan.)

Memoirs of the College of Science, Kyoto Imperial University. Series A, Vol. 11, No. 2, March. Pp. 43-117. (Kyoto and Tokyo: Maruzen Co., Ltd.) 1.50 yen.

Proceedings of the Imperial Academy. Vol. 4, No. 3, March. Pp. ix-x+85-135. (Tokyo.)

Bergens Museum. Årsberetning, 1926-1927. Pp. 98. Bergens Museums Årbok 1927. Naturvidenskapelig rekke. Heft 1. Pp. 80+67+15. Heft 2. Pp. 140+10+14+5. Bergens Museums Årbok 1928. Naturvidenskapelig rekke. Heft 1. Pp. 222. (Bergen: A.-S. John Griegs Boktrykkeri.)

CATALOGUES.

Watson's Microscope Record. No. 14, May. Pp. 32. (London: W. Watson and Sons, Ltd.)

Caprokol Antiseptic Solution S.T. 37. Pp. 4. Caprokol Therapy: with Clinical Reports of Representative Cases. Pp. 16. (London: The British Drug Houses, Ltd.)

Diary of Societies.

SATURDAY, JUNE 2.

ROYAL SOCIETY OF MEDICINE (Laryngology and Otology Sections).—Prof. G. Portmann: Vasomotor Affections of the Internal Ear.—W. S. Sharpe: The Influenzal Ear.

MONDAY, JUNE 4.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—G. L. Purser: *Calamoichthys calabaricus* (J. A. Smith). Part 1. The Alimentary and Respiratory Systems.—P. R. C. Macfarlane: Salmon (*Salmo salar*) of the River Moisie (Eastern Canada), 1926–1927.—Prof. R. A. Sampson: The Present-Day Performance of Clocks.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. J. A. Fleming: Relativity and Reality (Presidential Address).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

INSTITUTE OF ACTUARIES, at 5.—Annual General Meeting.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Capt. W. R. Hay: Pre-Ghal in Wasaristan.

ROYAL SOCIETY OF MEDICINE (Social Evening), at 9.15.—C. L. Woolley: Recent Excavations at Ur of the Chaldees.

TUESDAY, JUNE 5.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. C. Bolton: The Interpretation of Gastric Symptoms (I.).

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. E. B. Poulton: Note on the Feeding-habits of Insectivorous Bats.—Prof. J. P. Hill, F. E. Ince, and A. Subba Rau: The Development of the Fœtal Membranes in *Loris*, with Special Reference to the Mode of Vascularisation of the Chorion in the Lemuroidea and its Phylogenetic Significance.—Frances

M. Ballantyne: Note on the Male Genito-urinary Organs of *Ceratodus forsteri*.—Dr. C. Crossland: Notes on the Ecology of the Reef-builders of Tahiti.—Cambridge Suez Canal Expedition Reports:—L. M. I. Dean: Report on the Alcyonaria.—Dr. C. H. O'Donoghue: Report on the Opisthobranchiata.

LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.), at 6.30.—E. H. Ellis: Photomicrography.

WEDNESDAY, JUNE 6.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—From 7.30 to 10.—Annual Pond Life and General Microscopical Exhibition.

EUGENICS SOCIETY (at Linnean Society), at 8.—Prof. Malinowski and Dr. Gray: Marriage and Eugenics.

ROYAL SOCIETY OF MEDICINE (Surgery Section) (Annual General Meeting), at 8.30.—Dr. V. Veau, C. H. Fagge, and others: Discussion on Hare-lip.

THURSDAY, JUNE 7.

ROYAL SOCIETY, at 4.30.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. C. Bolton: The Interpretation of Gastric Symptoms (II.).

CHEMICAL SOCIETY, at 5.30.—F. L. Gilbert and Prof. T. M. Lowry: Studies of Valency. Part X. Electrometric Titration of Vernon's *a* and *β*-dimethyl-telluronium Bases.—F. L. Gilbert and Prof. T. M. Lowry.—Studies of Valency. Part XI. Molecular Conductivities and Extinction-coefficients of Derivatives of *cyclo*-telluropentane.—A. Key and P. K. Dutt: The Action of Diazo-salts on Aromatic Sulphonamides. Part II. The Mechanism of the Reaction and Constitution of the Diazo-sulphonamides.

FRIDAY, JUNE 8.

ROYAL ASTRONOMICAL SOCIETY, at 5.—W. H. Wright: Photography of the Planets in Light of Different Wave-lengths (George Darwin Lecture).—S. R. Pike: Note on the Separation of Gases in Prominences.—N. Goryatscheff: The Definitive Elements of the Orbit of Comet 1925 c (Orkisz).

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 5.—At 6.15 (Annual General Meeting).—M. Hine: Report on a Case of Neuro-fibromatosis of the Eyelid, and of a Case in which a Glass Ball burst in the Socket.—F. Ridley: Lysozyme-antibacterial Body present in Great Concentration in Tears, and Especially its Relation to the Human Eye.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.

MALACOLOGICAL SOCIETY (at Linnean Society), at 6.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—T. Robertson and T. N. George.—The Carboniferous Limestone of the Northern Outcrop of the South Wales Coalfield.

GEOLOGISTS' ASSOCIATION (in Architectural Theatre, University College), at 7.30.—Dr. T. Robertson and T. N. George: The Carboniferous Limestone of the North Crop of the South Wales Coalfield.—Dr. R. L. Sherlock: The Alleged Pliocene of Buckinghamshire and Hertfordshire.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. G. P. Thomson: The Waves of an Electron.

PUBLIC LECTURES.

MONDAY, JUNE 4.

LONDON SCHOOL OF ECONOMICS, at 5.—Prof. M. Mauss: The Theory of the Elementary Forms of Prayer (Australia) (I.). (Succeeding Lectures on June 5 and 6.)

ROYAL SCHOOL OF MINES, at 5.15.—G. Mortimer: The Founding of Aluminium and its Light Alloys. (Succeeding Lectures on June 11 and 18.)

TUESDAY, JUNE 5.

BATTERSEA POLYTECHNIC, at 7.—Dr. J. M. Robertson: The Heat Treatment of Steel. (Succeeding Lectures on June 12 and 19.)

THURSDAY, JUNE 7.

CHELSEA PHYSIC GARDEN (Swan Walk, Chelsea Embankment), at 5.—Prof. W. E. Dixon: Narcotic Plants (Chadwick Lecture).

INSTITUTE OF PATHOLOGY AND RESEARCH (St. Mary's Hospital), at 5.—Sir Oliver Lodge: The Uses we make of the Ether of Space.

FRIDAY, JUNE 8.

KING'S COLLEGE, at 5.30.—Dr. J. Krzyzanowski: Polish Culture in the Middle Ages: Education and the University of Cracow.

CONGRESSES.

JUNE 3 TO 7.

INSTITUTION OF CIVIL ENGINEERS (Celebration of Centenary of Incorporation. Also Engineering Conference).

Sunday, June 3, at 3 P.M.—Divine Service in Westminster Abbey.

Monday, June 4, at 11 A.M.—Address by President, etc.

At 4.30.—Sir James Alfred Ewing: A Century of Inventions (James Forrest Lecture).

Tuesday, June 5, 8 to 11.30 P.M.—Conversazione.

10.30 to 11.45.—Recent Developments in Concrete and Cement for Engineering Structures. Introduced by F. E. Wentworth-Sheilds.—Steel for Shipbuilding. Introduced by Sir William J. Berry.—Utilisation of Solid and Liquid Fuels. Introduced by Dr. C. H. Lander.—Coke-Oven, Town, and Producer Gas. Introduced by E. Ray.—(At Institution of Mechanical Engineers.) The Properties of Materials for Use at High Temperatures, with special reference to Boilers for Superheated Steam. Introduced by H. G. C. Batson.—(At Surveyors' Institution.) Electric Transmission of Power as applied to Large Areas. Introduced by A. Page.

11.45 to 1.—Developments in the Use of Materials in Railway Engineering. Introduced by C. J. Brown.—Railway Design and Maintenance as affected by the Application of Electricity. Introduced by A. R. Cooper and G. Ellson.—The Generation and Utilisation of High-Pressure Superheated Steam for Marine Propulsion. Introduced by Lord Weir and H. E. Yarrow.—Progress in the Adoption of the Internal-Combustion Engine for Marine Purposes. Introduced by Prof. C. J. Hawkes.—Waterless Gasholders. Introduced by F. Prentice.—(At Institution of Mechanical Engineers.) The Present Trend in Boiler Practice. Introduced by W. H. Patchell. (At Surveyors' Institution.) Domestic Lighting and Heating and its Influence on Load-Factor of Supply. Introduced by A. F. Berry.

Thursday, June 7.

10 to 11.30.—The Dimensions of Harbour and Dock Approaches. Introduced by Sir Cyril R. S. Kirkpatrick.—Harbour Breakwaters. Introduced by H. H. G. Mitchell.—Latest Types of Steam and Internal-Combustion Locomotives. Introduced by Sir Henry Fowler and H. N. Gresley.—The General Trend of Modern Development in Steam-Turbine Practice. Introduced by H. L. Guy.—(At Institution of Mechanical Engineers.) Tidal Power, and Turbines suitable for its Utilisation. Introduced by Prof. A. H. Gibson.—Progress in Hydro-Electric Installations, including Intakes, Leats, Tunnels, Dams, Headraces, Pipe-Lines and Tailraces. Introduced by J. McLellan.—(At Surveyors' Institution.) The Filtration and Treatment of Water for Domestic Purposes. Introduced by Sir Alexander Houston and H. E. Stilgoe.—Floods, with special reference to Waste-Weir Capacity. Introduced by W. J. E. Binnie and Dr. H. Lapworth.

11.30 to 12.15.—(At Institution of Mechanical Engineers.) Problems involved in Mining at Great Depths. Introduced by J. Whitehouse.

11.30 to 1.—Modern Road and Bridge Construction. Introduced by F. C. Cook.—The Problem of Road Traffic from the Engineering Point of View. Introduced by H. R. Hepworth.—Light High-Speed Internal-Combustion Engines. Introduced by H. R. Ricardo.—Heavy Internal-Combustion Engines. Introduced by G. Porter.—Prospective Development in the Generation of Electricity and its Influence on the Design of Station-Plant. Introduced by Dr. S. L. Pearce.—(At Surveyors' Institution.) The Advantages of Different Types of Sewage-Tanks. Introduced by W. Clifford.—Sewerage, with special relation to Run-off. Introduced by J. B. L. Meek.

12.15 to 1.—(At Institution of Mechanical Engineers.) The Metallurgy of Complex Lead-Zinc-Copper Ores. Introduced by S. Field.

JUNE 4 TO 9.

INSTITUTE OF QUARRYING (at Blackpool).—Prof. P. G. H. Boswell: Silica—its Commercial Properties and Markets.—W. J. Rees: Commercial Sands.—M. I. Williams-Ellis: Electric Traction as Applied to Quarries and Slate Mines.—T. R. Druitt: Cutting Costs in Slate Quarries.—H. S. Seaborne: Research.

JUNE 6 TO 9.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (at Rochester).

Wednesday, June 6, at 8 P.M.—Sir Martin Conway: Mountain Exploration (Presidential Address).

Thursday, June 7.

Archæological Section.

At 11 A.M.—
Dr. W. Martin: Presidential Address.
At 12 NOON—
A. E. Hurse: Archæology of the Medway Valley.

Botanical Section.

At 11 A.M.—
C. E. Salmon: Fruits and Seeds as a Means of distinguishing Allied Plants (Presidential Address).
At 12 NOON—
Rev. L. D. Sayers: Gall Formation in Plants.
At 12.30—
G. E. Hutchings: Vegetation of Rochester District.

Friday, June 8.

Geological Section.

At 10.30 A.M.—
H. H. Milner: Geology from the Air (Presidential Address).
At 11.30 A.M.—
Dr. S. W. Wooldridge: The Geomorphology of the North Downs.
At 12.30—
H. G. Dines: The Bapchild Palæolithic Site.

Zoological Section.

At 11 A.M.—
Prof. E. W. MacBride: The Conditions for Progressive Evolution (Presidential Address).
At 12 NOON—
H. H. S. Bovingdon: The Reflections of a Biologist on Food and Efficiency.

Saturday, June 9.

Regional Survey Section.

At 11 A.M.—
C. C. Fagg: The History of the Regional Survey Movement (Presidential Address).
At 12 NOON—
G. E. Hutchings: A Regional Survey of the Lower Medway Valley.

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Social Ethics, or Present-Day Conflicts.

THE conflict between religion and science, which a few years ago seemed nearly extinct, has recently revived in another form, this time not so much on the theological as on the ethical side. Doubtless there is a kind of ignorant bibliolatry still surviving, which may be said to have a Theological bearing ; but apart from that there is a sort of conflict between the ideals of science and the ideals of religion—a conflict rather mingled with the emancipation of youth during the present century, and of some practical importance. The study of anthropology and of folk-lore has been pressed into the service ; there is a tendency in some quarters to regard social conventions and other traditions as akin to savage taboos, and to expect sensible people to ignore them. Psychology, too, has developed a scheme called behaviourism, which seems to urge a freer rein to natural instincts, and has become an element in the emancipation of youth.

The revolution in physics, that has led to the examination and rejection of many ancient ideas, is by no means confined to that science. Something of the same sort has been going on contemporaneously in ordinary life. Old customs are being examined to see if they have a rational basis, and when they run counter to instinctive desires are apt to be discarded and rebelled against on hasty and irrational grounds. Youth is complimented on its courage, its willingness to run risks and try anything regardless of consequences. Its courage is undeniable, but its wisdom may be questioned. Even the physical risks which youth is willing to run, in such directions as swimming and flying and breaking of records, may involve the enticing of others to destruction. In other ambitious enterprises, the apparently growing idea that a social taboo has no rational basis and can be ignored with impunity, is becoming a danger.

Even among serious thinkers there is a difference of opinion on these matters. Some hold that we are entering on an age of reason, which submits everything to reconsideration and must involve changes in practice ; while others have taught that an age of reason would mean the extinction of the human race, that animal instincts are necessary for its continuance, and that the struggle for existence and fierce competition are essential to its well-being and energetic development. It is argued that this competitive struggle has been all along essential to evolution, that the survival of the fittest can only thus be accomplished, and that

rivalry and strife must and ought to continue, even though humanity has now reached a superior stage. It is urged, on the other hand, that with the attainment of consciousness mankind might aim at gradually superseding competition by co-operation and mutual aid, that is to say, by instigating a course of conduct, on a large and even an international scale, such as has hitherto been confined mainly to family life. It has long been known that a family prospers not by competition and strife among its members, but by individual sacrifice and mutual aid; and one ideal is to extend this atmosphere of family life to neighbours and ultimately to all humanity, whereas the opposing ideal is that competition and rivalry must continue, lest mankind sinks into a contented apathy and loses the motive for individual exertion.

The doctrine of evolution has no clear say in this matter. There are those who hold that the same conflict which has brought us to what we are must continue unchecked or even intensified, now that we have become conscious of its benefits and have the power of directing its course. There are others who hold that though this method has been of great service in the past, it should now be taken in hand and controlled by conscious intelligence; that in fact it is one of those good things which has had its day and should now gradually cease to be.

Thus on the ethical side of effective religion, which might be defined as the practical outcome of beliefs, there is a conflict between the ideals of competitive struggle on one hand, and the ideals of the Sermon on the Mount on the other. These two ideals have long been in the field against each other, and it would be a great mistake to suppose that our present condition is the result of one or other alone. Both have, as a matter of fact, contributed to the result. Opinions may differ as to the proportion of success attributable to either, but it is surely certain that our hospitals and other numerous philanthropic efforts—the servers of the infirm and helpers of the weak—have been a conspicuous and effective element in the advance of the social organism. Civilised instincts have never been limited to the graspings of benefits and the accumulation of property. It has long been found that happiness does not lie that way. There is a deep-planted instinct to help those in distress, to run even irrational risks for the help of our fellows, and to enter on forlorn hopes without counting the cost. Evolution surely teaches that many lines of conduct, of which it may be difficult to give a rational account, have grown up as the result of experience, and have been formulated in a system of convention, and what may thoughtlessly be called 'taboo,' as the outcome of experiments which have been made by our ancestors,—never perhaps rationally formulated, and yet handed down from one generation to another as an inherited result of experience. We find some of these conventions unconsciously implanted in animal and even in plant life. Methods of propagation deleterious to the race are guarded against in the very structure of organisms, so that they are inhibited not by reason but by physical difficulty. It may be that some of those conventions which are now being uprooted and rebelled against may have a similar evolutionary significance, and be more beneficial than we find it easy to explain.

Whatever view we take, if our conduct is to be regulated by intelligence in accordance with scientific ideals, it is surely necessary that the whole of the facts should be considered, and that we should not proceed to reason on data which are imperfect and incomplete, so as to determine our behaviour in the light of half knowledge. When youth proceeds to flaunt experience, to overthrow conventions, and to demonstrate its courage by all manner of experiments, it is bound to be proceeding without full knowledge of the facts. It cannot but be in a state of considerable ignorance; and in its exuberance it may be throwing away many of the safeguards which the experience of the race has wisely, though often unconsciously, set up.

It is proverbially rash to draw up an indictment against a nation or a class, and the tendency of the age can scarcely be generalised. There is undoubtedly a claim for greater freedom, less supervision, less restrictions; and this when granted may be selfishly abused by individuals, not necessarily young, for mere personal gratification. The mere desire to have a good time is not a lofty ambition. On the other hand, a reconsideration of old customs might result in a genuine effort towards improved social conditions, which admittedly are as yet far from perfect. In spite of perturbing incidents, the spirit which helped us through the War, and through the minor episode of the strike, is still alive, and only latent until a call comes. A few feel the call insistent and ever present; many a youth is asking him or her self *quo vadis*, and is endeavouring to exert a wholesome guiding influence. Youth should not be either praised or rebuked indiscriminately. Incitements to adventure are popular, but they are dangerous and

unnecessary. Temptations are strong enough without pandering to them.

Meanwhile, those experimenters who ignore the ideals of religion, and claim to be following the ideals of science, must be warned that science at present speaks with a divided voice. Religion has always had some bearing upon conduct—sometimes *good, sometimes bad; it is of long standing, in* one form or other as old as the race; and in civilised countries it can scarcely be doubted that the influence of religion on the whole has been good. Science, on the other hand, is of recent growth, and until lately has not had much influence on conduct. If its ideals are to be followed they should clearly be based on complete knowledge, otherwise they may mislead. No one will claim that our scientific knowledge is complete. It would be rather rash to assume that our knowledge is anything like sufficiently complete to be a safe guide to conduct, or such as to justify the discarding of evolutionary experience and replacing it by a system based on half knowledge.

To make this point of view more definite: it is undeniable that a certain group of scientific men have claimed that the religious belief in a spiritual world is a dream, and the survival of the individual apart from his bodily organism an illusion. If this is true, then such beliefs cannot but have an influence upon conduct; and youth, already urged to such conduct by its instincts, will take advantage of those beliefs to justify its own tendencies and to rush unthinking to its fate.

On the other hand, there is a small though perhaps growing group of scientific men who hold that human life on this planet is but a small part of existence; that the organism is only a manifestation of something which has its roots in another order of being; that we are associated with matter only for a time; that we have to contend against the results of our animal ancestry while on this planet; and further, that individual personality and character, though grown and developed here, survive the change which we call death; that the consequences of our actions are perennial; that the spiritual world to which we really belong is a reality; and that these things are now becoming capable of demonstration. If this belief turns out to be true, then that also must have an influence on conduct; and even the possibility that it is true should not be ignored by those who are helping to determine the conduct of themselves and future generations. Any scientific system which ignores this aspect of things is based on one-sided knowledge, and as such is a dangerous guide. Religion has always taken these things into account, and it is excessively dangerous to ignore its sanctions and evolutionary traditions, the result of long experience on the part of those who must be considered the highest of the race.

The present-day conflict is no small matter. The two views are in the field against each other, *and the outcome is in doubt.* Knowledge comes but wisdom lingers; and during the conflict of opinion humanity does not stand still. Emancipated youth is claiming its privileges, and prides itself on living dangerously.

The literature of the present day is full of the signs of this conflict. It is exhibited in biological and psychological writings, and it is illustrated in its practical working by many novels. Perhaps the novels are the most important part of the literature, for they are widely disseminated and read, though doubtless many of the other books are read too. The art of the novelist is to make a study of contemporary life, to throw it into dramatic form, and to work out the actual consequences of the beliefs of the time.

There is one such novel, called "The Age of Reason,"[1] to which I wish to direct the attention of scientific men; partly because it is very readable, but chiefly because the author seems to have a genius for absorbing information from many different types and for elaborating it in a popularly intelligible form, with only the exaggeration which is characteristic and inevitable in any dramatic representation. The author is Sir Philip Gibbs, of whom I have no personal knowledge, who made a great reputation as a war correspondent. He has been able to weld his study of the types into a tale, and without ostensibly acting as advocate or drawing any moral, has depicted with considerable skill the interactions of certain types, and the possible tragical outcome of the conflict. To enter into detail would probably be unsuited to these columns. Suffice it to say that among those types are a well-to-do West End parson with broad views, and an absurd wife; a biologist of assumed eminence fully satisfied with the materialistic outlook; two young women of different characters and training, each well meaning up to her own lights; and some young men who are earnest and well intentioned, though weak and rather at the mercy of their surroundings. There is also another clergyman, of the highest ideals, though with insufficient knowledge to be able to exert much influence, who nevertheless sacrifices himself

[1] "The Age of Reason": a Novel. By Sir Philip Gibbs. Pp. 288. (London: Hutchinson and Co., Ltd., n.d.) 7*s*. 6*d*. net.

heroically in the effort, but ultimately retreats to the safety of a religious order. All these and other incidental persons pursue their various ideals of life in the light of their knowledge and beliefs—such as they are—as so many in actual life are now doing. The working out of the theme by a man of genius can scarcely fail to be instructive, in spite of a few ugly episodes; and however much opinions may differ as to details, a serious attempt has evidently been made to grasp the situation and to depict the conflict now going on. No apology is needed, therefore, for bringing the book before the notice of the readers of NATURE.

OLIVER LODGE.

A Critical Period in the Development of the Plant World.

Palæontologia Sinica. Ser. A, vol. 2, fasc. 1: *Palæozoic Plants from Central Shansi.* By T. G. Halle. Pp. 317 + 64 plates. (Peking: Geological Survey of China, 1927.)

FROM a comparative study of floras of the past, the palæobotanist, especially if he is assisted by the enthusiasm of youth, expects to make some contribution towards a better understanding of the process of plant evolution. The fewer facts we possess, the easier it seems to fit them into a pre-arranged scheme; the larger the mass of material, the more difficult it becomes to interpret the conflicting testimony of many witnesses. Palæobotanical research has thrown much light on the relative antiquity of certain genera and families; but it may also be said that the longer one studies the records of the rocks the problem of evolution assumes a more baffling complexity. In order to visualise the march of plant-life over the unstable surface of the earth, it is necessary to work out, so far as possible, the distribution of plants both in space and in time. The recent publication of a volume by Prof. Halle of Stockholm on a collection of fossil plants from northern China affords an exceptionally good illustration of the bearing of palæobotanical research on problems of general biological interest. The memoir on the Palæozoic plants from Central Shansi, published as a volume of the "Palæontologia Sinica," is appropriately dedicated to the memory of Alfred Gabriel Nathorst, whose post at Stockholm—the Mecca of palæobotanists and one of the very few places where the science has been deemed worthy of the status of a separate department—is now very ably filled by the author.

Prof. Halle went to China in the autumn of 1916 to study, as palæontologists should, the plant-bearing strata in the field: after collecting material from many localities he was compelled, by a serious illness under very trying conditions, to abandon further work. An even more disastrous misfortune overtook him: the ship which was carrying the fossils to Sweden went down with all hands in a typhoon in September 1919. New collections of Palæozoic and Mesozoic plants made by Dr. Norin and by members of the Geological Survey of China were afterwards forwarded to Stockholm. The recently issued volume is devoted to the collections made by Dr. Norin in Central Shansi. The labour involved in their investigation must have been prodigious; there were 184 packing-cases, and, moreover, many of the plants were strange types. It is hoped to publish in a later volume an account of the material obtained by Mr. C. C. Wang in north-western Shansi. Prof. Halle has earned the gratitude of all students of extinct plants; and he may rest assured that all his fellow-workers rejoice that he has been entrusted with the exploration of one of the most promising fields of palæobotanical research—an undertaking demanding not only a wide knowledge of ancient floras, but also the ability to correlate taxonomic data with problems of primary importance to geologists and botanists.

The later Palæozoic vegetation of North America and Europe differed in many respects from the contemporary floras in the southern hemisphere and in India. In the latter part of the Carboniferous period and in the early stages of the Permian period, there were two fairly well-defined botanical provinces: a northern province reaching into the Arctic regions and extending as far south as the shores of the Tethys sea; a southern province represented by Gondwanaland. It has long been known that some members of the southern flora had wandered into the northern territory before the Triassic period was well advanced. The discovery of *Glossopteris* in Upper Permian beds in northern Russia in 1901, and later discoveries of Gondwanaland plants in Siberia, raised the question of possible routes of migration across the world-encircling Tethys sea. The inter-relation of the two provinces in the Permo-Carboniferous period is still vaguely defined, and the comparative lack of information on the late Palæozoic floras of China has been a serious gap in our knowledge.

The plant-bearing strata with which the memoir under consideration is concerned are classified by Dr. Norin as follows: At the base is the Yuehmenkou series consisting of sedimentary beds and seams of coal. The lower members of the series were assigned on the evidence of the fauna to

the uppermost part of the Lower Carboniferous system, and the upper portion was believed to be Permo-Carboniferous. Prof. Halle, *on the evidence* of the plants, regards the whole as Permo-Carboniferous in age. Then follows the Shihhotse series, a succession of delta deposits rich in plants: Dr. Norin assigns the series to the Permian period, and with this opinion Halle is in general agreement. Resting on the Shihhotse series is the Shihchienfeng series, a set of beds, without plant remains, but with layers of gypsum, deposited under more or less arid conditions.

After the formation of the Yuehmenkou and Shihhotse strata the physical environment changed; a well-drained region was converted into the marginal zone of a desert country. This change recalls a precisely similar shifting of the scenes in the northern hemisphere at the close of the Carboniferous period, when the humid forest belt across America and Europe was transformed into a semi-arid land inhabited by some of the hardier plants which remained as meagre representatives of the luxuriant vegetation of the Coal age. A comparison of the Permo-Carboniferous and early Triassic floras of the northern continents reveals a marked contrast in the nature and luxuriance of the vegetation. The floras which flourished during the closing stages of the Palæozoic era may be said to represent the last phase of a plant dynasty, which had gradually developed in vigour and in variety during the Devonian and Carboniferous periods and continued as a moribund vegetation into the Permian period.

The desert conditions which prevailed over a large continental area at the beginning of the Triassic period are reflected in the meagre vegetation which, in the later part of the period, was succeeded by a widely distributed and much richer flora. There are comparatively few clearly established connecting links between Triassic and Permo-Carboniferous floras: some types persisted, but the Triassic floras differ in many striking respects from those which preceded them; genera which may be described as modern suddenly become abundant and take the place of the familiar types of the Palæozoic era. We know very little about the world's vegetation at the period inaugurated by the Hercynian revolution, one of the revolutions which set a limit to the spread of the forests of the Coal age. In view of this apparent break in the orderly sequence of floras, it is of the greatest importance to seize opportunities of following the course of development of the plant world in an area such as that of northern China, where there is a conformable succession of fossiliferous strata at the upper limit of the Palæozoic system.

Another interesting question on which light may be expected from a fuller knowledge of the Far Eastern floras is the relation of them to contemporary floras in the northern and southern botanical provinces. Prof. Halle found that out of the 103 species described by him from northern Shansi, 70 are new and known only from China: the facies of the vegetation is similar to that of the northern Permo-Carboniferous province, and in the absence of *Glossopteris* and other genera it differs fundamentally from that of the Gondwanaland flora. The conclusions based on palæobotanical evidence may be briefly stated: many of the plants from the lower Yuehmenkou series are specifically identical with Stephanian (uppermost Carboniferous) forms from Europe, and may be regarded as Permo-Carboniferous in age. The upper portion of the series, which corresponds in age with the period of maximum coal production in northern China, is relatively poor in plants; the few species so far discovered range from Westphalian to Lower Permian. It would seem, therefore, that there is no palæobotanical reason for drawing a distinction in age between the lower and upper part of the Yuehmenkou series. Of the 58 species described from the lower Shihhotse series, only 15 occur in other countries, and these are Stephanian or Lower Permian types. Some suggest a Carboniferous age, while others agree more closely with Permian species. The boundary between late Carboniferous and early Permian forms is nowhere sharply marked.

Among the new species recorded from the Shihhotse series is *Gigantopteris Whitei*, one of several representatives of this remarkable fern, or possibly pteridosperm, which had previously been found in Lower Permian beds in Texas and in eastern Asia. Prof. Halle has added considerably to our knowledge of this genus, which had fronds reaching a breadth of 30 cm.: some of his species afford striking examples of the close correspondence between the flora of northern China and that of North America.

In some features the lower Shihhotse flora differs from European Stephanian floras: the widely distributed European genera *Callipteris* and *Walchia* are absent, and, on the other hand, the Shansi flora includes certain forms such as a species of *Cladophlebis*, some species of *Tæniopteris*, and a cycad, *Dioonites densinervis*, which clearly foreshadow Mesozoic types. There is a mixture of the ancient and more modern plant dynasties. Halle

regards the basal beds of the Shihhotse series as representing the beginning of the Permian period, though, as he points out, with undoubted Permian species are associated examples of genera which played a prominent part in Mesozoic floras. Of the upper Shihhotse series Halle says: "The most obvious evidence for a Permian age is to be found in the appearance of several forms of Mesozoic aspect, which seem to indicate the approach of the close of the Palæozoic era." The point is that the Shansi flora, probably a late Permian flora, exhibits rather a closer contact with the early Mesozoic floras than we find in contemporary floras in Europe and North America. In spite of this, Halle is disposed to think that the whole of the Shihhotse series may fall within the Lower Permian; he does not believe that even the uppermost beds "reach to anywhere near the Permian-Trias boundary."

The age of the Shihchienfang series is of special interest: the strata are conformable to those of the underlying Shihhotse series and indicate arid conditions. If the upper Shihhotse series, as Norin supposed, is Upper Permian, the overlying Shihchienfang series would be Triassic in age and equivalent to the Bunter sandstone of Europe. If, as Halle thinks probable, the upper Shihhotse beds are Lower Permian, the Shihchienfang should be correlated with gypsum-bearing Upper Permian of Europe: this correlation would afford an interesting parallel with the change from a humid to an arid climate at the close of the Carboniferous period in Europe and America.

Attention is directed without further comment to an important and valuable section in which the Chinese floras are compared with those of other parts of China and of Korea. Prof. Halle discusses at length the geographical range of the Shansi flora, which bears an intimate relationship with the northern or Arcto-Carboniferous floras of central and western Europe and North America. It is unfortunate that the rich material from American coalfields has not been more thoroughly investigated: making allowance for our relatively greater knowledge of European floras, the conclusion is that in the Shansi flora there are slightly more European than American species. On the other hand, "closely comparable but not identical species are found to a greater number in North America," and it cannot be said "that the relation to Europe is perceptibly closer than to North America."

Prof. Halle also discusses the relation of the Shansi flora to the contemporaneous floras of Angaraland. The Kusnezk flora of southern Siberia and north-western Mongolia extends as far north as lat. 71°-72° N., and it has been traced as far east as Vladivostok: its age is probably late Permian. Only one species is common to the Shansi and Kusnezk floras; the two are "almost entirely different." This is a surprising fact in view of the close relationship, both geographical and geological, between them. "There seems to remain a strong probability that China and the Siberian Angaraland belonged to regions markedly different in regard to vegetation and possibly climate at the close of the Palæozoic." It is suggested that the land of the Kusnezk flora may have been separated from that of the Shansi flora by a sea; in other words, there may have been two distinct phytogeographical regions in Asia outside the area of the *Glossopteris* or true Gondwanaland flora.

Whatever the explanation may be, it is clear that the facts recorded by Halle point to a greater range in variety of the northern floras than had previously been suspected. The discovery in Sumatra a few years ago of several species of plants that are widely distributed over the Arcto-Carboniferous province showed that the northern vegetation had penetrated far within Gondwanaland and had occupied territory which had always been considered the monopoly of the *Glossopteris* flora.

There is a close similarity between the Sumatran and the Shansi floras. It has long been known that certain members of the *Glossopteris* flora had reached Angaraland before the end of the Permian period, but it is only recently that evidence has been obtained of an equally great migration in the contrary direction. A controlling factor in the dispersal of plants has always been the nature of the geographical environment: as Halle says, "looking at the distribution of the late Palæozoic floras very broadly, it would seem that whereas the *Glossopteris* flora and, to some extent, the Angara flora with Gondwana elements are typically floras of the undisturbed continental areas, the Arcto-Carboniferous floras often have their greatest areas of uniform extension along the geosynclines."

The main purpose of this article is to direct attention to some of the many questions of general interest discussed by Prof. Halle. It must, however, be added that the greater part of the volume is occupied by admirable descriptions of the members of the Shansi flora, and there are many important floristic contributions. The author has produced a monumental work: the text is written in a clear and pleasant style which compares very favourably with that of many authors whose

mother-tongue is English; the illustrations are exceptionally good. It is a pleasure to be able whole-heartedly to congratulate both Prof. Halle and the editors of the "Palæontologia Sinica" on the service which they have rendered to palæobotany.

A. C. SEWARD.

A Papuan Monograph.

The Kiwai Papuans of British New Guinea: a Nature-Born Instance of Rousseau's Ideal Community. By Prof. Gunnar Landtman. Pp. xxxix + 485 + 64 plates. (London: Macmillan and Co., 1927.) 30*s.* net.

THIS important volume constitutes a worthy successor to Dr. Landtman's previous publication on the folk-lore of the Kiwai Papuans, probably the most complete account in existence of the folk-lore of any primitive people. To collect the data for two such works is no mean test of physical and mental fortitude, as the writer of this notice knows from personal experience, having spent a few weeks in the Fly Estuary during the wet season some twenty years ago, when his visit was brought to an end by fever, which a medical colleague considered sufficiently serious to warrant his removal to Thursday Island in a pearling lugger. But he stayed long enough before being overcome to realise that the dominant qualities of the place were mud and mosquitoes. Dr. Landtman then showed decided pluck in enduring two years (1910–1912), including two rainy seasons, and he fully deserves the repute which these volumes should bring him on both sides of the Atlantic. How he came to Kiwai is explained by Dr. Haddon, who contributes a model ten-page introduction (*O si sic omnes*):

"Many years ago my friend, Dr. Gunnar Landtman, came to see me at Cambridge, and as soon as we had greeted one another he said, 'I will go anywhere in the world you like to send me.' . . . It did not take much consideration on my part to make a suggestion. . . . I was fully aware of the fragmentary nature of many of the results we had obtained [during the Cambridge Anthropological Expedition to Torres Straits], and it was evident that a detailed study of the adjacent regions of New Guinea was necessary before the affinities of the culture of the Torres Straits islanders could be satisfactorily discussed. . . . I explained the position to Dr. Landtman, and he decided to make that area his field of research."

The successful weathering of the difficulties of the estuary did not, however, mean the end of the author's troubles. On his way back to Helsingfors his steamer sank, and irreparable disaster was only averted by a diver's skill in recovering the trunk containing the field notes, the exact position of which in the hold Dr. Landtman was able to indicate.

The Kiwai are a heavily built, muscular group of Western Papuans, whose origin is obscure, and whose culture seems in part to be derived from some distance to the west, that is, from those tribes which in New Guinea are generally called Tugeri. In physique they certainly differ from the slighter men of Strachan Island and of the lower reaches of the Bensbach River, their western neighbours in British territory.

Besides investigating the Kiwai, Dr. Landtman examined so far as possible the habits and beliefs of the Mawatta on the mainland to the west, and of the Masingle, the bush people hitherto known in anthropological literature as Masingara. All these people are totemistic; in Kiwai each person has but one totem, the great majority being plants; at Mawatta everyone has one chief totem and many subsidiary totems, and here rather more than half are animals, as are all the Masingle totems, with one possible exception. This way of stating the facts is perhaps over simple, especially as regards Mawatta—where "each person has . . . in most cases an almost indefinite number of subsidiary totems"—for a classification shows that, as at Mabuiag in Torres Straits, where the totems are divided into two groups, one all land and the other all water animals, so here the two great groups are associated with land and sea respectively, even the winds concerned being those blowing from the land related to the land animals and plants, and those from the sea with water animals and plants. It may, in fact, be suggested that to speak of an almost indefinite number of subsidiary totems is an expression in white man's language of a basic division of living things into two great categories belonging to the land and water respectively, to one or other of which every man with the exception of "a small anomalous group" must himself belong as part of what a European would call "the scheme of Nature." Such arrangements, if the term be permitted, whereby the clans of a group share the world among them, are by no means uncommon, as, for example, among the Euahlayi of New South Wales, also described as having many subsidiary totems.

No clan is considered superior to another; indeed the Kiwai are purposeful egalitarians—"no want one man he go ahead, one man he come behind, better all man he go together"—and public affairs are settled by a council of old men, who seem to agree without difficulty. Their religious ideas

reflect this sociological attitude, for they have no generally accepted systematised beliefs concerning the gods or the other world. No public cult exists, and no prayers are made in communal fashion by a larger or smaller group of the population; nor is there a systematised cult of the dead, although it is recognised that something survives when the body rots. On the other hand, beings that are neither ghosts, nor in the ordinary sense of the word animals, abound, and almost everyone practises petty magic; the oldest men of each group, being considered to have most knowledge, are those who conduct the greater ceremonies and more systematised rites. In spite of this lack of religious ideas the Kiwai have a series of great pantomimic ceremonies; the *horiomu*, connected with the dead, during part of which such wonderfully decorated turtle-shell masks as those brought back by Dr. Haddon in 1889, and now in the British Museum, are worn; the *mimia*, in part a fire ceremony, whereby illness is kept away and the youths hardened; the *ga'era*, the occasion for the collection of a vast quantity of food from the gardens, with very much the same rivalry that occurs in the preparation of the *tabu* feast of the Melanesian-speaking peoples of the Central Division of the Territory; the *nigori*, which has for its purpose the killing of many turtle; and, most important of all, the *moguru* or life-giving ceremony.

This last is the most secret and fear-inspiring rite of the Kiwai people. Dr. Landtman had great difficulty in obtaining definite knowledge, and it was only by allowing his informants to come secretly, late at night, and whisper their information, that he was able gradually to piece together its outstanding features. The ceremony takes place inside the men's long-house, and persists with intervals for sometimes so long as two months. It is difficult to follow the whole series of ideas attached to the *moguru*, but clearly one of its two chief functions is to provide the ' medicine ' which has the power to restore the languishing sago palms to full vigour. To produce this the Kiwai on this occasion (and on this occasion only) surrender themselves and their wives to promiscuous intercourse—only the closest blood relations avoiding each other—the chief ingredient in the ' medicine ' being the sexual secretions, which, mixed with red paint, is smeared by every man on the trunk of a sago palm in his garden, the tree being requested to grow big and produce much food. Bananas and coconuts might also be anointed, as well as the people themselves, a small quantity taken with food being regarded as prophylactic against most physical ills. Connected with this part of the ceremony is the sexual instruction of the adolescents of both sexes.

The second principal event of the *moguru* is the *goro*, the ceremony of the captured wild boar, and this is more difficult to summarise. A wild boar is hunted, brought to bay, and instead of being killed is stunned and muzzled, its legs being tied together. It is painted, and ornamented with plumes of the cassowary and birds of Paradise, and laid on a litter with the legs bent beneath the body, with a bundle of arrows placed on each side. Covered with leaves so that no one shall see it, the litter is carried into the *darimo* (man-house) and deposited on a platform erected in front of the great central post, the head of the boar facing the eastern gable entrance. Beside the boar are placed bundles of arrows, clubs, beheading knives, and head-carriers. At this stage the boar is killed and its blood sprinkled on the human figures carved on the post and on the weapons surrounding it. One of the ' big fighting men ' lies prostrate on top of the pig, his head pointing in the same direction; the ' new men,' that is, the initiates, now crawl on to the platform, passing astride over the prostrate man and the pig, each of them accompanied by his guardian, generally his maternal uncle, who when the boy's head is above that of the boar, puts ' medicine ' into his mouth. In this part of the ceremony there seems to be room for considerable variation, but there is no doubt that the great object of the episode is preparation for war—it makes the men hot for blood so that they think about nothing but fighting—yet the pig also yields ' medicine ' for the garden and for other purposes; its feet, after being dried and reddened, are buried in the sago plantation; the bones, stuck into the walls of the men's house, give protection from sickness, and so on. Naturally, women are rigorously excluded from this ceremony; but there is a notable exception—one very old woman is attached to every man-house, and with the old man who is the ' father ' assists in all the rites.

It has only been possible to mention, and that briefly, some of the most striking facts recorded in this volume, but since this is the first adequate monograph on a Papuan people to be published, the reviewer may conclude by indicating a theoretical deduction of considerable interest, though only further investigation can show how far it is valid. The work of Prof. Malinowski on the Trobriand Islanders shows that to these Papuo-Melanesians the most essential part of a magical

process is the spell. As indicated by Dr. Landtman, magic plays a most important part in the life of the Kiwai, but there is nothing in his record to suggest that the spell is specially important; the power of the magic seems to depend preponderantly on the actual ingredients of the 'medicine,' which are often chosen on frank *similia similibus* principles. The question then arises whether this difference is merely, as it were, accidental between two peoples inhabiting areas tolerably far apart, or whether it may be taken as the expression of a psychic and ultimately ethnic difference between true (Western) Papuans and (Papuo-) Melanesians.

Our Bookshelf.

(1) *Stellarastronomie.* Von H. Kobold. (Sonderausgabe aus der Encyklopädie der mathematischen Wissenschaften.) Pp. iii + 239-372. (Leipzig und Berlin: B. G. Teubner, 1926.) 5·80 gold marks.
(2) *An Outline of Stellar Astronomy.* By Peter Doig. Pp. viii + 183. (London: The Draughtsman Publishing Co., Ltd., 1927.) 7*s.* 6*d.* net.

THESE two books with somewhat similar titles are to a marked degree supplementary one to the other. Prof. Kobold's volume is an extract, 134 pages in length, from the "Encyclopädie der mathematischen Wissenschaften." It was written in 1924 and has a few references introduced up to 1926. It is very complete in its historical work, giving, for example, an excellent account of all the important star catalogues and the early work on stellar motions and on the structure of the universe. It also gives good accounts of the more recent investigations up to 1924, but to a large extent it is affected by the common fault or quality of encyclopædias, it gives both sides of a discussion and rarely offers a decisive view on controversial points.

Mr. Doig's book is, on the other hand, an attempt to give an account of the present outlook on the constitution, dimensions, motions, and distribution in space of the stars and nebulæ. Even in the short bibliography appended to each of his chapters he rarely goes back so much as ten years. His book is much more popular in style and he is rightly more dogmatic in his general statements about the nature of the stars and the structure of the universe. Both books will serve as useful sources of reference to the present-day student of astronomy—Kobold for the past and Doig for the present.

Reading the two volumes together, one is struck at the rapid change of outlook in recent years in stellar astronomy—apart from astrophysics proper, which is changing so largely from year to year with the development of theoretical spectroscopy and atomic physics. Kobold's book, with its merely occasional references to the contribution of astrophysics to the problems of the structure of the universe, reflects a period of isolation between the two halves of astronomy, an isolation which has now vanished. With Doig the interest lies on the other side—the physical rather than the statistical—though he, too, has considerable interest in the statistical application of many physical observations. His own work along these lines, much of it published in the *Journal of the British Astronomical Association*, reappears quite properly in this book, set in the framework of the recent work of Eddington, Jeans, Russell, Seares, Shapley, and others, of which he gives an interesting account in his book.

Maps, their History, Characteristics and Uses: a Handbook for Teachers. By Sir Herbert George Fordham. Second edition. Pp. xii + 83 + 8 plates. (Cambridge: At the University Press, 1927.) 6*s.* net.

ALL who are interested in cartography and its history will welcome the issue of a second edition of Sir George Fordham's little book, which forms such an admirable introduction to the subject. It begins with a few pages on the elementary notions which lie behind the making and using of maps, and then we have an interesting page or two on terminology. How many people who commonly make use of atlases know who first used the term 'atlas,' and what a curious, far-fetched term it is? And how many remember that the word ousted its rivals 'theatrum' and 'speculum'?

After a concise and clear account of the history of map production, the author devotes a section of his book to art in cartography. This is a matter which deserves more study by cartographers than it sometimes receives. The use of colour in modern maps has led, in some instances, to a kind of carelessness in design; as if it were possible to smash one colour down upon another, and trust that all would come right in the final printing. It is sometimes forgotten that the use of five or six colours imposes upon the cartographer not less, but more, care in the design of the map than when dealing with a map in black and white.

The remarks on the graphic expression of the surface forms appear, on the whole, to be sound; it might have been mentioned that the Dutch surveyor who in 1729 first drew contours—in connexion with sea-bed soundings—was called Cruquius, and that Hutton used them in Great Britain in 1777, and that they were in use in military sketches in England probably so early as 1793. The author refers favourably to the Army "Manual of Map Reading and Field Sketching," edition 1914; but it is doubtful if the student could now obtain a copy. The latest manual of the kind was published in 1921, and is larger, more difficult, and more 'professorial' than its predecessor. In conclusion, we can heartily recommend this little book to all who use maps, especially to teachers of geography.

Romani Versions. By Sir Donald Macalister. (Gypsy Lore Society Monographs, No. 5.) Pp. 67. (London: Bernard Quaritch, Ltd., 1928.) n.p.

SIR DONALD MACALISTER, like other noted scholars, has given some of his leisure hours to the making of translations from English poetry. But whereas

these have often been made in the long-cultivated tongues of Greece or Rome, the Principal of the University of Glasgow has chosen a less known medium, that strange Indian dialect which was brought to British shores some five or six centuries ago by wandering Gypsy tribes.

These versions are ingenious; often, so far as the non-Gypsy can judge, they attain beauty; certainly they testify to their author's knowledge of Romani. The poems are aptly chosen: "The Raggle-Taggle Gypsies," "The Princess and the Gypsies," "The Gypsy King," Scott's "The Lochmaben Harper," Kipling's "A Smuggler's Song," are suitable in their substance and spirit, and do not strain too much the limited, but genuine, Gypsy vocabulary. It is perhaps different with the polished artifice of 22 quatrains from FitzGerald's Omar, to which are added 22 translated with equal skill by Dr. J. Sampson.

Translation is not so difficult, perhaps, as it might at first sight seem. For while Romani has preserved something of the vocabulary and grammatical forms of its Indian original, its syntax is largely modelled on the language of its hosts. Also, as Dr. Sampson remarks in his introduction, even the real Gypsy songs collected in Greece by Paspati are imitations, both in metre and material, of popular Greek poetry.

Beyond the page or two of this introduction, the collection cannot, of course, claim to be of any scientific interest to the linguist or the student of folk-lore. But that was not the author's purpose. He made these versions to amuse himself; and without doubt they will bring as much pleasure and amusement to that band of Romani Rais whose delight in all things Gypsy is perhaps as intelligible as it is real.

"All I ask, the heaven above
And the road below me."

"Mangi muk o tem oprál
Ta o drom te java."

R. L. T.

Organic Chemistry for Advanced Students. By Prof. Julius B. Cohen. Fifth edition. Part 1: *Reactions.* Pp. vii + 427. Part 2: *Structure.* Pp. vii + 487. Part 3: *Synthesis.* Pp. vii + 440. (London: Edward Arnold and Co., 1928.) 18*s.* net each vol.

The fifth edition of this familiar work contains a good deal of new matter, but as the result of a judicious condensation of some of the less important sections, the complete work contains only 58 pages more than the fourth edition, which was published in 1923. No alterations have been made in the titles of the chapters. In Part 1, a revision of Chapters ii. and iii., on the nature of organic reactions and their dynamics, has afforded an opportunity of dealing with recent studies based on the electronic theory of chemical combination. In Part 2, a brief reference to the parachor theory has been incorporated in Chapter i., while Chapter v. has been amplified by the insertion of a short account of recent work on optically active derivatives of sulphur, boron, beryllium, zinc, and copper, and on the stereochemistry of metalammines. In Part 3, the account of the carbohydrates has been remodelled in accordance with new experimental data; we are glad to note, in passing, that the author has abandoned the term "monosaccharose" in favour of "monosaccharide." Part 3 includes, in addition, short accounts of recent advances in the chemistry of anthocyanins, terpenes, and sesquiterpenes; syntheses of glutathione, spermine, and thyroxine are other new features of this volume.

Altogether, the value of Prof. Cohen's book has been appreciably enhanced by the revision. It is well printed, the new sections having been reset in a particularly clear type. We suggest that the spacing of the formulæ in the synthesis of thyroxine (p. 178), and the unprefaced representation of glutathione at the stage of hydrogen acceptor (pp. 160 and 170), may prove somewhat confusing to the student at the first reading.

The Date of Easter and other Christian Festivals. By the Rev. David Ross Fotheringham. Pp. xv + 56. (London: Society for Promoting Christian Knowledge; New York and Toronto: The Macmillan Co., 1928.) Cloth, 2*s.* 6*d.* net; paper, 1*s.* 6*d.* net.

This book is largely taken up with a study of the evidence for the dates of the Nativity and Crucifixion. Much of this evidence is familiar to all, but some new points are introduced, including recent work on the moon's motion and the ancient calendar by the author's brother, Dr. J. K. Fotheringham, and by Mr. C. Schoch. The suggestion is made that the star of Bethlehem may be the planet Mars, rising heliacally. The author decides on December, 4 B.C. for the Nativity, and April 7, A.D. 30, for the Crucifixion. He then goes on to recommend the rule for determining Easter, that it should be April 9 if Sunday, or the first Sunday after this. This suggested rule is supported in the preface, which is written by Lord Desborough.

A. C. D. C.

The Annual Register: a Review of Public Events at Home and Abroad for the Year 1927. Edited by Dr. M. Epstein. Pp. xiv + 318 + 168. (London: Longmans, Green and Co., Ltd., 1928.) 30*s.* net.

This valuable record of the year, with its impartial survey of the world's history, is again planned on the lines which have long been familiar. Half of Part I., which is a narrative under the headings of various States, is devoted to the history of Great Britain and half to other countries, including all in which events of importance occurred. Part II., in addition to a chronological list of events and an obituary with short biographies, has the usual survey of literature, science, art, finance, and law. Science receives fourteen pages, of which more than half is devoted to biology in its various aspects, and the remainder to the physical sciences. The public documents printed in full are the treaties with Iraq and the Hejaz, and the Italian Labour Charter.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Nature of Clay, and its Significance in the Weathering Cycle.

THE characteristic constituent of the natural substance, clay, has been the subject of numerous investigations both by chemists and by pedologists. It is generally believed to be colloidal, and the residual product of the hydrolytic decomposition of mineral silicates. Whilst attempts have been made to study this complex by methods of acid extraction, the most promising line of advance has been the study of the finest fraction obtained in mechanical analysis—the so-called colloidal clay. Although this fraction, as isolated by some workers, may contain small proportions of unweathered material, we shall probably not err greatly in equating it with the weathering complex, particularly if a critical settling velocity of less than 10^{-4} cm./sec. has been used in its separation by means of sedimentation.

Considerations of space in the present communication preclude a full reference to recent work, but I would direct particular attention to an important investigation by W. O. Robinson and R. S. Holmes (*U.S. Dept. Agr. Bull.*, 1311, 1924). In this work, the authors report the composition of the colloidal clay from a number of North American soils. Perhaps their most important conclusion is that iron compounds, other than hydrated ferric oxide, are present as an essential part of the clay. Much of the confusion in the study of clay has arisen from regarding the clay complex as essentially an aluminium silicate or alumino-silicic acid, with hydrated ferric oxide present as an adventitious constituent. Robinson and Holmes examine the possibility that the clay complex is a mixture of an aluminium silicate of the kaolinite type ($Al_2O_3 . 2SiO_2 . 2H_2O$) and a ferric silicate of the nontronite type ($Fe_2O_3 . 2SiO_2 . 2H_2O$). Actually, only a minority of their clays fit this hypothesis. On one hand there are clays with excess of silica, and, on the other hand, clays with excess of sesquioxides—the latter clays being generally of a reddish or brownish colour.

The hypothesis examined by Robinson and Holmes could, however, only be verified by the examination of clays obtained from material which had originated directly from crystalline rocks and had, further, not been subjected to those leaching processes which cause a differentiation of the silica–sesquioxide complex. These changes result, in humid temperate climates, in the impoverishment of the surface in sesquioxides and the enrichment of a subsurface layer in these constituents. In extreme cases, in the so-called podsols, acid leaching gives rise to a bleached *A* horizon and a reddish brown, sometimes indurated, *B* horizon, which is relatively rich in sesquioxides. It is somewhat difficult to obtain material in which the silica–sesquioxide complex has not undergone some alteration, but I obtained, through the courtesy of Dr. Edward Greenly, three samples of clay from Anglesey which had originated from Mona Complex schists at a depth far below that at which the ordinary leaching processes operate. The clay fraction from a white clay gave a molecular ratio of silica to sesquioxides of 2·16; for a yellow clay the ratio was 2·09; and for a red clay 1·96. These figures are in fair agreement with the 2·0 ratio demanded by the kaolinite–nontronite hypothesis.

I have also examined a number of North Wales soils, derived from crystalline or consolidated rocks, in which it can be assumed that the clay is of primary origin. The average silica–sesquioxide ratio for the clay fraction of 17 such soils was 1·90, the individual ratios ranging from 1·51 to 2·22. Bearing in mind the tendency, under the conditions of North Wales, for sesquioxides to be leached down to lower levels, and also remembering that superficial erosion attacks the more siliceous *A* horizon, the fact that the ratio is less than 2·0 is in harmony with the hypothesis that the primary weathering product is a mixture of silicates of the kaolinite and nontronite type.

The figures of Robinson and Holmes and of other workers were then inspected in the light of what information was available as to their mode of origin, and it was evident that soils derived from crystalline rocks in humid temperate climates tend to give a weathering complex with a silica–sesquioxide ratio rather less than 2·0. It may be suggested that samples of such soils, collected without reference to considerations of profile, would probably be enriched in sesquioxides at the expense of eroded superficial horizons. I hope to elaborate this point in its significance for the regional study of soils in a further communication.

An investigation was also made of the clay fractions from a number of soils in which the parent material was alluvium or unconsolidated sediments. In these cases, the silica–sesquioxide ratio was always greater than 2·0, the average being actually 2·67 for 15 samples, with the individual ratios varying from 2·12 to 3·37. The published figures of other workers for the clay fractions from alluvial and unconsolidated deposits agree with these results. The more siliceous character of the clay fractions of such soils is not difficult to explain. One of the principal features of the hydrolytic decomposition of minerals is desilicification, and this is reflected in the appreciable content of silicic acid in river waters. Sea water, on the other hand, contains only traces of silicic acid. F. W. Clarke, in "Data of Geochemistry" (*U.S. Geol. Survey Bull.*, 770), places silica among the most important oceanic chemical sediments. The silica–sesquioxide ratio in the estimated contribution of rivers is of the order of 8·0. It is reasonable to suggest that the silicic acid present in river water undergoes precipitation together with estuarine and other littoral deposits, the clay complex of which is thereby enriched in silica relative to sesquioxides. Where these deposits again become exposed to atmospheric influences without intervening heat metamorphism, we obtain soils the clay fractions of which have a silica–sesquioxide greater than 2·0.

Summarising these results, I venture to put forward the view that the primary residual product of the chemical weathering of silicates is a mixture of kaolinite and nontronite, or of hydrated silicates having the same silica–sesquioxide ratio, namely, 2·0. Variations from this ratio may occur as a result of the differentiation consequent on soil profile development, leading in humid temperate climates to the production of a more siliceous *A* horizon and a less siliceous *B* horizon, and in humid tropical climates to the formation of laterite. Enrichment of the clay complex in silica takes place in estuarine and other littoral sediments owing to the concomitant precipitation of the silicic acid present in river waters.

The significance of the composition of the clay fraction has been recognised by many workers, notably by A. F. Joseph and his collaborators, who

have shown that clay properties are most strongly developed in the most siliceous clays. Hall and Russell, many years ago, attempted to correlate soil fertility with the composition of the clay fraction. It is evident, therefore, that students of the soil are likely to obtain results of the highest importance, both for the natural study of the soil and for the elucidation of problems of soil fertility, by giving attention to the composition of the clay fraction, particularly in its vertical variation in the soil profile.

G. W. ROBINSON.
University College of North Wales,
Bangor, May 21.

Insects and Potato Virus Diseases.

IT has long been a matter for conjecture as to what insect or insects are responsible in Great Britain for the dissemination of the 'virus' diseases affecting the potato plant. Experiments carried out by myself over a period of years show beyond doubt that, out of the normal insect potato fauna, one particular insect is a most efficient vehicle for the transmission of the serious disease known as 'leaf-roll.'

The insect in question is a small aphis, *Myzus persicæ* Sulz., and it attacks both the plant in the field and the sprouts of the tuber in the store. Under certain conditions I have been able to infect with fair regularity between ninety and one hundred per cent of the experimental plants with leaf-roll by means of this aphis. Further, I have proved, under glass-house conditions, that healthy potatoes, on the sprouts of which *Myzus persicæ* carrying the virus of leaf-roll has been feeding, will produce plants so badly 'rolled' within two months of the date of the first infection, as to give little or no crop. In the glass-house a number of known healthy potato tubers, with sprouts thus infected at the beginning of March, produced plants in an advanced stage of leaf-roll by the end of April.

It will thus be understood how it is possible for 'seed' potatoes, stored in a healthy condition, to give rise to a negligible crop in the ensuing season. Attempts to induce nine other species of insects which normally inhabit the potato plant to transmit the virus of leaf-roll under varying conditions have so far proved abortive. It is, however, unwise to deduce from these negative results that such insects are unable to transmit leaf-roll under any conditions. Suffice it to say that as yet they have not done so under conditions which gave positive results with *Myzus persicæ*.

As regards the disease known as 'mosaic,' the transmitting power of *Myzus persicæ* appears to be much less, and the percentage of experimental infections has been small. However, in experimenting with the virus of potato mosaic on another Solanaceous host, some curious facts relating to the behaviour of this virus have come to light. By infecting tobacco plants with the virus obtained from mosaic-affected 'Arran Victory' foliage by means of leaf mutilation inoculation, a very characteristic disease known as 'ringspot' is produced in the tobacco. The chief symptom of this is the formation of clearly defined whitish concentric rings, each having a central spot (Fig. 1).

On transferring this virus by needle inoculation back to healthy potatoes, a mosaic-like disease is produced in which the symptoms of the original mosaic are intensified and its infective nature very greatly increased. Its symptoms consist of a very characteristic and strongly marked mottling of the leaves, which later may become crinkled at the edges, accompanied by large numbers of small necrotic spots. It is, in fact, very similar to the potato virus disease known as 'crinkle,' with the exception that true crinkle is very much less infectious, so far as my experience goes. This altered virus can be passed by needle inoculation from potato to potato and from tobacco to tobacco or from one to the other with the utmost regularity, the symptoms developing in the former in eight to eleven days according to the temperature, and after a somewhat longer period in the latter.

It is now possible to induce the aphis *Myzus persicæ* to disseminate this virus to potatoes where

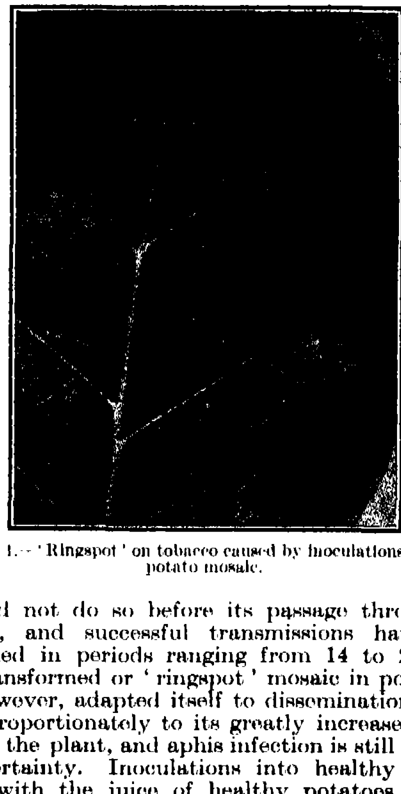

FIG. 1.—'Ringspot' on tobacco caused by inoculations with potato mosaic.

it would not do so before its passage through the tobacco, and successful transmissions have been performed in periods ranging from 14 to 24 days. This transformed or 'ringspot' mosaic in potato has not, however, adapted itself to dissemination by the aphis proportionately to its greatly increased infectivity to the plant, and aphis infection is still a matter of uncertainty. Inoculations into healthy tobacco plants with the juice of healthy potatoes or with viruses other than mosaic, have up to the present failed to produce ringspot, but when mosaic has been a component part of a virus complex ringspot has developed.

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The Excitation of the *D* Lines by the Green Sodium Band.

IN a recent paper (*Phys. Rev.*, May 1928) Prof. Wood and the present writer have discussed the conditions under which it is possible to excite the *D* line fluorescence in sodium vapour by light which is free from wave-lengths absorbed by the atom. A band in the green at 5200 A., 50 A. in width, was found to produce a maximum *D* line fluorescence when a foreign gas at a few millimetres pressure was mixed with the fluorescing vapour. The presence of a foreign gas seemed essential for the production of the *D* lines in this way, and the most obvious explanation seemed to be that the excited molecule collided with a foreign gas molecule and dissociated into one normal and one excited atom. But the dissociation potential as calculated by Pringsheim (*Zeit. f. Phys.*, **44**, 651; 1927) and Loomis (*Phys. Rev.*, **31**, 323; 1928) from

the analysis of the band spectra is much too high for this process to occur, as has been pointed out, and the alternative explanation was offered that the *D* lines were emitted when an atom was raised to the $2P$ levels on collision with an excited molecule. The molecule would then be left with but 0·3 volt energy, which would be distributed as part vibrational and part kinetic. The presence of a foreign gas would prevent rapid diffusion of the vapour to the cooler parts of the resonance tube, and allow the atomic and molecular densities to increase, thus increasing the probability of collision.

If this is the process occurring, it should be possible, then, to excite the atomic lines by the green molecular band in pure vapour of the proper vapour density. I have recently repeated these experiments, using an electrically heated resonance tube equipped with a thermocouple in order to obtain accurate temperature control, and have found that the green band does excite the *D* lines in pure vapour, but only in a narrow temperature range. The atomic lines appeared somewhat below 400°, rose to a sharp maximum at 410°, and disappeared again above 450°. The existence of a maximum intensity at 410° was very marked and could be determined within 5° or 10° very easily. Now, in the previous experiments no adequate temperature control was purposely employed, but it was found in the present work that the introduction of gas at a few millimetres pressure caused temperature changes of 10°-20°, the temperature rising on the introduction of the gas. Experiments showed this to be due entirely to the fact that the gas reduced the diffusion of the vapour to the cooler parts of the tube. The rapidly diffusing vapour, in the absence of gas, keeps the heated section at a lower temperature than it would attain if the diffusion were absent. Although the *D* lines were obtained in this way in the presence of gas, they were much less intense and appeared as before, only in a narrow temperature range.

An attempt was made to explain the phenomenon quantitatively. The intensity of the atomic lines formed in this way will be proportional to the number of collisions of excited molecules and atoms occurring per second, provided every excited atom so formed radiates. This, however, will not be the case, for a certain proportion of them is removed by collisions. Actually, the *D* line intensity will be measured by the number of excited atoms lost by radiation per second, and it is seen that collisions are operative both in increasing the number formed per second and in decreasing the number radiating per second, so that a balance between these factors may produce a maximum intensity at a definite temperature. Calculation showed, however, that for the *D* lines to be produced in this way, it is necessary to assume that the excited and normal molecules have diameters of the order of magnitude of 100×10^{-8}, or else to assume that the lifetime of excited molecules and atoms is 100 to 1000 times the accepted order of magnitude (10^{-8}).

In the course of the calculation it became necessary to know approximately the per cent dissociation of the molecule at 410°, the temperature at which the *D* line fluorescence was a maximum. To obtain this, the reaction isochore as modified by Fowler and Darwin (*Phil. Mag.*, **45**, 1; 1923) to include vibrationally and rotationally quantised systems was used, together with the constants of the green sodium band as given by Watson and Fredrickson (*Phys. Rev.*, **30**, 429; 1927). Assuming the vibrational levels to be fully excited at this temperature, which seems very probable, it turns out that the molecules are only 55 per cent dissociated at 410°, and that the per cent association increases with the temperature. This fact is pointed out for two reasons. One is that the per cent association has been generally considered to be small at this temperature, and this is not the case for molecules having a dissociation potential so high as 1 volt. The other is that it may be significant that the maximum intensity of the *D* lines, excited by the molecular band, should occur in a mixture of 50 per cent atoms and 50 per cent molecules.

E. L. KINSEY.

(National Research Fellow in Physics.)

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The Pulmonary Circulation of the Whale.

WHALES are remarkable not only for the time they remain under water, but also for the depth to which they descend. In my letter on the depth to which they descend (NATURE, Aug. 20, 1927, p. 263), I gave reasons for believing that the Greenland whale descends to the depth of a mile. The ability to reach that depth implies on the part of the whale the possession of certain attributes, namely:

1. It must be able to remain long enough under water to dive to that depth and make the return journey to the surface.

2. Its buoyancy must not depend on a compressible substance like air to such an extent that when it is at the end of its dive its negative buoyancy or tendency to sink is so great that its muscular powers are unable to cope with it.

3. Its natural orifices must be provided with valves to prevent the water entering the hollow viscera.

4. Its lungs and chest must be elastic and capable of contracting as the air in them is compressed and absorbed.

5. Its circulation must be so arranged that at times the venous blood can reach the aorta without having to pass through the lungs.

The Greenland whale appears to possess these attributes in a marked degree; when attacked it descends at the rate of seven or eight miles an hour, and after an interval of from a half to three-quarters of an hour reappears at the surface in an exhausted condition and is easily dispatched. It depends mainly on its blubber for its buoyancy, and only to a small extent on air, and as the former is incompressible it has a buoyant effect at all depths. Its blubber reaches a thickness of 22 in.; its great thickness is well shown in a photograph appearing in Cook's recent volume, "Pursuing the Whale."

As in other whales, the blow-holes of the Greenland whale are protected by valves which, in the undilated condition of the openings, prevent the entry of water without any effort on the animal's part. Knox, speaking of the blow-hole valves of a fin-whale, says: "The mechanism is admirable, and would sustain any pressure from above although the animal descended to thousands of fathoms." The blow-hole valves of the Greenland whale are described by Scoresby. In this whale even the small opening leading to the ear has its little valve.

The lungs and heart of the adult Greenland whale do not appear to have been examined, but they are doubtless at least as suitable for deep diving as those of other whales. Hunter, speaking of a fin-whale, says: "The lungs are extremely elastic in their substance, so much so as to squeeze out any air that may be thrown into them and become almost at once a solid mass, having a good deal the appearance, consistence, and feel of an ox's spleen."

As regards the existence of a channel through which the venous blood can reach the aorta, that is a patent condition of the ductus arteriosus. Murie, referring to a fin-whale, says: "The ductus-arteriosus existed as a thick rounded elastic cord. Its circum-

ference was 7 inches. Its canal was sufficiently closed to prevent the passage of blood by reason of the elasticity of its walls, but a probe the size of a quill could be pushed through the entire distance." Turner and Knox also found the vessel patent, although contracted in fin-whales.

In whales, owing to the peculiar lives they lead, the pulmonary circulation must often be carried on with considerable difficulty unless there is some arrangement against it. In the intervals between the respirations, the lungs, as Delage suggests, are probably used for hydrostatic purposes and the air in them is consequently often more or less compressed. When they descend to great depths, owing to the pressure of the water, their lungs must be in a very contracted state.

In view of these facts I venture to advance the following hypothesis concerning the heart of the Greenland and of other deep-diving whales: that in the intervals between the respirations when the air in the lungs is in a compressed state and at the times the animal is deep in the water and its chest greatly compressed, the venous blood reaches the aorta mainly via the ductus arteriosus instead of via the lungs as at other times; that the ductus is elastic and possibly contractile; and that it opens and allows the blood to pass as occasion requires.

R. W. GRAY.

Astrophysical Estimates of Ionisation Potentials of Iron, Yttrium, and Lanthanum.

THE work of Saha, Fowler, and Milne has shown how the intensities of ionised lines in stellar spectra are dependent upon temperature, pressure, ionisation, and excitation potentials. By studying the changes in intensity of a line from stars of one spectral class to another, astrophysical estimates have been made of the ionisation potentials of certain of the elements by several investigators.

In the case of a *Cepheid variable*, we have a star the luminosity of which changes slowly from maximum to minimum, then rises steeply to maximum again, with a regularity which is remarkable. During the same period the radial velocity goes through a cycle of changes as though the star were in a state of pulsation, expanding and then contracting, with consequent cyclic changes in the pressure and temperature of its outer portions giving rise to periodic variations in spectral classification.

Dr. F. C. Henroteau recently enlisted my interest in the variations in intensity of certain ionised lines, and in the course of an investigation of more than seventy spectrograms of η Aquilæ taken at the Dominion Observatory during the last few years, the behaviour of some twenty lines due to ionised atoms of scandium, titanium, iron, strontium, yttrium, barium, lanthanum has been studied. Microphotometer graphs of each spectrogram were made. An arc line insensitive to the periodic changes was selected closely adjacent to each of the spark lines under consideration and the ratio of the enhanced line to the arc line measured in each case. Plotting these ratios against phase (in η Aquilæ the period is 7·176382 days) the resulting curves exhibit general resemblance to one another but certain differences in position of maximum and spread of high values which must be attributed mainly to differences in ionisation potential. Taking the following known *ionisation potentials*:

At. No.	Element.	Ionisation Potential.
21	Sc	6·7 (Russell and Meggers)
22	Ti	6·5 (Kiess and Kiess)
38	Sr	5·67 (A. Fowler)
56	Ba	5·19 (A. Fowler)

as the basis, *the ionisation potentials of iron, yttrium, and lanthanum are estimated to be as follows:*

At. No.	Element.	Estimated I.P.
26	Fe	6·6 (5·5)
41	Y	6·6
57	La	4·9

In the case of iron, the alternative estimate (5·5 volts) is got by comparison with the graphs for strontium and barium, while the estimate 6·6 volts is the value relative to scandium and titanium. Spectroscopic values have been given as 5·9 and 8·15 by Sommerfeld, Gieseler, and Grotrian, while astrophysical estimates by Menzel are 7·5 and 13·0.

As regards yttrium, a spectroscopic determination has just been announced at the Washington meeting of the American Physical Society (April 20), by Meggers and Russell, agreeing with the above, 6·6 volts. This is of interest because the astrophysical estimates are certainly subject to large probable error.

For lanthanum I am unaware of any previous determination, and in confirmation of this and the other estimates, further study of the behaviour of sensitive lines in the spectra of Cepheid variables will be carried out. I am indebted to the Director of the Dominion Observatory for permission to utilise data taken from spectrograms belonging to that institution.

A. VIBERT DOUGLAS.

McGill University,
April 25.

Active Nitrogen.

IN some recent experiments it has been possible to show that metastable molecules of nitrogen are present in active nitrogen. A preliminary report of these experiments has been made by one of us (J. K.) before the April meeting of the American Physical Society. The absence of a spectroscopic transition from the first or A electronic level of the molecule to the normal level has been reported by Miss Sponer, who also suggested that this level may be a metastable one. Also the transition from the normal level of the molecule to the A level has not been observed in absorption. The long life of active nitrogen cannot, however, be explained on the hypothesis that active nitrogen is a metastable molecule. Its long life and its behaviour in the presence of catalysts suggests with certainty that active nitrogen is atomic and that metastable molecules are formed under the influence of the recombination of nitrogen atoms to molecules.

In order to account for the excitation of the first positive bands of nitrogen in the afterglow with abnormal intensity distribution, we assume that in addition to metastable molecules, metastable atoms of nitrogen are formed during the recombination of atoms to molecules. These metastable atoms excite the metastable molecules to the upper level of the first positive bands by collisions of the second kind. The lowest three terms of atomic nitrogen are predicted by the Hund theory to be ^4S, ^2D, and ^2P, where the ^4S term is a normal one and the ^2D and ^2P terms are metastable. The difference $^2D - {}^4S$ is found from Hopfield's data on the ionisation limits of N I to be 2·37 volts. The difference $^2P - {}^4S$ has been extrapolated from the spectrum of O II and found to be 3·56 volts. Collisions between nitrogen atoms in the ^2P state and metastable nitrogen molecules yield, as the most probable result, nitrogen molecules in the 11th vibrational state of the B electronic level. This is the upper level of the strongest afterglow bands. We make use here of the principle of resonance that has been so successful in collisions of the second kind.

Other experiments show that more than one active

entity is involved in the excitation of the first positive bands in the afterglow. This was done by destroying the visible afterglow by heating, and then showing that the 'dark modification' of active nitrogen could still excite the D lines of sodium. The NO bands, requiring about 6 volts for their excitation, are also quenched by heating. This seems to show that the metastable molecules are quenched by heating and the metastable atoms are undisturbed. Willey showed that when a mild electric discharge was passed through active nitrogen and the visible glow destroyed, the remaining gas was still active and was capable of exciting chemical reactions in which the energy was about 45,000 cal. This, it is seen, is in agreement with the present experiments.

The absence of absorption in active nitrogen between 3000 A. and 6500 A. has been reported by several observers. On the hypotheses presented here, the absorption, if present, should be either in the far ultra-violet or in the far red. The far ultra-violet corresponds to atomic absorption and the far red to the absorption of first positive bands, from the low A vibrational states in which most of the metastable molecules are likely to be.

A detailed account of this work will be presented later.

JOSEPH KAPLAN.
(National Research Fellow in Physics.)
GÜNTHER CARIO.
(Fellow of the International Education Board.)

Palmer Physical Laboratory,
Princeton, N.J.

Square Roots and the Decimal System.

IN NATURE of Mar. 3 is an obituary notice of the late Alexander Siemens. The last two sentences of this obituary suggest that possibly there is a misprint or a misunderstanding.

These sentences referred to are as follows:

"There was one thing said at this meeting which the writer never saw contradicted, and that was that without the decimal system it would not be possible to extract square roots. It is quite easy, however, to turn the square root of any number or fraction into a continued fraction and then find its value to any required degree of accuracy as a vulgar fraction."

I am sure Mr. Siemens never advocated the adoption of the decimal system in arithmetic or anything else but weights and measures. Any other application of the decimal system would be quite equal to the American Congressman that tried to get a bill through Congress enacting that π should be proclaimed by law to be 3·000.

C. E. W. DODWELL.

46 Coburg Road,
Halifax, N.S.,
May 4.

I HAVE read Mr. Dodwell's remarks with interest. It will be noticed that I did not say that it was my friend Mr. Siemens that made the statement, but merely that it was said at the meeting. My recollection is that he asked a rhetorical question somewhat as follows: "How were the square roots of numbers such as 6 to be found if we had no decimal system?" I am certain that I was only prevented from speaking on this question by my desire not to help the opponents of the decimal system. I did not attribute it to Siemens in my obituary notice, because I looked up the account of the meeting in the *Journal of the Institution of Electrical Engineers* and found that it had been deleted, probably by the person who said it.

A well-known method of extracting square roots without using decimals is that first given in English in the "Arithmetic" of James Thomson, the father of Lord Kelvin, which was published in 1819. It is interesting to remember that by 1880, when Lord Kelvin and his brother James edited it, it had run through seventy-one editions. Using this method, we get

$$\sqrt{6} = 2 + \sqrt{6} - 2 \qquad = 2 + \frac{2}{\sqrt{6}+2}$$

$$= 2 + \frac{1}{2 + 1/(\sqrt{6}+2)} = 2 + \frac{1}{2 + \frac{1}{4 + \dots}}.$$

The 2 and the 4 repeating. Thus we get as convergents to $\sqrt{6}$,

$$2,\ \frac{5}{2},\ \frac{22}{9},\ \frac{49}{20},\ \frac{218}{89},\ \frac{485}{198},\ \dots$$

The last convergent equals 2·449495 approximately, and the true value is 2·449490 approximately. The successive convergents are alternatively less and greater than the true value. In this connexion something may be said in favour of vulgar fractions. The method is still set in school examination papers.

A. R.

New Regularities in the Band Spectrum of Helium.

THE letter (NATURE, May 19) of Messrs. Takamine, Dieke, and Suga, reporting certain results in connexion with the analysis of the band spectrum of helium, was of peculiar interest to me, in view of the fact that I was proposing shortly to incorporate many of them in Part V. of a series of papers dealing with this subject. Mr. A. Harvey, working in collaboration with me, has measured and interpreted a number of new bands, chiefly in the less refrangible region, and, so far as can be gathered from the letter in question, has arrived at substantially similar conclusions. There appears to be at least one important difference of interpretation, but discussion of this had better await detailed publication. Meanwhile it may avoid confusion to remark that in all probability the band $3X \longrightarrow 2P$ ('ortho-He') of Takamine, Dieke, and Suga, is that near λ5885 already described in Part IV. (*Proc. Roy. Soc.*, A, **118**, p. 157), whilst one designated $4Z \longrightarrow 2P$ by Dr. Jevons and myself in a paper at present awaiting publication is actually the next series member to their $3Z \longrightarrow 2P$. It is remarkable, and fortunate, that the same symbols X and Z have been respectively chosen in both cases for the new levels. The latter was employed in our case because of the large and unusual Zeeman effect exhibited by the lines of this band.

The effective electronic quantum numbers of these new levels will be of interest to theoretical workers and are as follows, those of several known atomic and molecular levels being included for comparison:

	S.	*P.*	*D.*	*X.*	*Z.*
ortho He	1·689	1·937	2·997	—	—
par He	1·850	2·009	2·998	—	—
ortho He_2	1·788	1·928	3·013	2·958	2·935
par He_2	1·853	1·964	3·015	2·972	2·952

It will be noted that the $p He_2$ values are throughout higher than the corresponding $o He_2$ values, and it is significant that the atomic parhelium and orthohelium quantum numbers differ consistently from one another

in the same sense. We have here, probably for the first time, quite unambiguous evidence for the existence of molecular electronic levels which are additional to the ordinary atomic system of levels. Such additional levels constitute an important feature of Hund's recent theoretical work on band spectra. Briefly expressed, his view is that whereas in atoms the term type is determined by the total orbital angular momentum (l) of the outer electrons, in molecules it is determined by the component (i_l) of this parallel to the line of nuclei. Thus in atoms we have only one S sequence ($l=0$) of a given multiplicity, but in molecules more than one may exist, corresponding to $i_l=0$ ($l=0, 1, 2 \ldots$). The characteristics of the X level, for example, strongly suggest that it is related to the S level in some such way as this.

W. E. CURTIS.

Armstrong College,
Newcastle-upon-Tyne.

The Sligo Artefacts.

FOR some years past, in my researches upon the Norfolk coast, I have made a close study of the alleged hurling of large flints against each other during storms, and as, after much observation, I have not seen such collisions take place, I am unable to believe in their occurrence in the area I have investigated. So far as my knowledge extends, the capability of waves in picking up stones is limited to comparatively small specimens. These, when they fall, may strike others lying upon the beach, but such impacts, especially as they occur in water—a medium which definitely lessens the force of the blow—cannot remove, in ordinary circumstances, flakes of large dimensions (see *Science Progress*, No. 87, Jan. 1928). It is known that stones of considerable size are sometimes thrown by the action of the sea on to promenades, but these stones are apparently being rolled towards the shore, and by the uprush of the water when it meets a more or less vertical sea-wall, are carried on to the promenade. There cannot, of course, be any doubt that bulky masses of flint are propelled up the beach, sometimes aided by the buoying effect of attached seaweed, and I have witnessed such movements while storms were in progress upon the east coast. But the travel of the flints is very gradual, as it is only certain waves which are capable of moving them, and the extent of each stage of advance is generally small.

I am not familiar with the capabilities of the Atlantic in moving blocks of limestone upon the Sligo coast, but, for the reasons mentioned above, I would regard it as improbable that masses of this rock of the size described by Profs. Jones and Boswell in NATURE of June 2 could ever have been hurled to their present position by wave action. I can, however, imagine that such blocks could by slow degrees be transported by the sea to where they are now found. Actual observation during storms is what is needed for the elucidation of this question, and until this is carried out erroneous views regarding it may be prevalent.

Since Mr. Burchell's last letter to NATURE he has again visited Sligo and found *in situ* in ancient deposits, two more artefacts. One of these, made of quartzite, is a remarkable specimen, which is, I imagine, sure to be enthusiastically received by those who, like myself, by reason of the evidence already to hand, believe in the greater antiquity of man in Ireland. The other specimens, found previously by Mr. Burchell *in situ* in boulder clay, are, in my opinion, clearly of human origin, and of very great importance.

J. REID MOIR.

One House,
Ipswich.

A Voracious Pike.

THE photograph here reproduced (Fig. 1) shows the attitude of two pike as they were washed ashore dead in the lake here a few days ago. The smaller fish, weighing 7½ lb., had bitten off a good deal more than he could chew of the larger—8 lb. I suppose the two fishes met head on, so that neither could discern the size of the other. The smaller fish, seeing something that seemed edible before him, went for it and paid full penalty for its voracity. Several years ago the late Mr. Malloch, of Perth, sent me a photograph of two pike that had been washed ashore in Loch Tay in precisely the same posture as ours. If I remember aright, they weighed 8 or 9 lb. apiece.

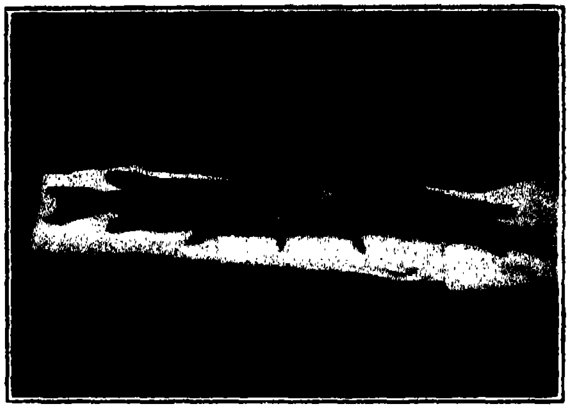

FIG. 1.

HERBERT MAXWELL.

Monreith, Whauphill,
Wigtonshire.

Woods and Wireless.

IN a letter in NATURE of April 7, Dr. Rolf makes some very interesting comments on the subject of absorption of wireless waves by trees, and refers to a paper in which I directed attention to this phenomenon. It is quite clear, as Dr. Rolf points out, that the capacity effect of the tree ought to be taken into account as well as its conductivity effect. It appears to me, however, to be a little doubtful whether such a simple modification of Sommerfeld's theory as Dr. Rolf proposes, is all that is required. The constants of conductivity and S.I.C. employed by Sommerfeld are for an isotropic medium, whereas used in connexion with trees they refer only to the vertical axis. Again, if we increase the conductivity of the tree we clearly increase the energy absorbed, and therefore the attenuation will be greater, whereas by Dr. Rolf's method, an increase of the conductivity leads to the opposite conclusion.

Dr. Rolf seeks to explain by the capacity effect of trees the curious phenomenon of negative damping (which, by the way, was first discovered not by myself but by Messrs. Ratcliffe and Barnett), but I am inclined to doubt whether this is the cause in the case of the curve obtained for Daventry, since this region is one of comparatively few trees, and further, the departure of the attenuation from its ideal value (assuming a bare surface) has been found to be small. The explanation, however, should not be abandoned without further investigation.

R. H. BARFIELD.

Radio Research Station,
Datchet, Windsor,
May 16.

Coal-mining Explosives.

THE dangers due to the presence of inflammable gas and dust in the working atmosphere have led to the development of a special class of explosives for use in coal mines. In general these are detonating explosives, to which have been added 'cooling salts' (for example, sodium chloride) or into which have been introduced a 'cooling agent' (ammonium nitrate), the object of which is to reduce either the amount or the temperature of the flame the explosive gives on detonation. An increased margin of safety in the presence of firedamp has been secured by these means. A rather serious drawback has been that the efficiency of the explosive has, naturally, been decreased, and as a result detonation has been made less certain; that is, the possibility of misfires has been increased. A limit is thus set, beyond it is not advisable to proceed. In the opinion of some observers, this limit has already been passed.

None of the present coal-mining explosives is a true safety explosive, and all are capable of igniting mixtures of firedamp and air in certain circumstances. On the other hand, many explosives, the use of which would rightly be considered dangerous in coal-mining work, may be fired under carefully controlled conditions in the presence of an inflammable firedamp–air mixture without causing ignition. It would appear that it is the conditions under which the explosive is fired that are of prime importance in deciding whether an ignition of firedamp or coal dust can take place or not, and the comparative immunity of the coal mines of Great Britain from ignitions due to the use of explosives is stated to be quite as much to the credit of the shot-firer for the care taken by him in carrying out his duties, as to that of the manufacturers of the explosives used.

As a basis for the researches on coal-mining explosives which are being carried out at the Safety in Mines Research Station at Buxton, it is therefore considered that the rational lines on which to proceed are to concentrate on the effects of methods used underground in firing explosives, in order to help the shot-firer to use them safely, rather than on the effects of the materials of which explosives are made in the hope of producing an inherently safe explosive. An outline of the methods used and of some of the results already obtained has been given recently by Dr. W. Payman.[1]

One of the difficulties of these researches is due to the fact that it is not possible to devise a single test which will give satisfactory information of the behaviour of an explosive under all the very varied conditions met with in mining operations. The main feature of the present official test, as recently modified by the Explosives in Mines Research Committee, consists of firing the explosive from a steel cannon, untamped, into an explosive mixture of firedamp and air. This gives a measure of the relative safeties of different explosives under one set of conditions, but though many of the explosives on the present 'Permitted List' have been fired under the conditions of the official test and 30 to 40 ounces have been used without causing ignition, yet some of these explosives have caused ignition of firedamp underground with so small a charge as 4 ounces.

A method of test sometimes used to supplement the official test in Great Britain and other countries is to measure photographically the amount of flame given out by an explosive on detonation. This method, on which great reliance is often placed, is of no real value taken alone, as is shown by the photographs reproduced in Fig. 1. Two explosives were used for these photographs, and those at (*a*) show the amount of flame produced on firing the explosive as in the official test. In the official test, Explosive A is more dangerous than Explosive B, although it gives less flame. For photographs (*b*) the experiment was repeated, except that the detonator was placed at the back of the charge instead of at the front. Though this makes no apparent change in the safety of either explosive in the official test, it will be seen that it results in much more flame being sent out by the explosive.

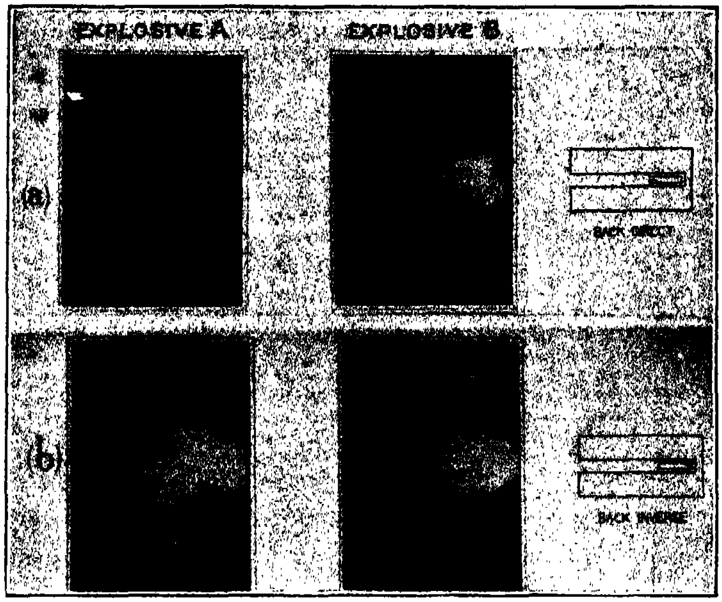

FIG. 1.

It is evident from these photographs that the modern coal-mining explosive, or 'permitted' explosive, as it is called, is by no means a flameless explosive. If we are to learn anything about the mechanism of ignition of a firedamp–air mixture

[1] "The Problem of the Safe Use of Coal-mining Explosives." W. Payman. Midland Institute of Mining Engineers, General Meeting, Leeds, April 17, 1928.

by an explosive, it will be necessary to find the answer to two questions. The first is not why do explosives cause the ignition of a gas mixture, but why do not these large, apparently hot, flames produced by 'permitted' explosives during official test always ignite firedamp–air mixtures when they are fired into them? Secondly, when ignition does result—for example when the charge is increased—is the flame then the cause, or if not, what is? The attempts to answer these questions are regarded by Dr. Payman as the most important part

FIG. 2.

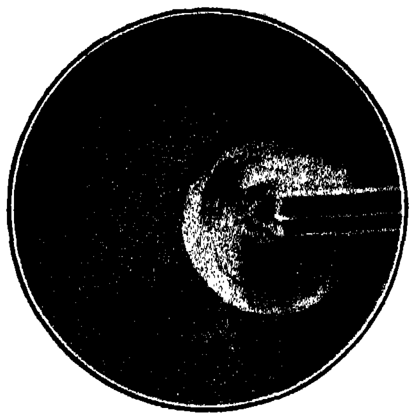

FIG. 3.

of the research work on explosives which is being carried out at Buxton.

When an explosive is detonated, it is converted into gaseous products at high temperature and pressure. When fired untamped, as in the official test, there is projected from the mouth of the shot-hole the flame of the explosive accompanied by the gaseous products of explosion. Further, the shattering effect which makes itself evident in practice by breaking down the coal must have a similar effect on the air outside the shot-hole. This is the concussion effect apparent to a greater or less degree by its effects on the ear whenever a shot is fired. Since it is known that nearly all flames will cause the ignition of an inflammable gas mixture, it is convenient to consider the flame as the chief potential source of ignition of firedamp when explosives are fired. The effects of the hot gases and shock and pressure waves can then be considered separately, not only with regard to the possibilities of their causing or aiding ignition, but also with regard to the likelihood that they may lessen or remove entirely the igniting power of the flame.

A method has been developed at Buxton, based on an old German optical device, which enables photographs to be obtained of the invisible detonation gases and waves sent out by an explosive in addition to photographs of the visible flame. This method depends essentially on the refraction of a beam of light at the edges of the detonation gases and at the surface of the shock wave. The method has been used to give both 'snapshots' and moving film records, the former using the spark produced on the almost instantaneous discharge of a Leyden jar, the latter using a powerful arc lamp to give the beam of light.[2] The utility of the method may be appreciated from Fig. 2, which shows a photograph of a normally invisible stream of compressed air passing through a glass tube.

In order to obtain a photograph of a shock—or concussion—wave independently of any flame or products of detonation, such a wave was produced by bursting a small celluloid disc by means of compressed air, the record reproduced in Fig. 3 being obtained. The front of the shock wave, which is approximately spherical, is shown as a circle, the wave resembling somewhat a soap-bubble blown from the end of a tube.

The next photograph (Fig. 4) shows the wave and the gaseous products of detonation when a No. 6 fulminate detonator is fired in an iron tube open at both ends. Here again we see the approximately spherical shock-wave, but now it is closely followed by the gases evolved on detonation. The shock-wave marks the boundary of disturbance, and the air outside this at the instant the photograph was taken is quite unaffected. The air which was formerly enclosed within the space defined by the spherical shock-wave has now been compressed into the space between the shock-wave front and the front of the gaseous products of detonation.

FIG. 4.

Moving film records have enabled the speed of the shock-wave to be determined, and have also given the relative position of flame, waves, and gases as they travel away from the shot-hole.

In addition to the purely scientific examination of the formation and spread of explosive gases, flames, and waves away from an explosive, these photographic methods are being linked up with experiments designed to examine the ignition process under actual conditions of mining practice.

[2] A full description of the method is given in "The Pressure Wave Sent Out by an Explosive," Part 1, by W. Payman and H. Robinson. Part 2 by W. Payman and W. Shepherd. *Safety in Mines Research Board Papers*, No. 18 and No. 29.

The Sun's Outer Atmosphere.[1]

By Prof. E. A. MILNE, F.R.S.

ASTRONOMERS are accustomed to divide the outer regions of the sun into four parts: (1) the photospheric layers, (2) the reversing layer, (3) the chromosphere, (4) the corona. In this address I wish to deal particularly with the chromosphere, but before doing so I should like to dwell a little on certain aspects of this fourfold division. Meteorologists make a similar subdivision of the earth's atmosphere. We have the troposphere, the stratosphere, the conducting layers, the auroral layers, and so on. But meteorologists have at least one advantage over solar physicists—meteorologists know where the earth's atmosphere begins. It may leave off very indefinitely, but it certainly begins quite definitely—it begins at the solid and liquid crust of the earth. It is sharply bounded below. But on the sun, and indeed on any star, no such sharp base exists. Whether the sun is wholly gaseous, or whether with Dr. Jeans we suppose it to be ultimately in a liquid state in the far interior, we are at least certain that owing to the high surface temperature and the positive temperature gradient implied by the outflow of heat, the entire outer layers, down to a depth much greater than the furthest depth we can see, are in the gaseous state. We therefore have no datum line for the base of the solar atmosphere.

It is true that, as seen in the sky, the sun has a sharp edge. But we have to remember that at the sun's distance one second of arc corresponds to 700 km., and that a line of sight passing one second of arc inside the sun's limb traverses 64,000 km. of the solar sphere. Thus the sharpness is to some extent illusory. We can, however, assert that above the level corresponding to the 'sharp edge' the gases are practically transparent as regards their continuous spectrum, whilst below this level they are practically opaque. If we knew the intrinsic opacity (per unit mass) of the solar material, we could calculate the pressure at which the transition from practical transparency to practical opacity takes place, for a line of sight nearly tangent to the sun. Assuming that general opacity arises from the ejection of photo electrons, the various unknowns may be estimated. We find that the opacity of a column of given length varies as the square of the pressure, and hence falls off rapidly outwards. It appears that practical transparency along a tangential line of sight occurs at a pressure of about 10^{-6} atmospheres. When we view the sun's surface normally, at the centre of the sun's disc, we see to a deeper level. Calculation shows that all but one per cent. of the light originates at depths where the pressure does not exceed 10^{-3} atmospheres. This change of pressure, 10^{-6} atmospheres to 10^{-3} atmospheres, appears to take place in a range of depth of some 50 km. These limits serve to define the 'photospheric layers'—the layers within which originates the light of the continuous spectrum sent to us by the sun.

Superimposed on the sun's continuous spectrum is an absorption line spectrum. Some of these lines show in their fine structure reversals, but we may ignore these and state that for the undisturbed solar disc we have, broadly speaking, a spectrum composed entirely of absorption lines. We are not compelled to assume that the layers producing these lines are entirely exterior to the photospheric layers. Theory shows that, provided the temperature decreases outwards, an absorption spectrum will be shown if the gas has a general coefficient of absorption and superimposed on this certain selective absorption coefficients associated with particular wave-lengths. Thus if the general coefficient of absorption remained definitely constant at all levels up to the sun's boundary, we should still have a Fraunhofer spectrum. Actually, if we accept the photoelectric origin of the general absorption, the general absorption coefficient per unit mass decreases with the pressure, and thus as we pass outwards the general absorption coefficient becomes practically zero whilst the selective absorption coefficients are still large. There is therefore a region effectively transparent except in the lines themselves. Nevertheless, within the photospheric range of pressures already mentioned, selective line absorption will also be occurring. The term 'reversing layer' is used to denote in a general way those layers which contribute to the Fraunhofer spectrum, but we now see that there is no precise delimitation between the reversing layer and the photospheric layers. The two shade into one another. The photospheric layers are also giving rise to line absorption, though this absorption will be weak; in other words, the residual intensities of the lines produced in this region will not be much below the intensity of the continuous background. The upper reversing layer, transparent except in the lines, will give rise to stronger lines, that is, lines with smaller residual intensities.

As evidence for this we have that the stellar sequence of spectra indicates a pressure of the order of 10^{-4} atmospheres for the layer in which absorption lines of excited atoms originate, but a pressure of the order of 10^{-7} atmospheres for the layer in which absorption lines of normal atoms originate. The former pressure lies inside our photospheric range of pressure, the latter pressure lies outside it.

In the upper reversing layer a new feature begins to present itself—the selective effect of radiation pressure near a wave-length of selective absorption. Now it must be supposed that selective absorption is occurring to some extent at all depths throughout the sun; in the far interior, the X-ray levels of the atoms will be giving rise to selective absorption. We may, therefore, pause for a moment to inquire how it is that selective radiation pressure only arises on the fringe of the sun. The pressure of radiation at any particular wave-length is

[1] Discourse delivered at the Royal Institution on Friday, Mar. 9.

proportional to two factors. One is the net outward stream of radiation—the difference between the inward and outward streams; the other is the selective absorption coefficient in that wave-length—the degree of obstruction offered. But the selective absorption has itself an influence on the net stream. Where the selective obstruction is high, neither an inward nor an outward beam can go very far without being absorbed, and consequently the average distance (from a given atom) from which either an inward or outward beam originates is very small. When the state is one of 'local thermodynamic equilibrium,' as can be shown to hold provided the density is not too low, this has the effect of making the inward and outward beams very nearly equal at a wave-length of strong selective absorption. They originate from places so close to one another, both in space and in temperature, that they are only slightly unequal. They accordingly very nearly cut one another out. Thus in the product (selective absorption coefficient) × (net stream) the effect of the large selective absorption coefficient is neutralised by the small net stream, and we get no appreciable effect of selective radiation pressure; the radiation pressure is the same at a wave-length of selective absorption as at a wave-length where there is no selective absorption.

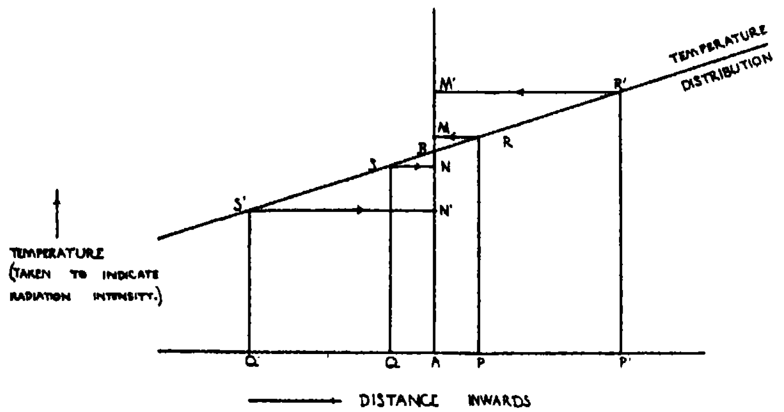

FIG. 1.—Diagram to illustrate the absence of selective radiation pressure in local thermodynamic equilibrium in interior. AM and AN represent the outward and inward fluxes at A in ν-radiation, AM′ and AN′ the outward and inward fluxes at A in ν'-radiation, where $k_\nu > k_{\nu'}$ (k = absorption coefficient). These fluxes originate at the mean positions P, Q, P′, Q′ respectively, where AP < AP′ because $k_\nu > k_{\nu'}$. The following relations hold:

i. Large absorption coefficient k_ν.
Net flux at A $\propto$ AM − AN = MN $\propto$ PQ $\propto 1/k_\nu$.

ii. Small absorption coefficient $k_{\nu'}$.
Net flux at A $\propto$ AM′ − AN′ = M′N′ $\propto$ P′Q′ $\propto 1/k_{\nu'}$.

Hence (k_ν × net flux in ν-radiation) = ($k_{\nu'}$ × net flux in ν'-radiation), or radiation pressure due to ν-radiation = radiation pressure due to ν'-radiation.
Thus no selective effect in the interior.

Let us now see what happens near the boundary of the star, assuming local thermodynamic equilibrium holds up to the boundary. Near the outer confines of the star the inward stream is small, and there is little to neutralise the outward stream. The net stream is almost equal to the outward stream, and a big selective absorption coefficient will give rise to a big selective radiation pressure.

We can look at the matter at a slightly different angle. At the outside of the star, the big selective absorption coefficient, combined with such outward stream as exists, gives rise to a big selective radiation pressure, even though the big selective coefficient has itself cut down the outward stream to a value below the photospheric value. As we go inwards, an inward stream is generated by the back radiation from the atoms traversed, and this soon nearly balances the outward stream, giving a small net stream in the interior.

At all depths selective absorption cuts down the intensity of each stream. The difference between the interior and the surface is that in the interior the two streams are cut down to nearly the same amount and balance one another, whilst at the surface the outward stream, though cut down, is unbalanced.

The consequence of this is that in the upper reversing layer the gases are pushed outwards by selective radiation pressure, and so the layer is less compressed than the lower reversing layer and photospheric layer beneath. It is not easy to make an exact calculation, but it appears roughly that for calcium atoms the pressure decreases from 10^{-5} atmospheres to some very small pressure in a range of about 100 km. This estimate is not to be pressed—it may perhaps be an under-estimate. But we shall not go far wrong in attributing a thickness of the order of some hundreds of kilometres to the upper reversing layer.

In this region, in a steady state, the atoms are maintained in equilibrium under gravity, the gradient of gas pressure and selective radiation pressure. As we go outwards selective radiation pressure steadily increases in importance. The question arises, what happens at the upper boundary of this layer? Actually, it cannot have a definite upper boundary, but we will suppose we are endeavouring to trace the pressure upwards by the same principles as govern the equilibrium of the earth's atmosphere, selective radiation pressure only being added. Two possibilities arise: either selective radiation pressure, though increasing, remains steadily less than gravity, or it attains a value greater than gravity. It may do the former for some kinds of atoms, the latter for other kinds of atoms. In the former case nothing particular happens; the atoms of this particular kind simply thin out moderately rapidly. In the latter case, we arrive at a contradiction. When radiation pressure exceeds gravity, equilibrium is no longer possible unless the gradient of gas pressure becomes reversed. As it is difficult to see how the gas pressure could ever begin to decrease again once it began to increase—and it must ultimately

decrease because the sun's atmosphere is finite—we reject this possibility. But if equilibrium is no

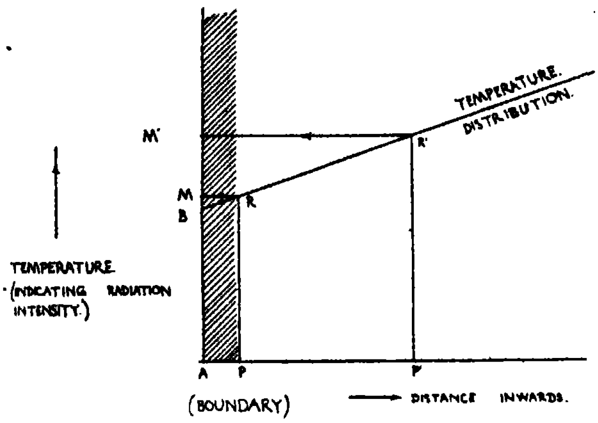

FIG. 2.—Diagram to illustrate existence of selective radiation pressure at boundary (chromosphere absent). AM and AN represent the emergent fluxes at the boundary in ν and ν'-radiation ($k_\nu > k_{\nu'}$). They originate at depths P and P′ respectively, and so correspond to temperatures PR and P′R′. Since k_ν is large, P is practically at A, and the emergent flux in ν-radiation corresponds closely to the boundary temperature AB. The following relations hold:

i. Large absorption coefficient k_ν.
Net flux $\propto AM = AB + BM = AB + c/k_\nu$.

ii. Small absorption coefficient $k_{\nu'}$.
Net flux $\propto AM' = AB + BM' = AB + c/k_{\nu'}$.

ν – Radiation pressure $\propto k_\nu AM = k_\nu AB + c$.
ν' – Radiation pressure $\propto k_{\nu'} AM' = k_{\nu'} AB + c$.
Hence $k_\nu > k_{\nu'}$ implies ν-radiation pressure $>$ ν'-radiation pressure.

longer possible, since we have assumed equilibrium all the time, something must be wrong with our assumptions. We could only now keep the atoms in equilibrium if we assumed some kind of hypothetical net which caged the atoms down. Let us suppose that the atoms are, in fact, kept in equilibrium by a net of this kind, and that then the net is suddenly removed. What will happen?

The atoms, being acted on by a radiation pressure exceeding gravity, will be ejected from the layers below. An outer atmosphere will come into being. But the ejection of atoms will not proceed indefinitely. As this new outer atmosphere becomes thicker and thicker its back radiation will begin to be appreciable; it must be constantly returning to the layers below some fraction of the radiation incident on it. The back radiation will exert a downward pressure, which will go on increasing with increasing thickness of the outer atmosphere until finally its back pressure is equal to the pressure exerted by our hypothetical net. After that no more atoms will be ejected, and the outer atmosphere will be permanent, and will exist in a state of equilibrium.

In the case of the sun we identify this outer atmosphere with the chromosphere, observed at times of total solar eclipse and spectroscopically at other times. About a century ago, Canning called a New World into existence to redress the balance of the Old. For millions of years the sun has been calling a new atmosphere into existence to redress the balance of the old.

(To be continued.)

Obituary.

DR. CHARLES H. GILBERT.

IN the passing of Dr. Charles Gilbert, America has lost one of her most trusted fishery authorities and a zoologist of wide reputation. He had retired from his professorial duties at Stanford University, California, some three years ago, and was devoting his whole energies to the working out of salmon problems on the Pacific coast, and specially in Alaska, where the most productive salmon fisheries of the world now exist, when a sharp attack of bronchitis terminated his career.

A native of the State of Illinois, Dr. Gilbert early came under the spell of that famous ichthyologist, David Starr Jordan, and in a short time was his most prominent pupil and then his associate in various expeditions. Ere long, papers were appearing on the fishes of southern California and the Pacific Islands over their joint names. When the Stanford University was created in 1891, Jordan became the principal and Gilbert the professor of zoology. At the age of sixty-five he retired, after occupying the chair for thirty-four years. His published work during this long period, as shown in Dr. Bashford Dean's "Bibliography of Fishes," was almost exclusively on systematic ichthyology. He described many new species—in one paper 32, and in another 25—in a search of American waters. He studied the fishes of Panama when de Lesseps was engaged upon his unsuccessful effort to construct the canal, and he also wrote on the fishes of the inhospitable Galapagos Islands, and of Hawaii and Japan.

It was in 1880 that Dr. Gilbert first became associated with the U.S. Fisheries Commission, and from that time forward much of his work had practical application to fishery problems on the Pacific Coast. The interests of the salmon began to claim him from the year 1912, and it may be said without much fear of contradiction that his best and most useful work was carried on in the elucidation of the great runs of salmon in British Columbia and Alaska, and that in this branch of investigation he became the leading authority. Salmon research in Scotland had already revealed not only the importance of marking fish, but also the great value of salmon scale study, and Gilbert was the first in America to appreciate the insight into the life history of fishes which this branch of study can yield.

The runs of salmon in the famous Fraser River, which since the days of the Hudson's Bay Company had been regarded as inexhaustible, had begun to decline in a rather alarming manner, and a great fall of rock into the Hell's Gate cañon during the making of the Canadian Northern Railroad had blocked the river and wiped out the 'big run' which occurred every fourth year. The extensive

canning industry became seriously alarmed. Gilbert came to the aid of British Columbia and produced a series of admirable papers on the life history of the most valuable species (*Oncorhynchus nerka*), the Sockeye, and laid the foundation for the scientific study of the other species found in the rivers of the coast.

Since the salmon interests of the State of Washington and of British Columbia were inextricably linked in any scheme of regulative treatment, it was clear that only by the creation of a joint body representing both the United States and Canada could satisfactory results be attained. Dr. Gilbert was one of those who actively urged the calling of a conference for the consideration of this proposal, and in the spring of 1925 a representative body assembled at Seattle. From this there sprang into being the International Pacific Salmon Investigation Federation under the chairmanship of Mr. Henry O'Malley, the U.S. Commissioner of Fisheries. One of the important lines of investigation decided upon was the migrations of salmon to Alaska and an estimate of the spawning stocks necessary for the maintenance of the fisheries, and this work was naturally put into Dr. Gilbert's hands. The biological work generally is in charge of Dr. Willis Rich, of the U.S. Bureau of Fisheries, a worker who has repeatedly collaborated with Dr. Gilbert in recent years.

The Federation has suffered a great loss in the death of one of its most thorough and trustworthy investigators. W. L. C.

DR. HIDEYO NOGUCHI.

WE much regret to see the announcement that Dr. Noguchi died at Accra on May 21, of yellow fever contracted in the course of his investigation of the cause and mode of transmission of that disease. Our readers will recall that Prof. Adrian Stokes died in the same way in September last, and some of them may remember the death of that brilliant young man, Walter Myers, when he went to Para on the same errand so long ago as 1901.

During the last ten years Dr. Noguchi has been extensively engaged on the parasitology of yellow fever as it occurred in Central and South America, working in conjunction with the sanitary campaign by which the International Health Board have very nearly succeeded in eradicating the disease in those parts. In Ecuador in 1918 he found a spirochæte which could be grown in pure culture and with which a disease resembling yellow fever could be produced in guinea-pigs and some other animals. The organism had been seen in the kidney of a fatal case some years before by Stimson, but his account was published briefly in an official report, and no particular importance was attached to it. Noguchi produced cumulative evidence that his *Leptospira icteroides* was distinct from other similar organisms and etiologically related to yellow fever, which was very strong if not entirely conclusive: a convenient summary by him will be found in the *Lancet* (1922, vol. i. p. 1185). The well-established facts that the disease can be transmitted by an ultramicroscopic agent either by injection or through the mosquito are quite in harmony with his thesis, for other spirochætes are known to have invisible phases. With his cultures he prepared vaccines and sera, but there has, we believe, been no satisfactory opportunity for getting a conclusive test of their value in prevention and treatment. The American commission which for the past two years has been investigating the disease as it occurs in West Africa, to which Prof. Stokes was attached, found that the indigenous monkeys and other animals were quite immune to the disease, but by the use of highly susceptible *Macacus* imported from India they have provided further experimental proof that the disease is transmissible by mosquitoes, and that the virus is invisible. Of the *Leptospira* they could find nothing, possibly because yellow fever in Africa is not the same thing as yellow fever in the Americas. It was doubtless this discrepancy which led Dr. Noguchi to Accra last November with such unhappy results.

Dr. Noguchi was born in Japan in 1876, and educated at Tokyo University and the Institute for Infectious Diseases. He went to the United States in 1901 as lecturer on pathology in the University of Pennsylvania, and afterwards worked at the Carnegie Institution. Since 1914 he has been one of the most distinguished members of the staff of the Rockefeller Institute. Apart from yellow fever, he will be remembered for his pioneer work on the cultivation of spirochætes outside the body and their specific differentiation, for his demonstration of the *Spirochæta pallida* in the brain which gave the final proof that general paralysis was syphilitic, and for his work on vaccine virus. The successive volumes of the *Journal of Experimental Medicine* are good enough evidence of his fertile brain and clever hands. Lately he has been working out the cause of oroya fever in Peru, which seems to be due to a minute parasite inside the red blood corpuscles.

WE regret to announce the following deaths:

Mr. A. R. Bennett, a well-known telephone engineer who was responsible for many inventions connected with the telephone in its early days, on May 24, aged seventy-eight years.

Dr. William F. M. Goss, past president of the American Society of Mechanical Engineers and formerly professor of railway engineering and dean of the college of engineering at the University of Illinois, on Mar. 23, aged sixty-eight years.

Dr. John Horne, F.R.S., formerly assistant director in Scotland of the Geological Survey, on May 29, aged eighty years.

Prof. C. W. Howard, director of the Government Bureau for the Improvement of Sericulture in Kwongtung Province, who had recently been appointed head of the Department of Biology at Wheaton College, Illinois, and was an entomologist of wide experience in the United States, South Africa, and China, on Mar. 1, aged forty-six years.

Prof. Otto Nordenskjöld, an honorary corresponding member of the Royal Geographical Society, leader of the Swedish Antarctic expedition of 1902–3, on June 2, aged fifty-eight years.

News and Views.

THE King's Birthday honours list includes the names of the following men of science and others associated with scientific work: *Order of Merit*—Sir George Grierson, in recognition of his eminent position as an Oriental scholar and of the value to the Empire of his work on Indian languages and dialects. *Baron*—The Right Hon. Sir Alfred Mond, Bart., chairman of Imperial Chemical Industries, Ltd. *Knights*—Dr. J. H. Jeans, secretary of the Royal Society; and Capt. G. H. Wilkins, the distinguished Australian aviator and explorer, who recently flew an aeroplane across the Arctic Ocean from Alaska to Spitsbergen. *Companion of Honour*—Prof. J. S. Haldane, Director of the Mining Research Laboratory of the University of Birmingham. *G.B.E.*—Sir John Dewrance, past president of the Institution of Mechanical Engineers. *C.B.E.*—Dr. C. H. Lander, Director of Fuel Research, Department of Scientific and Industrial Research; and Mr. H. E. Wimperis, Director of Scientific Research, Air Ministry. *O.B.E.*—Prof. A. V. Bernard, professor of hygiene and preventive medicine in the University of Malta, and Medical Officer of Health, Malta; Mr. R. S. Cooke, Inspector-General, Ministry of Auqaf, and Honorary Director of Antiquities, Iraq; Mr. E. R. Sawer, Director of the Department of Agriculture, Palestine; Dr. W. S. Tucker, Director of Acoustics at the Air Defence Experimental Establishment, War Office; and Mr. R. McK. Wood, principal scientific officer, Royal Aircraft Establishment, Farnborough. *M.B.E.*—Mr. W. R. Black, assistant principal, Ministry of Agriculture and Fisheries; Dr. J. F. Corson, assistant bacteriologist, Medical and Sanitary Department, Tanganyika Territory; and Mr. G. Maclean, Sleeping Sickness Officer, Medical and Sanitary Department, Tanganyika Territory.

THE Institution of Civil Engineers has had the good fortune to be served by a succession of secretaries of outstanding ability, the name of one of whom, James Forrest, is commemorated by the James Forrest Lecture, while the name of his predecessor was given to the Manby Premium. Charles Manby (1804-1884) was the son of Aaron Manby, and helped his father construct the first iron steamer to go to sea, and also worked under him at the Paris Gas Works and the Charenton Ironworks. Establishing himself in London as a civil engineer, in 1839 he became secretary to the Institution, in the duties of which James Forrest (1825–1917) assisted him. On retirement in 1856, Manby was presented with a sum of money "as a token of personal esteem and in recognition of the valuable services" he had rendered to the members individually and collectively. During the early 'fifties, Forrest had been assistant secretary to the Society of Arts, but on Manby's retirement he returned to the Institution of Civil Engineers and continued to hold that important post until 1896. During his tenure of office the names on the roll had risen from between 800 and 900 to 6900, inclusive of the student class, while the annual income had grown from £3000 to more than £20,000. Various marks of respect were shown Forrest. His portrait was presented to the Institution in 1890, an endowment fund for the James Forrest Lecture was raised in 1891, while Forrest himself, after retirement, established in 1897 the James Forrest medal, to be awarded annually to the writer of the best student's paper. On retirement, Forrest was succeeded by Dr. Tudsbery, who in turn has been succeeded by Dr. Jeffcott.

ON the eve of his elevation to the peerage, Sir Alfred Mond was able to announce to the first ordinary general meeting of the shareholders of Imperial Chemical Industries, Ltd., that the profits for the year had exceeded the estimate by half a million pounds, a result he attributed to the improvement of trade consequent upon a less disturbed labour position, the uniformly good relations prevailing between the management and employees in the various firms absorbed in the merger, the continually increasing demand for heavy chemicals in the artificial silk industry, in agriculture, etc., to the increased capacity of the combine to be adventurous in research and in applying its results, and to the negotiating power which its capital resources conferred upon it. Referring to negotiations with chemical interests in other countries, Sir Alfred said the merger has laid it down as a cardinal point of policy that it must regard itself as the guardian of the national safety in the way of production of chemical products, and many of its research activities are based upon the need for carrying that policy into effect. It expects shortly to put into operation a plant to manufacture methanol, an important raw material of the dye industry for which Great Britain is at present dependent on foreign sources of supply, and the Billingham factory hopes to make the production of petrol from coal a commercial proposition. Impetus has been given to the researches into this chemical engineering problem by the import duty on oil fuel. The tradition of the associated firms of the essential necessity of research and its continuous application has been strengthened by the formation of a consultative research council representative of the academic and industrial world.

THE Commission for Synoptic Weather Information met in London during the week May 29–June 2, under the presidency of Lieut.-Col. E. Gold, Assistant Director of the Meteorological Office, Air Ministry. The Commission deals with the international exchange of the meteorological reports on which weather forecasts are based. It specifies the codes in which the reports shall be abbreviated and the time-table according to which the different radio services shall transmit the reports. Representatives from the meteorological services of Denmark, Holland, Belgium, France, Germany, Norway, Sweden, Finland, Russia, Poland, Czecho-Slovakia, Iceland, Portugal, Spain, and Great Britain attended the meeting, as well as the Director of the Meteorological Service of Canada and the Chief of the United States Weather Bureau. The meeting in London was preceded by a meeting in Paris of a sub-commission appointed to formulate proposals in

regard to the collection and distribution of meteorological reports from the ocean. This sub-commission met under the presidency of General Delcambre, the Director of the National Meteorological Office of France. The British representative at the meeting at Paris was Commdr. L. A. Brooke-Smith, superintendent of the Marine Division of the Meteorological Office, Air Ministry. During the meeting in London the delegates were entertained by H.M. Government to luncheon, at which Sir Philip Sassoon, the Under-Secretary of State for Air, presided. They also paid a visit to the aerodrome at Croydon, when they inspected the meteorological service which provides for the requirements of aviation between London and the Continent.

By permission of the Air Ministry, a special meeting of the Royal Meteorological Society was held at the Croydon Aerodrome on Thursday afternoon, May 31. About two hundred fellows and their friends were present, including representatives from the International Commission for Synoptic Weather Information who were attending a conference at the Air Ministry. After a brief address of welcome by Sir Richard Gregory, president of the Society, supported by Dr. G. C. Simpson, Director of the Meteorological Office, a lecture on the "Development of Meteorological Services for Aviation" was given by Capt. F. Entwistle, Superintendent, Aviation Services Division, Meteorological Office. Capt. Entwistle explained the organisation by which pilots are not only informed of the weather conditions over the route they are flying at the time of the commencement of the flight, but also of the changes likely to occur and the prevailing conditions at neighbouring stations, so that an alternative route can be taken in the event of bad conditions on the normal route. Tea was provided at the Aerodrome Hotel, and afterwards guides conducted parties to the various points of interest in the aerodrome. These included the recently opened booking and waiting rooms, customs' offices, emigration department, control tower, etc. A popular feature of the afternoon was the opportunity provided by Imperial Airways, Ltd., to make short flights at a reduced charge in commodious air liners specially detailed for this purpose. About one-third of the company took advantage of this opportunity to make an ascent.

The last news from General Nobile in the *Italia* was received on the morning of May 25, when the airship was approaching Spitsbergen on the way back from the Pole in bad weather. Various relief measures have been taken in the hope that the explorers have reached land in safety. The *Citta di Milano*, the *Italia's* base ship, made a cruise from King's Bay to Amsterdam Island, where heavy pack-ice forced her to return. The *Times* reports that Norway has sent Lieut. L. Holm with an aeroplane by sea to Spitsbergen, where Capt. R. Larsen will probably join him. The Store Norske Spitsbergen Coal Co. has arranged to put at the disposal of the search a team of sledge dogs with experienced dog-drivers. They will be sent overland from Advent Bay. The Italian and Swedish Governments also propose to send aeroplanes, and the Soviet Government has dispatched an ice-breaker from Archangel to the Barents Sea. The most probable place for the airmen to be found is the northern coast of Spitsbergen. There they may have found a few Norwegian trappers wintering. Sea communication with the north coast is not yet open, and the explorers, in want of sledge equipment, may have decided against an overland journey to King's Bay or Advent Bay. On the other hand, if the *Italia*, by want of fuel, or by damage to the envelope, was forced down on the drifting ice, there is less hope of the explorers having been able to reach safety. But the lack of news for some weeks need not be taken to imply disaster to all on board. The *Italia* may even have been carried as far as Novaya Zemlya.

The Samuel Augustine Courtauld Institute of Biochemistry will be opened at the Middlesex Hospital on June 14 by H.R.H. Prince Arthur of Connaught. At the ceremony, Sir Archibald E. Garrod will give an address on "The Place of Biochemistry in Medicine." The Institute, which is part of the scheme for the new Middlesex Hospital, was made possible by the generosity of Mr. S. A. Courtauld. It occupies a site at the back of the present Hospital and is six stories high, with a basement and sub-basement, connected to the main building by underground passages and a bridge across Union Street. Below ground is the boiler-house, designed to meet the needs of the whole of the new Hospital; on the ground floor is a well-designed restaurant for students of the Medical School; the upper five floors are given over entirely to biochemical work, and consist of four large fully equipped laboratories, one for students, another for clinical routine work, and two for research. There is also a series of small rooms for special purposes, such as the incubator room, the dark room, large-scale preparation room, library, office, and private room. Besides these, on the top floor there is some space that has not yet been allotted, and two large well-ventilated animal houses. The whole Institute is fully equipped with the most up-to-date apparatus, and everything has been done to ensure that the best possible means are at the disposal of the professor and his staff for the furtherance of biochemical research.

At the thirty-seventh annual general meeting of the Institution of Mining and Metallurgy, held at Burlington House, Piccadilly, on May 17, Mr. R. E. Palmer, president of the Institution, occupied the chair. In the course of the proceedings, the Hon. Peter Larkin, High Commissioner for Canada, presented to the Institution on behalf of Canadian friends and admirers of the late Dr. Willet G. Miller, Provincial Geologist for Ontario, a replica of the portrait of Dr. Miller which is now hanging in the Ontario Parliament Buildings. The president received it on behalf of the Institution. Dr. Miller was the recipient of the Gold Medal of the Institution in 1915, "in recognition of his eminence as an economic geologist, and of the important part played in mining by economic geology." Mr. Palmer then presented the Gold Medal of the Institution to the Right Hon. Sir

Alfred Mond, "in recognition of his scientific and industrial services in the development of the mineral resources and metallurgical industries of the British Empire." Sir Alfred Mond acknowledged this award of the highest honour the Institution can confer in a speech of considerable interest, in which he reviewed the advances made in the mining and metallurgical industries more particularly from the Empire point of view. Mr. Palmer delivered his presidential address, having for its subject "The Institution—its Objects, Aims, and Value, not only to the Members, but to the Profession and Mining Industry as a whole," after which he inducted the new president, Prof. S. J. Truscott, into the chair.

THE coming congress of the International Astronomical Union at Leyden on July 5–12 offers every prospect of being an important and interesting meeting. Between two and three hundred delegates, representing more than twenty countries, so far removed as Japan and Mexico, will meet to discuss programmes of work which either require international co-operation or are best forwarded by general agreement in many details. For the first time since the War, representatives of the Central Powers and of Russia will be present; this year they come as visitors, but it is to be hoped that at the next conference their countries may have seen their way to enable them to come as full members. The main work of the Union lies in the meetings of some twenty-seven standing committees devoted to special lines of astronomical work. Resolutions adopted by the various committees will, after any financial implications have been examined, be placed before a general assembly of the Union at the close of the meeting. A visit to the Zuider Zee reclamation works is among the functions on the lighter side of the programme of the Union. The president is Prof. W. de Sitter, Director of the Leyden Observatory, and the local secretary is Dr. Hins, of the Observatory staff.

THE effects of recent electricity legislation in Great Britain on the status and salaries of the engineers employed in the electricity supply industry is producing new difficulties which will have to be overcome if the community is to benefit. According to the Act, if a station fails to generate electricity at a price less than that at which it can be supplied to it by the Central Board, it is liable to lose its status as a generating station and be converted into a distributing station. Now the price which a station charges for electricity depends on the salaries and wages of the engineers it employs. If these are too low, it may be flourishing at the expense of other stations which pay their workmen higher wages. It seems necessary that some special legislative machinery be employed which will adjust salaries and wages, and so prevent strikes. It looks as if the electricity supply industry has become, or is on the point of becoming, the most vital industry in Great Britain. As the machines for producing the electric energy needed for electric lighting and industrial purposes are being concentrated in a few very large stations, the whole system will be very vulnerable to labour disturbances and a very brief stoppage would inflict most serious loss on the country. Formerly, railway transport could claim to be the most vital industry, but the general strike which happened a few years ago proved that road motor transport, its formidable competitor, could greatly mitigate the damage that would otherwise have fallen on the public. The objection to legislative machinery to prevent strikes and lockouts is that there are always some employers and trade unions who will ignore the proper channels for ventilating grievances.

SIR ERNEST RUTHERFORD, Cambridge, and M. Jean Perrin, professor of physical chemistry at the Sorbonne, have been elected associates of the Royal Academy of Belgium.

SIR WILLIAM J. POPE has been elected Prime Warden of the Goldsmiths' Company in succession to Sir John Mullens. Other fellows of the Royal Society who have been Prime Wardens of the Company are Mr. George Matthey, Sir Frederick Bramwell, Sir Frederick Abel, Sir J. Wolfe Barry, Mr. C. T. Heycock, and Sir Dugald Clerk.

MR. E. A. REEVES, map curator and instructor in practical astronomy and surveying to the Royal Geographical Society, has been awarded the Society's Victoria Medal. Mr. Reeves was president of Section E (Geography) at the Newcastle meeting in 1916 of the British Association, and is a distinguished cartographer. The Victoria Medal is given occasionally for purely scientific attainments, the last award being in 1927, to Sir Charles Close.

MR. H. RICHARDSON, Principal of the Bradford Technical College, has been made Officier d'Académie by the French Government. Mr. Richardson, who was formerly a Beyer fellow of the University of Manchester, was, before he received his present appointment, director of university studies in the College of Technology, Manchester, and secretary of the Board of the Faculty of Technology in the University. He has been closely concerned with the development of technical education in the textile industry. The French order 'Palmes Universitaires,' designed "to honour eminent talent and to reward services rendered to education," comprises two grades, Officier d'Académie and Officier de l'Instruction Publique. It is the former decoration which Mr. Richardson has received.

AN earthquake of moderate intensity was recorded at Kew Observatory on June 1, at 13 hr. 24 min. 51 sec. G.M.T. The epicentre is estimated to have been 5770 miles away, but the records are too small to give any indication of the direction.

THE Royal Danish Research Ship *Dana* is to leave Copenhagen about June 8 on a two years' world cruise under the command of Dr. Johannes Schmidt. We understand that both physical and biological work will be undertaken, and as regards the latter, it is expected to include much more pelagic than bottom work. All the oceans of the world will be visited, but special attention will be given to the western part of the Pacific Ocean.

OWING to numerous requests on the part of archæologists, Mr. Reid Moir will make an exhibit in London, during June and July, of specimens

illustrative of all the phases of prehistoric man as revealed in recent years in East Anglia. The exhibition, which, through the kindness of the Society of Antiquaries, is being held in its rooms in Burlington House, will open on Monday, June 18, and close on Saturday, July 7. There will be no charge for admission. The specimens will be on exhibit from 10 A.M. to 6 P.M. daily, with the following exceptions: Tuesday, June 19 and 26, 10 A.M. to 1 P.M.; Saturday, June 23 and 30, and July 7, 10 A.M. to mid-day. The exhibit will be explained by geological sections, and each group of specimens will be carefully labelled.

THE Advisory Committee recently appointed by the president of the Scottish Board of Health—the Right Hon. Sir John Gilmour, Bart., Secretary of State for Scotland—held its first meeting on Friday, June 1, at the offices of the Board, 121A Princes Street, Edinburgh, under the chairmanship of Sir John Findlay, Bart. Sir John Gilmour, who received the members of the Committee, referred to the difficulty and complexity of the problems on which the Committee has been called upon to advise, and gave an assurance that any practical proposals put forward for reducing the pollution of rivers would receive sympathetic consideration. The Committee considered the general scope of the terms of reference given to it, and resolved to carry out, as a preliminary measure, an investigation of the extent, nature, and effect of pollution on the River Tweed and its tributaries and of the administration of the Rivers Pollution Prevention Acts in that area. Evidence is to be invited on behalf of the various interests concerned.

A REMARKABLY cheap geological map of Europe has been made available by the Oxford University Press. It is not new, but is a re-issue of the map, well known to older geologists, that was prepared by Topley and Goodchild for Sir Joseph Prestwich. The size is 22 in. × 16 in., and as the map is durably mounted on linen to fold, it should, at the modest price of half-a-crown, appeal to students all over the world. Although more detail may have been presented in later and more expensive maps, the Oxford map has the very real advantage of clearly displaying the major structural features by means of a simple but effective system of colouring. Despite its age there is no reason to regard it as out-of-date, for within the limited scope of its small scale it still remains a trustworthy guide to the salient features of a continent which, in the west and south, is too complicated for detailed representation on a map of any reasonable scale. Thus, even apart from the low price, it may be confidently recommended as a most useful adjunct to the study of the geology of Europe.

THE List of Second-hand Scientific Instruments (No. 92) which has recently been issued by Messrs. C. Baker, 244 High Holborn, W.C.1, is larger than usual, for the customary January list was held over. The catalogue, which contains nearly sixty pages of matter, contains a big selection of apparatus, mainly optical in character. More than a third relates to microscopes and accessories, and the short electrical section contains instruments which were the property of the late Sir David Salamons. Photographic apparatus is now brought together in a separate catalogue, so it does not appear in the general list. Intending purchasers of microscopes or fittings, and surveying and electrical instruments, should certainly see Messrs. Baker's List No. 92.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A head of the mechanical and civil engineering department of the Technical College, Sunderland—The Chief Education Officer, Education Offices, Sunderland (June 12). An assistant librarian at Birkbeck College —The Secretary, Birkbeck College, Breams Buildings, Fetter Lane, E.C.4 (June 12). Three forest officers, on probation, under H.M. Forestry Commissioners—The Secretary, Forestry Commission, 22 Grosvenor Gardens, S.W.1 (June 14). A professor of electrical engineering under the Egyptian Ministry of Education—The Director, Egyptian Education Office, 39 Victoria Street, S.W.1 (June 14). A lecturer for production engineering at the County Technical College, Wednesbury—The Director of Education, County Education Offices, Stafford (June 16). A junior technical officer in an Admiralty Experimental Establishment—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (June 16). A temporary assistant lecturer in the training department (women) of the University College of South Wales and Monmouthshire, with special qualifications in biology and nature study—The Registrar, University College, Cardiff (June 19). An assistant in the library of Bedford College for Women—The Secretary, Bedford College for Women, Regent's Park, N.W.1 (June 20). Professors of civil engineering, mechanical engineering, and electrical engineering, at the College of Engineering, Guindy, Madras—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1 (June 23). An assistant lecturer in physics at the University College of Wales, Aberystwyth—The Secretary, University College of Wales, Aberystwyth (June 24). A lecturer in textile physics in the department of textile industries of the University of Leeds—The Registrar, The University, Leeds (June 25). A temporary reader in organic chemistry in the University of Dacca, East Bengal—The Registrar, University of Dacca, East Bengal (June 26). Two lecturers at the Municipal Technical College, Swansea, with qualifications in two of the following subjects—chemistry, botany, and pharmacy—The Director of Education, Education Office, Dynevor Place, Swansea (June 28). A research student in the department of medical entomology of the London School of Hygiene and Tropical Medicine—The Secretary, London School of Hygiene and Tropical Medicine, 23 Endsleigh Gardens, W.C.1 (July 7). An assistant in field husbandry at the Massey Agricultural College, New Zealand—The High Commissioner for New Zealand, 415 Strand, W.C.2. A lecture assistant and laboratory steward in the chemistry department of the Royal Technical College, Salford—The Secretary for Education, Education Office, Salford. A lecturer in geography, botany, and zoology at the Bedford Training College—The Principal, Training College, 14 The Crescent, Bedford.

Research Items.

BEISAN.—Some additional particulars of the cult objects found in the temples of Tell el-Hosn at Beisan by the expedition of the Museum of Pennsylvania to Beth-shan, are given in an account of the excavations by Mr. Alan Rowe, Field Director, which appears in the *Museum Journal* (Philadelphia) for the last quarter of 1927. Two new Canaanitish temples were discovered, bringing the total up to six, a door jamb showing a portrait of Rameses-Wesr-Khepesh, the actual builder of the temple of Dagon of 1 Chronicles x. 10, and the blackened trunk of a palm tree, proving that the date, now entirely absent from Beisan, flourished there 3400 years ago. It is known also to have been plentiful in Byzantine and early Arabic times. In the inner sanctuary of the southern temple of Thothmes III. was found the shoulder blade of a young bull, part of the animal sacrifice which was offered in the adjoining room. In this room were the altar of sacrifice, the channels for the blood, and the hole containing the remains of the wooden post to which the victim was attached. At the south end of the altar were two horns of a bull that had been slaughtered upon it, and to the west, a collar bone of a bull with a sacrificial dagger of bronze and wood. The bull was about three years old, recalling the bullock of three years offered by Hannah in Shiloh. A hole near by with small pieces of wood and a semi-circular piece of plaster, suggested that here was a pole on which the carcase was suspended for dressing, as shown in the papyrus of Anhai. A heavy bronze pendant showing a lion seizing a bull (?) was probably an amulet which hung on the neck of the victim. In the southern corridor were found hundreds of cigar-shaped clay objects, 3½ inches in length, which were doubtless votive offerings representing rolls of bread or cakes for the Queen of Heaven. Of two round objects of clay, one showed a seal impression containing the Egyptian word *imenyt*, ‘daily offering,’ which is here compared with ‘shewbread’ of Israelitish usage.

LIVER IN PERNICIOUS ANÆMIA. — Pernicious anæmia is a disease characterised by progressive blood destruction and usually terminating fatally within three or four years whatever the treatment. In 1925, Whipple and Robscheit-Robbins observed that in the treatment of experimental hæmorrhagic anæmias in dogs, a diet rich in liver exerted a remarkable regenerating effect. A little later, Minot and Murphy applied this observation to the treatment of pernicious anæmia in man, and announced last year that they had treated 125 cases of this disease, with success in practically all the cases. A number of reports by other observers has now appeared which fully substantiate the curative effect of liver treatment in pernicious anæmia (*Lancet*, April 28). The liver must be given raw, or very lightly cooked, 200 grams, or thereabouts, daily, and the diet has to be continued for weeks or months. Some individuals fail to tolerate the diet, and it needs careful regulation. Certain liver extracts may be substituted for the liver itself. The beneficial effect of the treatment is seen both in the general improvement in the patient and in the regeneration of the blood.

THE BIRDS OF CHINA.—In spite of the troubles in which its country has been plunged, the Peking Society of Natural History has been able to issue a new part of Volume I. of its *Bulletin*, containing a second and final instalment of a tentative list of Chinese birds by Messrs. Wilder, Gee, and Moffett. The part shows evidence of difficulties in production: it bears no date (the copy before us arrived at NATURE office on April 10), but the many errata might have been much reduced by careful proof-reading. The present part deals with the Passeres, and has followed modern precedent in splitting many of the older genera. The number of species in the completed list is 1028, or, if sub-species be added, 1468 forms. The list is intended to be a real guide to Chinese birds, for all the information is repeated in Chinese and the genuine colloquial names of species, as well as Chinese translations of the English names, have been inserted.

COPEPODS AND HYDROGEN ION CONCENTRATION.—Mr. A. G. Lowndes, in a paper entitled “Freshwater Copepoda and Hydrogen Ion Concentration” (*Annals and Magazine of Natural History*, Ser. 10, vol. i, April) embodies the results of several years' continual observations undertaken in order to find out the connexion (if any) between the distribution of freshwater copepods and the hydrogen ion concentration of the water in which they lived. The method was very simple, the pH of various pieces of water being taken directly in the field and the copepods collected being carefully identified in the laboratory. The localities studied, besides many in England, include the Island of Skye and Spitsbergen, and a large number of genera and species is recorded. The pH varies from 3·0 to 9·8, and although no species occurs through the whole range, yet all those studied are capable of living within a very wide margin. Thus a variety of *Cyclops longvidus* can live between pH 3·0 and 7·2. This copepod, selected for special observation and reared from egg to adult under the widest possible variation of hydrogen ion concentration, showed that provided calcium and magnesium salts were not present in too great a quantity, a high value of pH is not injurious. It bred freely, and there was no alteration in structure so far as direct measurements could show. Individuals taken from ponds with low and high pH showed no more variation than those taken from the same pond. It is shown from these observations and experiments that the hydrogen ion concentration can have no direct influence on *Cyclops longvidus*, and its influence on other species is probably small.

THE SHELL OF TORTOISES.—It has been shown that plates of bone, superficial to the true bony skeleton, occur in the carapace and plastron of certain tortoises, and Oliver P. Hay has suggested that these represent the relics of a primitive superficial armour, which still remains almost complete in the leather-back turtle, *Dermochelys*. In a second contribution on the subject (*Proc. U.S. Nat. Mus.*, vol. 73, art. 3) Hay describes these epithecal bones in another specimen of the South American “matamata,” *Chelys*. He considers that primitively the horny scutes upon the surface of a tortoise's armour coincided with epithecal ossicles, but that in the highly developed thecophorous turtles the coincidence no longer exists. This leads him to suppose that, contrary to the usual view, the horny shields had primarily no relation to the costal plates, but were intimately related to a more superficial series, the epithecal plates. As a result of the ultimate suppression of the latter in the course of ages, the horny shields were brought into contact with the more deeply lodged thecal bones. The shields themselves do not grow at their edges merely, but a new layer of horn is laid down upon the whole inner face.

FLOWERING PLANTS OF THE PANAMA CANAL ZONE.—The Smithsonian Institution of Washington, D.C., has just published a handbook on the flowering plants

of the Panama Canal Zone. It is the work of Paul C. Standley, of the National Herbarium, and is the result of co-operation of the Smithsonian Institution, the U.S. Department of Agriculture, and the Canal Zone Authorities. The handbook is on the popular plan and will be found useful to lumbermen, horticulturists, and casual visitors. Since many of the plants of the Canal Zone are common to all Central America and the West Indies, the usefulness of the book is correspondingly increased. Besides a brief description of each plant, the author discusses its history, gives all the vernacular names so that the plant can be readily identified locally, and a résumé of its uses.

COLOUR VARIETIES OF RICE.—A study of colour inheritance in rice has been made by Messrs. Mitra, Gupta, and Ganguli (*Memoirs Dept. Agric. India*, Bot. Series, vol. 15, No. 4) in Assam. The amount of natural crossing is found to be so low as 0·5 per cent, perhaps owing to the heavy rains and morning dew preventing the aerial transference of pollen. The colours of different parts of the rice plant are inherited independently, although there may also be correlation of colour in these parts, which include the leaf-sheath, pulvinus, ligule, auricle, internodes, outer and inner glume, stigma, and kernel. The pigmented cell sap may give red, yellow, brown, purple, and black colours, but they usually disappear from the mature plant except in the spikelet. Purple is dominant over green or white, red over white, green or yellow over brown, and black over green or yellow, and dominance may also be incomplete. Purple, pink, brown, yellow, red, and black colours appear in a series of shades determined by independent colour factors. When coloured and non-coloured factors were crossed, a Mendelian 3 : 1 ratio generally resulted, but in more complicated cases 9 : 7, 9 : 3 : 4, 9 : 6 : 1, etc. Thus the pulvinus is white or purple, and when certain forms with white-green pulvinus were crossed together, the F_1 was light purple (intermediate), while the F_2 gave a ratio of 9 purple : 7 green. In one case white × white stigma gave 15 white : 1 purple stigma in F_2. A detailed study of the colour inheritance in various organs is useful in delimiting the many varieties of cultivated rice.

NEW CALIFORNIAN MIOCENE MOLLUSCA.—New species of mollusca, and one *Serpula*, from the Vaqueros and Temblor formations of the Californian Miocene are described by L. W. Wiedey (*Trans. San Diego Soc. Nat. Hist.*, vol. 5), no attempt, however, being made at present to monograph the faunas as a whole. The material has been collected from widely scattered localities in the State south of the San Francisco Bay region. A historical view of the two formations precedes the systematic description of 34 new species (including the *Serpula*) illustrated on 13 very good plates. The faunas of both present warm-water aspects in their assemblages of genera. While the preceding Upper Oligocene fauna was predominantly of cool-water nature, an invasion of many truly tropical genera took place during the Vaqueros, which was succeeded by somewhat cooler conditions during the Temblor formation, when a warm temperature type is indicated as having prevailed.

THE LUNAR PERIODICITY OF EARTHQUAKES.—During the year 1927 the seismographs at the Hawaiian Volcano Observatory recorded 1149 local earthquakes (*Volcano Letter*, No. 170, Mar. 29). Among them, the regular recurrence of times of increased seismic activity was too noticeable to be set aside as accidental. These epochs of greater activity occur at intervals of about two weeks and near the times of the first and last quarter phases of the moon. According to Perrey's first law, similar epochs coincide nearly with the times of new and full moon, but it should be remembered that Perrey's law relates to ordinary earthquakes, while most of the Hawaiian tremors are of volcanic origin.

EXPLORATION IN NOVAYA ZEMLYA.—The exploration of Novaya Zemlya, in spite of a Norwegian expedition a few years ago, was far from complete when in 1921 the Russian Institute for the Exploration of the North begun a series of systematically planned expeditions. The work has continued year by year up to the present, under the direction of Dr. R. Samoilovitch, who gives a summary with map in *Arktis* (Heft 1/2; 1928). The most important part of the work lay on the survey and geological examination of the east coasts, particularly of the northern island, which were previously imperfectly known. A great deal of oceanographical work was also done, including an examination of the fauna of the shore waters and the currents of Kara Strait. Favourable ice conditions in 1927 allowed a cruise to Franz Josef Land and back, on which many oceanographical stations were made. When the results are available, they should fill some of the gaps in the knowledge of the Barents Sea.

COAL-SEAMS OF NORTHUMBERLAND AND DURHAM.—During the past few years, Dr. Wm. Hopkins has been collecting evidence bearing on the correlation of the coal-seams of the north-east coalfield of England, and his results and conclusions, now published (with a very full discussion) in the *Trans. Inst. Min. Eng.* (vol. 74, pp. 221-241; 1927; and vol. 75, pp. 49-59; 1928), constitute an important contribution to our knowledge of a field which until recently has been unduly neglected. Dr. Hopkins has modified the hitherto accepted correlations of some of the more important seams, and the scheme which he advocates is illustrated by two plates of vertical sections. The sources of evidence collected from pit to pit include the thickness, lithological characters, and sequence of the beds intervening between the seams, and in particular the characters of the fossil bands associated with the seams. Some of the mussel bands can be used to confirm or modify the tentative conclusions based on other lines of evidence, and the 'ostracod band' above the Harvey seam, comprising a unique assemblage of mussels, annelids, and ostracods, affords a particularly valuable datum plane, since it can be traced over the greater part of the field, and is everywhere stamped with a succession of characters not simulated in any way by the other fossil bands of the area. Dr. Hopkins has brought into order a confused mass of data, and has established a general framework which itself suggests new problems for future investigations.

RYDBERG TERM TABLES.—Rydberg's tables of $N/(m+a)^2$, which have been invaluable in the analysis of the series spectra of neutral atoms, contained several errors as they appeared in the standard "Seriengesetze der Linienspektren" (Paschen-Götze). They have been reprinted in a corrected form in the April number of the *Journal of the Optical Society of America*, together with the four-, nine-, and sixteen-fold numbers appropriate to the spectra of singly, doubly, and trebly ionised atoms respectively. The computing has been done partly by Prof. Paschen himself, and partly by Messrs. C. J. Humphreys, J. E. Mack, and R. A. Sawyer. The last-mentioned author, who was recently associated with Prof. Paschen in the analysis of the first spark spectrum of aluminium (Al II), has translated a short article by the latter describing the method of use of the tables.

OIL AND GAS AT BELL SPRINGS, WYOMING.—The enterprise of the American people in continuing their detailed search for oil in the Rocky Mountain region, despite the excessive over-production of this commodity which that country, hence the world at large, is experiencing, is in many respects remarkable. It is attested periodically by the appearance of appropriate bulletins of the United States' Geological Survey, of which No. 796—D, the work of Messrs. C. E. Dobbin, H. W. Hoots, and C. H. Dane, is the latest example. Perusal of this account of the Bell Springs region does not encourage the belief in any ultimate discovery of a second Salt Creek, the one really big oilfield which this State, incidentally the whole Rocky Mountain region of the United States, has produced. On the contrary, save for the striking of dry gas at the top of the Cloverly formation (Cretaceous) on what is known as the Separation Flats structure, little of economic interest seems to have eventuated from some eight years of exploration. Technically this dry gas, in really large quantities, presents some interesting problems, both to the geologist and to the engineer. In this case, the first yield was at the rate of 11,000,000 cubic feet per day, which was afterwards increased by drilling 30 feet deeper to 15,000,000 cubic feet, at a pressure of 860 lb. per square inch. Ordinarily, it might have been presumed with reason that further drilling would reveal the presence of some petroleum, but, instead, the well in question went to water, and all attempts to shut it off by plugging back to the gas zone, failed. The moral seems to be that in this Rocky Mountain region large quantities of *dry* gas (in itself entirely a commercial proposition providing it occurs in accessible areas and can be economically fed to centres of civilisation, as in Alberta, Canada) tend to be indicative of the absence of petroleum in any magnitude. The literature is full of similar examples from this region, and the chief problem raised is that of the genesis of the gas: how it comes about that such enormous quantities of dry gas are formed without the accompanying achievement of mineral oil. Alternatively, if petroleum was formed initially, what has become of it?

STANDARDISATION OF SILVER NITRATE SOLUTIONS FOR USE WITH SEA WATER.—For more than twenty-five years standard sea water obtainable only from the Hydrographic Laboratories of Copenhagen has been used for the standardisation of silver nitrate solutions used in oceanic investigations. Several criticisms of this standard have appeared recently, and in the *Journal of the American Chemical Society* for March, T. G. Thomson describes experiments from which he concludes that the use of pure sodium chloride solutions and ordinary standard apparatus gives equally accurate results. Two solutions of silver nitrate were estimated, with both pure sodium chloride solutions and standard sea water from the Hydrographic Laboratories. The results obtained with each standard closely agreed within the limits of experimental error. The empirical formula $Cl_w = 0.008 + 0.99980\ Cl_v - 0.001228\ Cl^2_v$ was derived for the conversion of the chloride per litre at 20° C. to the chlorine per kilogram; Cl_w represents grams of chlorine per kilogram and Cl_v grams per litre.

COAL CARBONISATION TESTS.—In accordance with the established scheme of the Department of Scientific and Industrial Research, a test has been carried out on another type of plant for carbonising coal at low temperatures (Department of Scientific and Industrial Research. Report of Test by the Director of Fuel Research on the Crozier Retort installed by Mineral Oils Extraction, Limited, at Wembley. (London: H.M. Stationery Office, 1928. 9*d*. net.). This retort was designed primarily for the treatment of shale. It is a vertical retort of elongated cross-section externally heated, but having as a special feature cross flues at five levels, whereby the heating gases are carried through the body of the charge. The retort is operated intermittently, but might conceivably be worked continuously. Owing to the elaborate internal construction, it cannot be used with coking material and the actual test was made on a Scotch splint coal with scarcely any tendency to fusion. The yields (per ton) were: coke 15·4 cwt., gas of low calorific value 23·9 therms, tar 16·4 gal., crude spirit 0·8 gal., ammonium sulphate 9·1 lb. From the results given, it is clear that the plant has a limited field of service so far as coal is concerned, and from the account given of the test, it seems as though there is room for considerable perfection in details of design.

THE QUANTUM YIELD IN THE PHOTOCHEMICAL DECOMPOSITION OF NITROGEN DIOXIDE.—From the pressure changes which occur when nitrogen dioxide is exposed to the radiation from a mercury vapour lamp, Norrish concluded that to a certain extent nitric oxide and oxygen are produced by photochemical decomposition of the dioxide. In the *Journal of the American Chemical Society* for March, R. G. Dickinson and W. P. Baxter describe experiments which confirm this view and afford measurements of the quantum yield of the reaction with monochromatic radiation. The conditions were arranged so that the pressures of the reaction products were sufficiently low (less than 0·1 mm.) for their rate of recombination to be very slow. The reaction could thus be considered simply as a decomposition rather than a photochemical equilibrium. After exposure, the nitrogen peroxide was frozen out with liquid air and the pressure of the residual gas measured by means of a quartz fibre gauge. The yield was found to be largely independent of the pressures of NO_2 and N_2O_4, but was greatly influenced by the wave-length of the radiation. It is assumed that the first step in the reaction is the absorption of a quantum by a molecule of NO_2, which then reacts with an unactivated molecule: $NO_2 + h\nu \rightarrow NO'_2$; $NO'_2 + NO_2 = 2NO + O_2$. In the absence of degradation to heat or other loss of energy, the yield should be unity. The most effective wave-length used was 3660 A., which gave a yield of 0·77.

THEORY OF THE AUTOGYRO.—An autogyro obtains remarkably high lift forces from a system of freely rotating blades, and it is important to develop a theory which will explain the behaviour of an autogyro and will provide a method of estimating the effect of changes in the fundamental parameters of the system. In R. and M. 1111, Aeronautical Research Committee (London: H.M. Stationery Office, 1928. 1*s*. 6*d*. net) Mr. H. Glauert develops a theory depending on the assumptions that the angles of incidence of the blade elements are small, that the interference flow is similar to that caused by an ordinary aerofoil, and that only first order harmonics of periodic terms need be retained in the equations. An alternative method of analysis by considering the energy losses of an autogyro is developed in an appendix to the main report. The maximum lift coefficient of an autogyro, using the disc area as fundamental area and the forward speed as fundamental speed, lies between 0·5 and 0·6 in general, and the best lift-drag ratio is of the order of 6 or 8 at most. Moreover, since it is necessary to maintain a sufficient ratio of tip speed to forward speed, the stalling speed of an autogyro must rise with the maximum speed of level flight, and so the principal merit of the autogyro system, the low landing speed, would disappear in the case of high speed aircraft.

The Cracking of Lead Cable Sheathing.

A PAPER on the important practical subject of "The Deterioration of Lead Cable Sheathing," by Messrs. S. Beckinsale and H. Waterhouse, read at the spring meeting of the Institute of Metals, represents work done in the Research Department, Woolwich, for the British Non-Ferrous Metals Research Association. The authors have examined a large number of lead cable sheaths which have failed in service by inter-crystalline cracking, and it was found in all cases that the material which had failed was lead of a high degree of chemical purity. It has been suggested that this type of cracking may have resulted from overheating during the extrusion of the sheath. It is shown, however, in the present paper that for lead of the composition generally used, working can be done from room temperature up to within a few degrees of the melting point without leading to cracking, and the only difference observed in the lead rolled at different temperatures was that the grain size tended to increase as the temperature was raised. It was not found possible to reproduce any cracking corresponding with that observed in service by variations of the working temperature.

It has been observed previously that the structure of the same cable sheath varies very appreciably so far as the size of the crystals is concerned. This point has been taken up with considerable care by the present authors, and they have shown that there is no probability that appreciable grain growth has occurred during service. They have also failed to find any reason to believe that there is a relationship between the frequency of the cracking and the crystal size. This type of cracking has also been attributed to allotropic changes in the lead, but careful work, both pyrometric and mechanical, has failed to reveal any evidence of such allotropic change, and it is considered that the possibility of such things being in any way responsible for the cracking must be dismissed.

Cracking is well known to occur in brass which is subjected to the simultaneous effect of stress and corrosive action. Similar cracking in lead has been obtained under the combined action of tensile stress and corrosion with solutions of acetic acid or lead acetate. It is not believed, however, that such corrosive attack can have any important bearing on the present subject, since it was observed that the cracking in service commenced on the inner surface of the sheath and spread outwards, and that it was not until the cracks had reached the exterior surface that the slightest evidence of local corrosion of the inner surface could be detected. It was shown, however, that while silver, copper, bismuth, and nickel all diminished the resistance of lead to corrosion in soluble acetates, arsenic, cadmium, and particularly tin and antimony, all rendered lead more resistant. There are cases on record where acetic or some other organic acid appears to have played an important part in the failure by corrosion of lead sheet and cable sheathing which had been in contact with oak, though pitch pine and deal appear to be without action. Creosote, if free from acetic acid, also has no influence in the production of intercrystalline cracking.

The failure of the sheathing occurs generally in situations subject to vibration, or where the metal is subject to changes of length due to fluctuations of temperature, and the view that the cracking is due to 'fatigue' is one for which there is considerable support. Fatigue tests have been carried out which indicate a range of stress at the fatigue limit of approximately only 0·18 ton per square inch, and cracks were found in the fatigue test pieces which bear a striking relationship to those in the cable sheathing which had failed.

Since the cracking in service was thus in all probability due to fatigue, experiments were carried out with lead alloys in which the fatigue limit was higher. Even very small amounts of metals, such as bismuth and silver, which are regarded as undesirable impurities in certain respects, have a beneficial effect in raising the fatigue limit. The most satisfactory method of doing this, however, is to use the binary or ternary alloys of lead containing tin, antimony, or cadmium; 0·5 per cent of cadmium increases the fatigue limit to more than three times that of pure lead, while similar increases can be obtained by using ternary alloys containing cadmium and either tin or antimony. These ternary alloys have not only a high fatigue limit, but they also have a permanence of composition during melting and a resistance to oxidation at raised temperatures which are superior to those of the binary alloys, while in addition they possess good corrosion-resisting properties. F. C. T.

University Statistics,[1] 1926–27.

SINCE the acceptance by Oxford and Cambridge of annual parliamentary grants and the consequent inclusion of these two universities in the University Grants Committee's returns, these statistics have presented a fairly comprehensive survey of university work in Great Britain. For five years now the returns have comprised all universities and, with few exceptions, all university colleges in Great Britain, and it seems a pity that they are not supplemented by others, in identical form, for the excepted institutions.

The total number of full-time students of both sexes in 1926–27 was 42,354. The proportion of women to men has risen during the past five years from 14 : 36 to 15 : 35. In England as a whole women formed, in 1926–27, 28·3 per cent of the total number; in Wales, 39·3 per cent; in Scotland, 34 per cent; in London institutions, 35·7 per cent. Since the War the large body of students aided under the government scheme for the higher education of ex-service men has obscured the situation in regard to student enrolments. As this large body has gradually passed out of the universities the total number of men students has continuously fallen until 1925–26, when only 17 of the ex-service scholarship holders remained. Now for the first time the actual tendencies of student enrolments to increase are exhibited in the returns, which show an increase of 748 (men 658, women 90) over the number of full-time students in the preceding year. If from the figures shown in the returns for preceding years the number of ex-service scholarship holders are deducted, the decreases shown in 1925–26 and 1924–25 are converted into increases of 58 and 360 respectively, and the decrease in 1923–24 is reduced to 113. Similarly, the increase in the proportion of women is converted to a slight decrease.

[1] Returns from Universities and University Colleges in receipt of Treasury Grant, 1926–27. (London: H.M. Stationery Office, 1928.) Pp. 24. 3s. net.

Since 1922–23 a very remarkable change has taken place in what may be called the balance of university studies—the distribution of full-time students among the main subject groups. Between 1913–14 and 1922–1923 the returns (in which, as already stated, Oxford and Cambridge were not included) showed a fall of more than five per cent in the percentage of the total represented by students in the arts group (including theology, fine art, law, music, commerce, economics, and education), whilst the percentage represented by the medical group rose by more than three, and the percentage of the other three groups, pure science, technology, and agriculture, rose very slightly. Since 1922–23, on the other hand, the returns, including now Oxford and Cambridge, show a rise in the percentage of the arts group from 40·8 to 51·7, whilst the number of students in that group has risen by above 3500, despite a fall of more than 2000 in the grand total of students. The position of the pure science and agriculture groups has remained fairly steady, but for the medical and technology groups both percentages and actual numbers have markedly decreased, namely, from 11,866 (26·6 per cent) and 5567 (12·5) to 8415 (19·9) and 3970 (9·4) respectively. The greatest changes were in Scotland, where the percentage of the medical group fell from 35·2 to 22·7, while the percentage of the arts group rose from 38·9 to 56·1.

This extraordinary rise in favour of the arts group of subjects is attributed by the University Grants Committee to the attraction exercised, during a period of bad trade and restricted opportunities in other professions, by the improved prospects offered by the profession of teaching. This explanation is supported to some extent by statistics of teachers in grant-aided secondary schools in England and Wales. Between 1922 and 1927 their total number increased by 676, while the number of those of them who were university graduates increased by more than two thousand,—from 11,937 to 14,019—the increases year by year being 241, 419, 552, and 870. Clearly the teaching profession has been absorbing a largely increasing proportion of the universities' output of graduates. The falling off in the number of the technological students is, the Committee considers, due to the continuance of serious depression in many industries.

A similar rise in favour of the arts group of subjects and decline in number of students of technology are disclosed by recent statistics of university education in Prussia. The years 1924 to 1927 have seen in Prussia a steady decline in the student enrolments of the Technischen Hochschulen from 8603 to 7936, whilst most of the subjects grouped under the heading of arts show an increase, which is most noticeable under modern languages. Of interest in this connexion are the following extracts from the United States Bureau of Education's biennial survey of higher education, 1924–26: "Immediately after the War . . . the idea gained ground that educational institutions should emphasize training to very specific objectives. The two-year period under review gives many indications that there has been a decided reaction . . . a returning faith, if not in the disciplinary value of the so-called cultural subjects, at any rate in their practical value and in the habits of application developed by the exertion required to master them."

A new table, introduced for the first time last year, classifies research and other advanced students under the branches of study in which they were engaged. Under certain branches of science it gives the following numbers of full-time advanced students: chemistry 511, engineering 141, physics 132, botany 83, geology 52, mathematics 47, zoology 43, metallurgy 42, agriculture 35, physiology 33. Commenting on the dominant position of chemistry, the Committee suggests that the other sciences, and especially the biological sciences other than medicine, have been far too much neglected by advanced students at the universities. It observes also in regard to chemistry that the immediate demand is more for men who have combined a study of this subject with such other subjects as engineering, agriculture, bio-chemistry, and botany than for men whose special knowledge is confined to the ordinary branches of pure chemistry.

Annual Visitation of the Royal Observatory, Greenwich.

THE visitation of the Royal Observatory, Greenwich, took place on Saturday, June 2, and was attended, as usual, by a large gathering of astronomers and their friends. The Astronomer Royal presented his report for the year ended on May 10 last.

The usual observations of sun, moon, planets, and stars were made with the transit circle. The moon's longitude was 6·2″ in advance of that given by Brown's tables. The residual has been diminishing by 0·2″ per annum since the new tables were introduced in 1923. The latitude is systematically south of the tables by ½″. It will be remembered that Brown removed the constant term of 1″ which Hansen had applied to the latitude, but the observations show that some such term is needed. The catalogue of 11,000 stars between declination 32° and 64° is making good progress, and should be finished in 1930. The stars selected as comparison stars for Eros in 1931 are also being observed; they are so closely packed that it is difficult to get sufficient observations of each of them.

A re-discussion of the declinations of stars near the pole shows that there is no evidence of secular change of latitude since the erection of the transit circle in 1851. The observations would scarcely permit of a greater change than 0·1″ per century. The observations with the Cookson floating zenith telescope have been discussed both for latitude variation and aberration. The aberration constant for the seven years 1919–26 is 20·447″; that for the previous seven years was 20·442″; the corresponding values of the solar parallax are 8·814″ and 8·816″. The parallaxes of 39 stars were determined from photographs with the Thompson equatorial, bringing the total up to date to 369 stars.

Spectroscopic observations of the 'colour-temperature' of early-type stars have been continued with the 30-inch reflector; the spectroscope has been modified by the substitution of a mirror for the lens; this enables the investigation to be carried farther towards the red end of the spectrum, which previously was in bad focus. The micro-photometer has also been modified to permit shorter sections of the spectrum to be measured, thus avoiding regions of absorption. The 30-inch reflector was also used for the photography of comets Grigg-Skjellerup and Pons-Winnecke. The latter was photographed when very near the earth, its angular motion being nearly equal to that of the moon. Its nucleus at that time was quite small and stellar, permitting accurate measures to be made.

The astrographic equatorial is being used for

determining proper motions in the Greenwich zone, by re-photographing fields taken twenty-five to thirty years ago. The zone from declination 73° to 77° has been under observation during the year. Special attention has been paid to stars measurable as double stars on the plates; Dr. Groot published a paper on these stars in the *Mon. Not. R.A.S.* for last November.

The egress of Mercury at the transit of last November was observed both visually and photographically. Three consecutive transits of Mercury (those of 1914, 1924, and 1927) have been well observed at Greenwich; the first of the present century, that of 1907, was also seen by glimpses, but the contacts could not be observed.

The mean area of spots on the sun in 1927 was practically the same as in 1926. The first four months of 1928 show no appreciable change. The indications at present point to a flat maximum like that of 1907 and lower than that of 1917. The curve for the last four cycles supports the result obtained from magnetic polarities of spots, that the complete cycle comprises two eleven-year periods. An interesting album was exhibited showing photographic traces of the more remarkable magnetic storms in juxtaposition with photographs of the sun's disc at the time; in most cases there was a large sunspot near the central meridian, or a region that had been active not long before. The subject is under further investigation.

The Astronomer Royal refers with satisfaction in his report to the successful results obtained at Giggleswick in the solar eclipse of June 29. One investigation that failed at that time, the comparison of the calcium doublet in the infra-red with the *H* and *K* lines, was afterwards carried out at Greenwich with a larger dispersion. The line at 8542 A. was found to be somewhat more intense than *K*. Preparations are being made for observing the eclipse of 1929, total in the Malay peninsula; Dr. Jackson and Mr. Melotte are going, and will make further investigation of the gravitational bending of light.

Magnetic observations are now made at Abinger. The results for the last three years are:

	Decl. W.	Hor. Force.	Vert. Force.	Dip.
1925	13° 22·7′	0·18597	0·42946	66° 35·1′
1926	13 10·4	0.18581	0·42947	66 36·3
1927	12 58·4	0·18575	0·42932	66 36·2

The result for 1925 is the mean of the ten months February–November. The greatest daily movement of the air was 1003 miles on Feb. 11. Interesting traces of the sudden variations in temperature, direction of wind, and barometric pressure on this day, due to the passage of a 'line-squall,' were exhibited. The rainfall for 1927 was 27·78 inches, being 3·54 above the average. There were 82 entirely sunless days, the total bright sunshine being 27·4 per cent. of the possible amount.

The time service is now based on weekly observations with a small reversible transit instrument; it is found that the results of this differ in the mean by 0·09 sec. from those with the transit-circle. The Shortt clocks are so reliable that their rate can be trusted for a week. With reference to the distribution of Greenwich time from the broadcasting station at Rugby, the Astronomer Royal notes that the distribution of time by galvanic signals was suggested by Airy in his report for 1849 and carried out on a small scale in 1852. Note is made of the indebtedness of the time department to the enthusiasm, care, and patience of Mr. Bowyer.

A. C. D. CROMMELIN.

University and Educational Intelligence.

CAMBRIDGE.—Dr. A. E. Barclay, Christ's College, has been appointed lecturer in medical radiology and electrology. Mr. W. N. C. van Grutten, King's College, has been appointed an assistant secretary to the Appointments Board.

Prof. G. H. Hardy gave the Rouse Ball lecture on June 6 on the subject "Mathematical Proof."

The chair of astrophysics was partially endowed by an anonymous donor in 1913, and it is reported that this donor has now paid over £12,000 to the University, a sum greater than the money originally offered to the University.

LONDON.—The title of reader in physics in the University has been conferred on Miss M. O. Saltmarsh as from May 17 last, in respect of the post held by her at Bedford College. Dr. Saltmarsh studied at Girton College, Cambridge, and for two periods was engaged on research work in physics at the Cavendish Laboratory. Since 1910 she has been respectively demonstrator, assistant lecturer, and lecturer at Bedford College. She was granted leave of absence by the College Council to give visiting lectures to the department of physics at Vassar College, Poughkeepsie, N.Y., U.S.A., in 1920–21. Her recent published work has been on spectrum analysis.

Applications are invited for the Graham Scholarship in pathology, value £300 per annum, and tenable in the first instance for two years, founded to enable "a young man to continue his pathological researches and at the same time to secure his services to the school of advanced medical studies connected with University College Hospital as a teacher under the direction of the professor of pathology." Applications must reach the Academic Registrar, University of London, South Kensington, S.W.7, by June 26.

The following post-graduate studentships are being offered by the Council of Bedford College for Women: Amy Lady Tate research scholarship, value £125 for two years, and an anonymous research studentship, value £100 for one year. Candidates must be graduates of Bedford College in the faculty of arts or science. Applications must reach the Secretary of the College, Regent's Park, N.W.1, by June 27.

THE Research Prize awarded by the Scientific Club of Winnipeg for the best research work done in the University of Manitoba during a period of three years by a recent graduate, has been divided between Leonard B. Clark and Charles F. Goodeve, whose work was carried on in the Departments of Zoology and Chemistry respectively.

THE Streatfeild Research Scholarship in medicine and surgery, the annual value of which will probably be £250 and the tenure three years, will shortly be awarded. Applications, which should state the nature of the proposed research, the place where it will be carried out, and the status of the applicant, should be sent to the Registrar, Royal College of Physicians, Pall Mall East, S.W.1, by, at latest, June 29.

VACATION courses in glass-blowing and instrument-making have been arranged for by the Society for the Advancement of the Training of Instrument Makers (Vereeniging tot Bevordering van de Opleiding tot Instrumentmaker), for the latter half of August, in the Physical (Cryogenic) Laboratory of the University, Leyden, Holland, particulars of which are obtainable from Dr. C. A. Crommelin of that laboratory.

Calendar of Customs and Festivals.

(Addenda to May) May 29.

RESTORATION OR ROYAL OAK DAY.—Established by Act of Parliament and first celebrated in 1665 as a day of general thanksgiving for the restoration of Charles II. to the throne. It was, and still is, marked in popular observance by the wearing of an oak leaf, which at one time used to be gilded, associating the day with the story of the king's escape from the Parliamentarians by hiding in an oak. The alternative name "Oak Apple Day" was justified by the requirement in some localities that the sprig of oak should bear galls, and at Northampton, when the corporation went in procession to All Souls' Church, the charity boys and girls each wore a gilt oak apple on a sprig of oak, for which gilded potatoes were substituted if no oak apples were obtainable.

The simple form of celebration by wearing an oak leaf has been supplemented in various localities by other observances, which, it is most probable, must be regarded as transferences derived from the May Day celebrations. In Derbyshire, for example, oak boughs were hung over the doors of houses; at Basingstoke, and in the neighbouring towns, bands of men gathered oak sprigs which they hung on knockers, latches, and other parts of the doors of houses, a service for which they expected gifts of beer, etc. Garlands were sometimes hung on the doors of houses. At Durham, May 29 was one of three days on which the Dean and Chapter caused twenty shillings in copper to be scrambled for, a custom known as 'push penny,' which antedated the Restoration and went back to monastic times. The choir sang anthems from the large tower, also a May Day custom.

In Devonshire, at Starcross, the connexion with May Day was indicated by the children's custom of carrying about May babies in boxes which resembled coffins; and at Tiverton a procession included an 'Oliver'—a character dressed in black with hands and face smeared with soot, and his body bound with a strong cord, who capered ridiculously and was pelted with dirt and stones by the crowd—and a throne of oak boughs on which a child was seated.

RIDING THE MARCHES.—In Scotland, a custom analogous to that of 'beating the bounds' in England, was observed in certain districts at the end of May. At Hawick it took place on the last Friday in the month, when the standard of the town was carried by a cornet followed by the magistrates and burgesses round the boundaries, and formal demonstration of their legal rites was made. An ancient song celebrating the border contests with the English was sung by the cornet from the roof of an old tenement belonging to the town. At Inveresk this custom of riding the marches was observed once in fifty years, when a company armed with spears and including a minstrel and a fully armed champion paraded the boundaries.

June 11.

ST. BARNABAS.—On this feast it appears to have been the custom to decorate some churches with garlands of roses and woodruff. Entries to this effect appear in the accounts of St. Mary-at-Hill, London. For 1512 the entry runs: "Rec'd of the gadryng of the Maydyns on St. Barnabas Day vjs viijd."

A miraculous walnut tree which grew beside the holy thorn in the churchyard of Glastonbury Abbey never budded before St. Barnabas Day, but on that day shot forth its leaves. Cuttings from this tree were much in request at a high price, even after the Reformation, King James I. being among those who obtained them.

St. Barnabas Day was proverbially the longest day and shortest night, as indeed it would be under the Old Style, and storms were believed to be prevalent on this day.

At the parish of Hesket, in Cumberland, the Court of Inglewood Forest was held annually on St. Barnabas day in the open air. The suitors assembled on the highway side at a place marked by an ancient thorn, paid their annual dues to the lord of the forest and selected juries from among the twenty manors forming part of the demesne. Cumberland being one of the counties in England in which evidences of Norse influence are especially notable, it is not surprising to find here a survival of the Scandinavian institution of the open air communal assembly, the *thing*, and that it should be associated with a tree traditionally held in regard. The ash was also especially reverenced by the northern nations. In their legendary beliefs it was the ash tree Yggdrasi which supported the earth. There is ample evidence of the sacred tree in British folklore. In Irish belief there were five trees, situated in different parts of the country, which were looked upon with veneration as having magical properties. Of these one was a yew, one an oak, and two were ashes. The fall of these five magical trees was held to signify the triumph of Christianity over paganism. Down to historical times each tribe in Ireland possessed a sacred tree—which in some sort symbolised the existence of the clan, for if it were hewn down by an enemy it signified the overthrow of the clan. An oak tree near Oswestry, known as Mile Oak, was popularly associated with St. Oswald and was held inviolable. Many place names indicate a derivation from an association with a thorn, an ash, or an oak. Among the Celtic peoples, the hazel was specially venerated.

Tree worship was prevalent in early times among all Aryan-speaking peoples. The sacred fig-tree of Romulus in the Forum at Rome was worshipped down to the time of the Empire, and on the Palatine Hill was a cornel tree which was esteemed one of the most sacred objects of the city. At Benevento was a sacred walnut tree which was especially noted in the popular imagination as a meeting-place of witches.

June 15.

ST. VITUS DAY.—This day seems to have been connected with rain in the same way as St. Swithin. If it rained on this day, according to a popular proverb, it would rain for thirty days. Offerings were made to St. Vitus on this day as a protection against disease, and in particular against the disease with which the saint's name is associated. The reason for this association is not known. The saint, who was a native of Sicily and was martyred about A.D. 303, in an entirely legendary account which confuses two different persons, is said to have cured a son of Diocletian of possession—historically an impossibility—also Diocletian had no son.

ST. VOUGAS OR VIE (sixth century), venerated especially at Treguenec in Brittany, an Irish bishop who, like many other Irish saints, sailed on a stone across the sea. A rock off the coast of Brittany is traditionally known as 'the Ship,' and it is supposed to be that which served St. Vie. He is associated with a sacred grove. When a church dedicated to him was built on the spot where his relics had been revered, a wood was cut down. His relics at Treguenec were visited by pilgrims who sought relief from fever. In Ireland, in Carn parish, Co. Wexford, are a church and well dedicated to St. Vauk or Vaak.

Societies and Academies.

LONDON.

Physical Society, May 11.—**E. G. Richardson**: The amplitude of sound waves in resonators. After a consideration of the relations between the 'pipe' and the 'Helmholtz resonator,' graphs of the variation of amplitude, obtained by means of a hot-wire anemometer traversed through various types of resonator, are reproduced. By means of a calibrated manometer of the vibrating membrane type, some direct values of the impedance of orifices are obtained. Traverses across an orifice through which the air is vibrating in simple harmonic form are obtained with the hot wire: these show a tendency for the air to vibrate with greater amplitude in annuli remote from the centre of the orifice.—**R. E. Clay**: The focus of a gas-filled X-ray tube. Pinhole photographs of the focus obtained with various radii of curvature of the cathode and various distances from the anticathode are discussed; it is concluded that with the tubes of the type considered, a radius of about 2 cm. and a distance of 3 or 4 cm. are the best conditions.

Royal Statistical Society, May 15.—**D. Caradog Jones**: The cost of living of a sample of middle-class budgets. The budgets were divided into three groups, representing, respectively, families living in London, in large towns with a population exceeding 50,000, and in smaller towns and country places. For families of about the same type, the budgets revealed a higher level of expenditure in the small towns than in the large towns. This seems to be due in part to the higher cost of living experienced rather than to the higher standard of living enjoyed there. On an average, out of a total family expenditure of between £400 and £500 a year, in round numbers 40 per cent is spent on housekeeping and service, 20 per cent on rent, rates, fuel and light, 10 per cent on clothing, 10 per cent also on holidays, clubs, and recreation, 5 per cent on insurance. In general, the proportion of the total income spent on the necessaries of life, such as food and house-room, tends to fall as the income rises. In the normal middle-class family, nearly 40 per cent of the total food bill represented expenditure on meat, fish, bacon, etc. The dairy products, milk, butter, eggs and cheese, came next in order of importance, costing about two-thirds as much as the first group. Bread, including cakes and biscuits, and also fruit and vegetables, each accounted for roughly half as much as the dairy group. There was then a drop to 5 per cent for jam and sugar, and for tea, coffee, cocoa, etc. When this group of middle-class families is compared with the Sumner Committee group of working-class families, it is found that the middle class spend relatively more on meat, milk, and fruit, while the working class spend more on bread, tea, and sugar.

PARIS.

Academy of Sciences, May 7.—**G. Bigourdan**: The various methods used for the calculation of pendulum corrections. It is usual to employ one master pendulum and several subsidiary pendulums. The most exact method implies a continuous comparison of all the pendulums in order to eliminate any temporary irregularity in any one of them. Other methods in use are adversely criticised.—**Pierre Termier** and **Eugène Maury**: New geological observations in eastern Corsica: phenomena of crushing and lamination: mylonites and tectonic breccia.—**Georges Claude**: Obtaining energy from the sea. In connexion with this project, a 50-watt turbine has been made, which, working between 15° and 35° C. gives power of 40 kilowatts.—**Louis Roy**: The intrinsic equations of elastic surfaces with three parameters.—**C. Sauvageau**: The question of *Tilopteris Mertensii*. Observations tending to prove that this alga multiplies by simple budding. There is no alternation of generations.—**Maurice Caullery** was elected a member of the Section of Anatomy in succession to the late F. Henneguy.—**V. Hlavatý**: The second fundamental form II.: generalisation of the theorem of Enneper.—**Miécislas Biernacki**: The lines of Julia of integral functions.—**D. V. Jonesco**: Some theorems of existence of the integrals of systems of differential equations.—**Vladimir Bernstein**: Concerning a formula of F. and R. Nevanlinna relative to the meromorph functions in a sector.—**Serge Bernstein**: Functions regularly monotone.—**R. Gosse**: The equations $s = f(x, y, z, p, q)$ which admit an invariant for one single system of characteristics.—**W. Gontcharoff**: Series of zeros of successive differentials.—**J. Herbrand**: The theory of the demonstration.—**D. Riabouchinsky**: Some remarks on functions of current.—**D. Gernez**: The rapid construction on the map of lines for utilising radiogoniometric bearings taken from a vessel.—**Léopold Infeld**: Maxwell's equations in the theory common to gravitation and electricity.—**R. Darbord**: The absolute measurement of coefficients of influence.—**E. Pierret**: A new method of maintaining oscillations in a triode valve. Description of a method of obtaining stable waves of wave-length between 14 cm. and 18 cm.—**M. Fallot**: The magnetic susceptibility and second supposed isoelectric point of gelatine. Determinations of the magnetic susceptibility of gelatine as a function of the hydrogen ion concentration showed only one minimum value, at $pH = 4 \cdot 7$. The refractive index and dispersion of these gelatine solutions were found to be independent of the hydrogen ion concentration.—**G. Bruhat** and **M. Pauthenier**: Remarks on the theory of electrostriction and its experimental control.—**L. Décombe**: Electrified spherical films, the photo-electric effect and the X-ray fluorescence spectrum.—**Marcel Cau**: Double refraction and dichroism of thin films of iron obtained by distillation. The films were produced on plates of glass placed over an iron wire heated electrically in a vacuum. The films, which were grey by transmitted light and presented a polished appearance, showed double refraction accompanied by dichroism. The effect is produced by the magnetic field of the current used for the distillation.—**Marc de Hemptinne**: The photolysis of benzaldehyde. A study of the absorption spectrum suggests that benzaldehyde should be decomposed under the influence of rays of wave-length less than 2500 A., and benzene and carbon monoxide should be the products of decomposition. Experiments are described confirming these predictions.—**Aubert, Dumanois, and Pignot**: The effects of antidetonants in the vapour phase. Experiments showing that antidetonants acting in the gaseous phase increased the time of combustion.—**C. F. Muttelet**: Study of the acidity of fruit juice and of jams.—**Mme. Ramart-Lucas**: The comparative stability of isomers according to their absorption spectra.—**A. Wahl** and **Lobeck**: A new reaction of the disulphisatides.—**J. A. Le Bel**: Stalactites. A description of some peculiarities of some stalactites found in a cave at Les Eyzies (Dordogne).—**F. Dienert**: The circulation of subterranean waters in alluvium. Examples of the use of dyes for following the circulation of underground water.—**J. Viret**: The Oligocene fauna of Coderet, near Branssat (Allier).—**E. Leblond**: The formation of accessory vacuoles in *Closterium lunula*.—**R. Dieuzeide**: The transformation and disappearance of certain denticles of the skin of *Centrophorus*

granulosus.—A. Lacassagne : The action of the *K*-rays of aluminium on some micro-organisms. Details of the effects of varying time exposures to the rays on cultures of pyocyanic bacillus, prodigiosus, staphylococcus and entero-coccus.—F. Holmeck : Attempt at the interpretation from the energy point of view of the action of the *K*-rays of aluminium on micro-organisms.

CAPE TOWN.

Royal Society of South Africa, April 18.—**Th. Schrire** : On some new species of bacteria isolated from *Xenopus Lævis*. Three new organisms have been isolated from a mould-like growth on a frog (*Xenopus Lævis*). The disease could not be reproduced by inoculation with various methods, but a mixed infection with all three organisms is highly pathogenic to frogs.—**J. F. V. Phillips** : *Curtisia Faginea* Ait. ('Assegaai') : An ecological study. This tree is important sylviculturally and economically. It is best developed in the Knysna forests, although it ranges from the Cape Peninsula to the forests of Gazaland. It is very rarely a dominant, and still more occurs in pure communities. It is most at home in the medium moist forest at Knysna. In pole and later stages the species is definitely semi-light-demanding. The plant flowers regularly, fruits fairly regularly and heavily. The fruits are of moderate fertility ; the greater number aggregate at the base of the parent. The rate of growth in girth is slow.—**S. Schonland** : Materials for a revision of Crassulaceæ (The South African species of the genus *Crassula* L. emend. Schonl.). A wider view than usual is taken of specific limits, but no less than 219 species of *Crassula* are recognised in South Africa.—**H. G. Fourcade** : A new method of aerial surveying : note on the determination of the verticals of a plate pair.—**A. V. Duthie** : On a terrestrial Isœtes, *I. stellenbossiensis*, A. Duthie, from the Stellenbosch Flats. This is the third species of Isœtes to be described from the Union of South Africa. It occurs in shallow depressions, which are damp in the winter but dry during the summer months, and has been found growing beside xerophytic plants.—**Margaret R. Levyns** : Veld-burning experiments at Ida's Valley, Stellenbosch. The type of vegetation covering the area is that known as 'rhenosterveld,' which is not a stable type of plant community. Burning leads to rapid increase of the rhenoster bush and certain other plants, and also induces vigorous growth among the petaloid monocotyledons and some other plants, this vigour being of a temporary nature. Clearing the ground of bush does not favour the spread of the rhenoster bush. In this case vigorous growth is more apparent among the grasses than among the petaloid monocotyledons.

GENEVA.

Society of Physics and Natural History, April 19.—**S. C. Guha** : The microcrescometer, normal type and universal type. Study of the growth of the coleoptilum of oats. The author presents two different forms of an instrument designed to measure the growth of plants, multiplying the movements up to 5000 and 20,000 times, by means of a lever which causes an angular displacement of a mirror. He gives the first results of his observations on the daily growth of the coleoptilum of oats, showing a maximum between 10 A.M. and noon.

May 3.—**Gr. Gutzeit** : A rapid method of qualitative analysis. The author has attempted to generalise the use of spot reactions, carried out on filter paper or on a porcelain plate with depressions, with the aid of various specific organic reagents. Characteristic reactions for 23 metals and 17 acid groups are given.—**P. Rossier** and **G. Tiercy** : The auxiliary chronometer *Nm* of the Observatory of Geneva and the rating of chronometers submitted to examination. This Nardin chronometer has been regulated for mean time and compared with the Riefler sidereal time pendulum. The comparisons have been made by two different methods of measurement ; the maximum difference in the two cases has been 0·02 sec.—**P. Balavoine** : The tannin content of wine is influenced by the climatic conditions at the time of vinification. This fact has been proved by comparing products obtained simultaneously and working on a similar portion in the eastern Pyrenees and at Geneva. All the other characteristics remain similar ; the proportions of tannin are respectively 0·17 and 0·02. Other experiments lead to the same conclusion.—**B. P. G. Hochreutiner** : A new Cyrtandropsis in the Hawaiian islands. The observed facts lead to the conclusion that the Cyrtandropsis are formed from different species of the genus *Cyrtandra*, which have afterwards evolved in a convergent manner.

Official Publications Received.

BRITISH.

Canada North of Fifty-six Degrees : the Land of Long Summer Days. By E. M. Kindle. (*The Canadian Naturalist*, Vol. 42, No. 3, March.) Pp. iv+58-86+20 plates. (Ottawa : The Ottawa Field-Naturalists' Club.) 50 cents.

Air Ministry. Aeronautical Research Committee : Reports and Memoranda. No. 1122 (AE. 295) : Lift and Drag of Three Model Aeroplanes. Comparative Tests in Atmospheric and Variable Density Wind Tunnels at the same Reynolds Number. By H. C. H. Townend. (T. 2462, revd.) Pp. 6+6 plates. 6*d*. net. No. 1123 (AE. 296) : Wind Tunnel Tests with High Tip Speed Airscrews. The Characteristics of Bi-Convex No. 2 Aerofoil Section at High Speeds. By Dr. G. P. Douglas and W. G. A. Perring. (T. 2533.) Pp. 10+5 plates. 9*d*. net. (London : H.M. Stationery Office.)

The Welsh Journal of Agriculture : the Journal of the Welsh Agricultural Education Conference. Vol. 4. Pp. 431. (Cardiff : University of Wales Press Board.) 2*s*. 6*d*. ; cloth, 4*s*.

Schedule and Programme of the British Aquarists' Association Third Annual Exhibition, July 24th to July 28th (inclusive), 1928, at Trinity Hall, Great Portland Street, London, W.1. Pp. 28. (London.) 3*d*.

South Western Naturalists' Union. Annual Report and Proceedings, to 31st December 1927. Pp. 44. (Bristol.)

The Journal of the Quekett Microscopical Club. Edited by W. S. Warton. Ser. 2, Vol. 16, No. 94, May. Pp. 48. (London : Williams and Norgate, Ltd.) 3*s*. 6*d*. net.

Catalogue of Indian Insects. Part 13 : Cicindelidae. By Mercia Heynes-Wood and Cedric Dover. Pp. v+138. (Calcutta : Government of India Central Publication Branch.) 2.8 rupees ; 4*s*. 6*d*.

Falmouth Observatory. Meteorological Notes and Tables for the Year 1927. By Joshua Bath Phillips. Pp. 8. (Falmouth.)

Transactions of the Royal Society of Edinburgh. Vol. 55, Part 3, No. 32 : On the Feeding Mechanism of the Fairy Shrimp, *Chirocephalus diaphanus* Prevost. By Prof. H. Graham Cannon. Pp. 807-822. (Edinburgh : Robert Grant and Son ; London : Williams and Norgate, Ltd.) 2*s*.

Industrial Safety Congress organised jointly by the Home Office and the National "Safety First" Association, and held in Caxton Hall, Westminster, and at the Home Office Industrial Museum, Westminster, London, March 20th, 1928. Report of Proceedings. Pp. 59. (London : H.M. Stationery Office.) 9*d*. net.

Transactions of the Optical Society. Vol. 29, No. 3. Pp. 101-148. (London.) 10*s*.

Air Ministry. Aeronautical Research Committee : Reports and Memoranda. No. 1124 (Ae. 297) : Wind Tunnel Tests with High Tip Speed Airscrews. The Characteristics of a Conventional Airscrew Section, Aerofoil R. and M. 322, No. 3, at High Speeds. By Dr. G. P. Douglas and W. G. A. Perring. (T. 2530.) Pp. 14+6 plates. 9*d*. net. No. 1125 (Ae. 298) : An Analysis of some Causes of Discrepancy between the Calculated Failing Load of the Structure of an Aircraft and the Load at which Failure occurs on Strength Test. By H. B. Howard and K. T. Spencer. (D. 184, revd.) Pp. 9+5 plates. 6*d*. net. (London : H.M. Stationery Office.)

FOREIGN.

United States Department of Agriculture. Technical Bulletin No. 60 : Ineffectiveness of Internal Medication of Poultry for the Control of External Parasites. By D. C. Parman and W. S. Abbott, and J. J. Culver and W. M. Davidson. Pp. 24. (Washington, D.C. : Government Printing Office.) 5 cents.

Department of the Interior : Bureau of Education. Bulletin, 1927, No. 40 : Statistics of Universities, Colleges and Professional Schools, 1925–26. Pp. 167. (Washington, D.C. : Government Printing Office.) 25 cents.

Instituts scientifiques de Buitenzorg : 's Lands Plantentuin. Treubia : Recueil de travaux zoologiques, hydrobiologiques et océanographiques. Vol. 9, *Supplément, Janvier* : *Monographie* der Indo-Australischen Scoliiden (Hym. Acul.) mit zoogeographischen Betrachtungen. Von Dr. J. G. Betrem. Pp. iv+388+5 Tafeln. (Buitenzorg.)

Report on Norwegian Fishery and Marine Investigations. Vol. 3, No. 9 : The Rearing of Lobster Larvae at Flødevigen. By Alf Dannevig. Pp. 15. (Bergen : A.-S. John Griegs Boktrykkeri.)

Department of Commerce : Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 572 : Cause and Removal of certain Heterogeneities in Glass. By L. W. Tilton, A. N. Finn and A. Q. Tool. Pp. 719-736. (Washington, D.C. : Government Printing Office.) 10 cents.

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 37 : Experimental Study on the Effects of Low Barometric *Pressures and* Oxygen *Deprivation* upon the Efficiency of Mental and Physical Work. By Kwan-ichi Tanaka. Pp. 127-231. (Tôkyô : Koseikai Publishing House.) 1.55 yen.

United States Department of Agriculture. Technical Bulletin No. 59 : The European Corn Borer and its Controlling Factors in Europe. By W. R. Thompson and H. L. Parker. Pp. 63. (Washington, D.C. : Government Printing Office.) 10 cents.

Department of the Interior : Bureau of Education. Bulletin, 1928, No. 3 : College and University Extension Helps in Adult Education. By L. R. Alderman. Pp. iv+85. (Washington, D.C. : Government Printing Office.) 10 cents.

Japanese Journal of Geology and Geography. Transactions and Abstracts. Vol. 5, No. 4. Pp. ii+138-224+17-22+7+plates 13-23. (Tokyo : National Research Council of Japan.)

CATALOGUES.

Auswahl neuerer Bücher. Pp. 24. (Berlin und Bonn a. Rh. : Ferd. Dümmlers Verlag.)

Catalogue of Scientific Books and Publications of Learned Societies. (No. 309.) Pp. 78. (Cambridge : W. Heffer and Sons, Ltd.)

Diary of Societies.

FRIDAY, JUNE 8.

ROYAL ASTRONOMICAL SOCIETY, at 5.—W. H. Wright : Photography of the Planets in Light of Different Wave-lengths (George Darwin Lecture).—S. R. Pike : Note on the Separation of Gases in Prominences. —N. Goryatscheff : The Definitive Elements of the Orbit of Comet 1925 *c* (Orkisz).

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 5.—At 6.15 (Annual General Meeting).—M. Hine : Report on a Case of Neurofibromatosis of the Eyelid, and of a Case in which a Glass Ball burst in the Socket.—F. Ridley : Lysozyme-antibacterial Body present in Great Concentration in Tears, and Especially its Relation to the Human Eye.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—L. F. Richardson and others : Contact Potential in the Dolezalek Electrometer connected Idiostatically.—G. P. Barnard : Some Experiments on the Light-Sensitivity of Commercial Selenium Cells.—Dr. J. R. I. Hepburn : The Vapour Pressure of Water over Sulphuric Acid-Water Mixtures at 25° C. and its Measurement by an Improved Dew-point Apparatus.—Demonstration :—A simple Practical Application of the Properties of Selenium Cells, G. P. Barnard.

MALACOLOGICAL SOCIETY (at Linnean Society), at 6.—Prof. A. E. Boycott : The Habitats of *Clausilia biplicata* Montg.—R. Winckworth : Remarks on Limpets and Description of New Species of *Acmæa*.

GEOLOGISTS' ASSOCIATION (in Architectural Theatre, University College), at 7.30.—Dr. T. Robertson and T. N. George : The Carboniferous *Limestone of the North Crop of the South Wales Coalfield*.—Dr. R. L. Sherlock : The Alleged Pliocene of Buckinghamshire and Hertfordshire.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. G. P. Thomson : The Waves of an Electron.

SATURDAY, JUNE 9.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (North-Eastern District), at 10.30 A.M. (at Municipal Buildings, West Hartlepool).—At 5 (at Grand Hotel, West Hartlepool).—F. Durkin : Municipal Work at West Hartlepool.—J. H. Miers : Municipal Work at Hartlepool.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District) (at Town Hall, Wakefield), at 2.—L. Ives : Municipal Work in Wakefield.

BIOCHEMICAL SOCIETY (at Rothamsted Experimental Station, Harpenden). —E. Boyland and S. F. Cook : The Blood Pigment of Ascidians.—R. R. Morrison, P. R. Peacock, and S. Wright : The Action of X-radiation on Vitamin D in Irradiated Ergosterol.—L. R. Bishop : A Study of the Proteins in Barley.—P. H. H. Gray : Production of Indigotin from Indol by Soil Bacteria.—G. V. Jacks : The Formation of Humus.

TUESDAY, JUNE 12.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. C. Bolton : The Interpretation of Gastric Symptoms (3).

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Prof. J. S. Huxley : Some Problems of Animal Growth.

WEDNESDAY, JUNE 13.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. G. B. Barbour : A Re-excavated Cretaceous Valley on the Mongolian Border.—S. I. Tomkeieff : The Volcanic Complex of Calton Hill (Derbyshire) : a Petrological Study.—Dr. S. H. Haughton : A Brief Account, illustrated by lantern slides, of the Arrangements in Progress for the Forthcoming XVth Session of the International Geological Congress, to be held in South Africa in July and August 1929.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (Annual General Meeting) (at Northampton Polytechnic Institute), at 8.15.

THURSDAY, JUNE 14.

ROYAL SOCIETY, at 4.30.—Prof. A. V. Hill : (*a*) Myothermic Apparatus ; (*b*) The Role of Oxidation in Maintaining the Dynamic Equilibrium of the *Muscle Cell* ; (*c*) The Absolute Value of the Isometric Heat Coefficient Tl/H in a Muscle Twitch and the Effect of Stimulation and Fatigue ; (*d*) The Absence of Delayed Anaerobic Heat in a Series of Muscle Twitches ; (*e*) The Recovery Heat-Production in Oxygen after a Series of Muscle Twitches.—Prof. A. V. Hill and W. Hartree : The Anaerobic Delayed Heat-Production after a Tetanus.—C. H. Best and Ruth Partridge : The Equation of Motion of a Runner Exerting a Maximal Effort.—*To be read in title only* :—C. A. Seyler : The Dictyoxylon Cortex of Lycopodiales as a Constituent of Coal.—B. Sahni : On Clepsydropsis Australis, a Zygopterid Tree Fern with a Tempskya-like False Stem from the Carboniferous Rocks of Australia. —W. O. James : Experimental Researches on Vegetable Assimilation and Respiration. XIX.—A. W. Greenwood : Studies on the Relation of Gonadic Structure to Plumage Characterisation in the Domestic Fowl. IV.—Prof. T. P. Hilditch : Relationships between Chemical Composition of Vegetable Seed Fats and their Botanical Origin.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. G. H. Hardy : A Formula of Ramanujan.—E. L. Ince : Simultaneous Linear Partial Differential Equations of the Second Order. K. Knopp : Über Reihen mit positiven Gliedern.—Echo D. Pepper : On Density Distribution in Stellar Space.—E. G. C. Poole : Dirichlet's Principle for a Flat Ring.—T. G. Room : Notes on some Geometrical Configurations : (I.)-(VIII.).—W. E. Sumpner : Fractional Integration. —C. T. Preece : Theorems stated by Ramanujan (III.).—Prof. G. N. Watson : Theorems stated by Ramanujan (IV.).

OPTICAL SOCIETY (at Imperial College of Science), at 7.30.—Instr. Capt. T. Y. Baker : The Errors of a Reflecting Prism.—W. D. Wright : A Trichromatic Colorimeter with Spectral Primaries.—T. Smith : (*a*) The Theory of Aplanatic Surfaces ; (*b*) The Primordial Coefficients of Asymmetrical Lenses ; (*c*) Note on the Use of Lenses in Series for Sight Testing.—Demonstration :—Slides illustrating Studies in Diffraction, the late F. W. Shurlock.

SATURDAY, JUNE 16.

ROYAL SOCIETY OF MEDICINE (Therapeutics Section) (at Pharmacological Laboratory, Oxford).—Annual General Meeting and Laboratory Meeting.

MINING INSTITUTE OF SCOTLAND (at Dunfermline).

PUBLIC LECTURES.

MONDAY, JUNE 11.

KING'S COLLEGE, at 5.30.—Prof. E. L. Stevenson : The Expansion of Geographical Knowledge in the Early Renaissance as illustrated by Contemporary Maps (1) : The Geography of the pre-Columbian Period.

WEDNESDAY, JUNE 13.

KING'S COLLEGE, at 5.30.—Prof. E. L. Stevenson : The Expansion of Geographical Knowledge in the Early Renaissance as illustrated by Contemporary Maps (2) : Christopher Columbus and the Beginnings of Trans-Oceanic Discovery.

THURSDAY, JUNE 14.

INSTITUTE OF PATHOLOGY AND RESEARCH (St. Mary's Hospital), at 5.—Dr. P. Fildes : Principles of the Treatment of Tetanus with Antitoxin.

FRIDAY, JUNE 15.

KING'S COLLEGE, at 5.30.—Prof. A. Wildon Carr : Some Problems in Metaphysics (1) : The Nature of Human Freedom.

CONGRESS.

JUNE 6 TO 9.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (at Rochester).

Friday, June 8.

Geological Section.

At 10.30 A.M.—
H. H. Milner : Geology from the Air (Presidential Address).
At 11.30 A.M.—
Dr. S. W. Wooldridge : The Geomorphology of the North Downs.
At 12.30—
H. G. Dines : The Bapchild Palæolithic Site.

Zoological Section.

At 11 A.M.—
Prof. E. W. MacBride : The Conditions for Progressive Evolution (Presidential Address).
At 12 NOON—
H. H. S. Bovingdon : The Reflections of a Biologist on Food and Efficiency.

Saturday, June 9.

Regional Survey Section.

At 11 A.M.—
C. C. Fagg : The History of the Regional Survey Movement (Presidential Address).
At 12 NOON—
G. E. Hutchings : A Regional Survey of the Lower Medway Valley.

SATURDAY, JUNE 16, 1928.

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Emigration within the British Empire.

THE Report of the Oversea Settlement Committee for 1927,[1] while a distinct improvement on the corresponding report for the previous year, is still far from being a satisfactory production. It is inadequate to its theme, and such detailed information as it contains scarcely does justice to the magnitude of the expenditure incurred by the Home or Overseas governments. An official publication of this kind could be utilised as an effective stimulus to emigration of British stock from our over-populated island to the undeveloped fertile lands in our possession, for prospective emigrants are more inclined to rely upon statements in official publications for guidance than the alluring but too commonly reckless statements which appear in unofficial handbooks and pamphlets. Moreover, it should have an educative value : it should be so framed as to provoke comment in the press and Parliaments of the Dominions, and it is to be feared that this will not happen unless dogmatic assertion of fundamental policy is accompanied by careful statement of the grounds on which policy has been based.

For example, the report states that " The essential need of the Oversea Dominions for an increase of population to develop their resources and the desire that this increase should be effected by means of British stock, are the objectives on which all are agreed." But the Oversea Dominions are not reminded that failure to co-operate with the mother country to satisfy this need is a source of danger to them and of the gravest anxiety to those statesmen at home who realise that the resurgent coloured peoples of the world have legitimate cause for complaint if they are arbitrarily denied access to empty and potentially fertile lands in British possession upon which we are making only half-hearted efforts to settle our own people. Dominion statesmen are not forcibly reminded that their policy of discouragement of immigration of all except agricultural and domestic workers is a contributory cause of the rapidly declining birth-rate in the mother country, and that if this continues the proportion of foreign to British immigrants is bound to increase, with an inevitable lowering of the standard of living of the whole of the peoples of the Dominions. Canada, in particular, should be made to realise that the standard of living of the peoples of central and southern Europe, from the countries of which more than half

[1] Report of the Oversea Settlement Committee for the year ended 31 December 1927. (Cmd. No. 3088.) Pp. 44. (London : H.M. Stationery Office, 1928.) 9*d*. net.

its immigrants for 1927 were recruited, is very much lower than that of the people of Great Britain.

The reluctance of the Dominions to foster immigration is not difficult to understand. They are not yet convinced that unrestricted immigration need not necessarily further congest an already overstocked labour market. Labour leaders overseas need more than the assurance given in this report, based upon the history of the United States, that the open-door policy would effect vast developments in agriculture and primary production accompanied by unprecedented industrial expansion, with a corresponding distinctive rise in the standard of living. They can be pardoned for thinking that Great Britain's offer of pound for pound to assist emigration under the Empire Settlement Act of 1922 is a poor bribe to the Dominions for their acceptance of the responsibility for the after-maintenance of a transferred part of our surplus population.

The statistics given on p. 15 of this report are therefore of the utmost value. They deal in convincing manner with the healthy effect of increased population between 1891 and 1921 on the external trade of Canada, Australia, and New Zealand. In this period the population of Canada increased by 80 per cent, whilst the *per caput* value of its external trade in 1921 was more than six times that of 1891: in New Zealand the population nearly doubled, while the *per caput* value of its external trade almost trebled: and in Australia, the population between 1891 and 1921 increased by 70 per cent, and the *per caput* value of its external trade by 116 per cent. It is a great pity that the report does not contain statistics of unemployment in the three Dominions for the same period, but it is more than probable that they are unobtainable. The two sets of statistics might reasonably be expected to provide overwhelming proof of the beneficial effects of the transference of Great Britain's surplus population on the prosperity of the Dominions and thus go far to overcome the present opposition of Overseas governments to schemes intended to increase the movement.

It may occasion some surprise that the report of the Oversea Settlement Committee for the year 1927, five years after the passing of the Empire Settlement Act, should contain the following passage:—

"The problem of Empire Settlement is closely interwoven with that of Empire industry and Empire trade, and one of the first steps *to be taken* [the italics are ours] with a view to making passage assistance more widely available should be to ascertain, in consultation with the Dominions:—

"(*a*) What occupations exist throughout the Empire which could be enlarged and provide increased employment if further man-power were made available locally;

"(*b*) What new industries, primary and secondary, can be created within the Empire and developed by men and women of British descent;

"(*c*) How far it is possible to extend the preference for British settlers in those parts of the Empire which require fresh settlers for their development."

The Committee rightly says that a satisfactory answer to these questions would go far to solve present difficulties, but it is legitimate to ask why they have not been formulated until now. It passes our comprehension how the Committee could have dealt with its task hitherto without information on these various points.

In commenting on the Committee's report for 1926, it was suggested in these columns that "the immediate need is for a comprehensive survey of the accessible and potential resources of the Empire," but we had no idea that such a survey as we contemplated would have to include the matters enumerated above. We had in mind surveys as that mentioned in Section III. of the present report, namely, a geophysical survey of the mineral resources of certain parts of Australia, upon which task Mr. A. Broughton Ede has lately embarked with the financial support of the British and Australian Commonwealth governments. Apparently, however, these wider schemes are not considered as activities proper to the functions of the Oversea Settlement Committee. Regarding the geophysical survey of Australia, it remarks: "It was decided that the effect on development and immigration was too indirect to justify a contribution to the cost of the proposed survey under the Empire Settlement Act."

Undoubtedly the Committee has a most difficult task to perform; but it is one of ever-increasing importance. There are abundant empty spaces within the Empire suitable for settlement by our own people. Great Britain, judging by our unemployment, is badly overcrowded. The nation is spending vast sums annually on the maintenance of an army of unemployed, and what is still more disastrous, the will-to-work of a large section of the population is being steadily undermined. The situation calls for almost heroic measures, but the Oversea Settlement Committee appears to be afflicted with a fearful timidity. It is true that Great Britain as a whole suffers from the same disease, but we have the right to expect that those

face to face with the problem of Empire settlement, provided with all facilities for arriving at a true appreciation of the situation, should give the Empire a bold lead. So far the Committee has failed to rise more than a few steps to the height of opportunity. The schemes in operation as outlined in the report are quite inadequate to the urgent needs of our time.

What is wanted is a report dealing with the problem of Empire settlement in a thoroughly scientific spirit and couched in such language that it will command the attention of the various governments of the Empire as a whole, and provoke them to energetic action.

World Meteorology.

Manual of Meteorology. By Sir Napier Shaw, with the assistance of Elaine Austin. Vol. 2: *Comparative Meteorology.* Pp. xl + 445. (Cambridge: At the University Press, 1928.) 36*s.* net.

THE science of meteorology has had no very happy or harmonious development. After the invention of the thermometer and barometer, elementary meteorological phenomena such as expansion of air by heating, melting and congelation, evaporation and condensation, were for a time in the focus of physical investigation. But practicable experiments and personal observation did not prove sufficient for penetrating that intricate complex of physical phenomena which constitutes weather. Then the invention of the galvanometer and electrometer, which opened new worlds to the experimental physicist, became simply fatal to progress in the old field. The telegraphic weather chart seemed to open a new era, and led to the transfer of meteorological research from the individual university investigator to richly equipped offices and institutes. But the isobaric chart failed to be that 'lamp of Aladdin' which made all difficulties disappear. Disillusion and pessimism followed upon the highly-raised illusions. "Galton himself," says Sir Napier Shaw, "after twenty-five years of unparalleled effort as chairman of the Kew Committee of the Royal Society, and a leading member of the directing council of the Meteorological Office, the most powerful body of scientific men that ever directed anything, became disillusioned and discouraged at the end. He doubted that anything would come of it all." I could give many parallel examples from other countries of leading men of this science who, like Sir Francis Galton, began in enthusiasm and ended in pessimism.

Sir Napier Shaw has never shared this pessimism. Nor has he been in doubt that there is one, and only one, way out of the difficulties, namely, to see the problem in its *full universality.* This spirit of universality is the most marked feature of Sir Napier Shaw's book, and will secure it a prominent place in the history of meteorology. It marked strikingly already the first introductory volume, "Meteorology in History," which might also have been called "Meteorology and Humanity," as it gives the development of human views upon the phenomena of the weather from the most ancient times to the age of the telegraphic weather chart. The same spirit characterises still more this second volume, "Comparative Meteorology," in which the more special meteorological work is begun.

First of all, Sir Napier Shaw does not see meteorology as anything like an isolated science, bordered by the official duty of a meteorological institute. He sees it as a branch of universal physics. At every opportunity he has emphasised that the cultivation of meteorology as a science remains a university duty, in spite of all special institutes erected; and throughout his book the establishment of the full connexion between meteorology and general physics is a marked feature. It has induced his enthusiasm for the tephigram, of which he shows the universal use for bringing the principles of thermodynamics into application to meteorological processes; and it underlies his attempt to condense our general meteorological knowledge in definitions, axioms, and theorems—certainly a very brave attempt which can but react favourably upon further development.

This spirit of universality takes, however, its externally most striking form by the fact that, wherever the book is opened, we meet with maps of the *entire world.* No more eloquent expression could be given to the principle that only a map which is too great to have a *frame* is a satisfactory meteorological map. So long as a frame is there, the origin of what happens inside the frame may be looked for outside it. But when maps for all atmospheric levels go all round the earth we approach in meteorology to the conditions which have made experimental physics so relatively easy, namely, that all the variables of the problem can be brought under the control of the investigator.

It would lead too far to enter upon the many interesting details of the book, many of which may perhaps be discussed more advantageously when Vol. 3 has appeared. But I must mention Sir Napier Shaw's open-minded and, at the same time, reserved attitude towards the newest subjects of

discussion in meteorology. Through his "Life History of Surface Air Currents" he is one of the chief predecessors of those who succeeded finally in formulating what is now called the "Polar Front Theory," and his diagram on p. 381, in which he represents the wind distribution in a cyclone, not by the traditional spirals, but by straight lines, will remain the most eloquent protest ever formulated against the theory of cyclones as homogeneous revolving systems. But at the same time he distinguishes carefully between the unquestionable empirical facts, as the actual existence of a polar front and certain typical phenomena related to it, and the attempts to bring these facts within the scope of theory.

In connexion with this important distinction, I must take the opportunity to mention a correction of historical order, common to Sir Napier Shaw's book and many other books and papers dealing with meteorology which have appeared in recent years. It is true that I was formally the director of the Bergen Institute at the time when the polar front got its name, and was stated to be, not a more or less exceptional phenomenon, but on the contrary a daily characteristic feature of every weather map. But this discovery is not mine. It belongs to the working young meteorologists of the Bergen school, J. Bjerknes, H. Solberg, and T. Bergeron,—the last of the three joined in the work a little later than the first two. For my own part, I have never drawn a weather map, or performed an analysis of such a map according to what is now called those 'Bergen methods,' which have made it impossible for the polar front to escape observation. Thus to state it again, the creation of these methods of weather analysis, and the empirical discoveries which are made by use of them, are due to the three young men I have mentioned, and not to me.

Parallel to and interacting with the empirical investigations of these young meteorologists, my own attempts went to bring the stated facts within the scope of theory. This led to what has been called the 'Wave Theory' of cyclones or of cyclone formation. In its origin, this theory is older than our precise knowledge of the phenomena which it should explain. General dynamical principles led me in the years 1915 and 1916 to assume that a cyclonic vortex could originate in no other way than as some kind of wave, though I was not able to see what kind of wave, or how it transformed into a vortex. I hoped, however, to get a clearer view by generalising systematically the classical wave theory. But only a first and introductory paper relating to this research appeared (Leipzig, 1916). I remained in doubt how to continue it. Sir Napier Shaw's diagram might have brought me on the right track. But I did not at that time feel sure if I should not look upon it rather as a joke than as a serious suggestion. At the Bergen Institute, however, from the summer of 1918 onward, every day brought a new and from day to day more carefully analysed weather chart, giving more and more detailed information on the life cycle of cyclones from birth to death, and the effect upon my theoretical work was an instantaneous one. There could no longer be any doubt, either concerning the character of the initial wave, or of the general dynamics of its development to a vortex of ultimately complete homogeneity. The fact that in these circumstances my theoretical comment on the empirical discoveries came to appear practically simultaneously with the publication of the latter, may explain why the whole 'Polar Front Theory,' taken as including both the now generally accepted empirical facts, and also—though perhaps still rejected by most meteorologists—the 'Wave Theory,' was credited to me, while I can take the responsibility merely for the latter.

Sir Napier Shaw's attitude towards the two cyclone theories, the 'pure' vortex theory, and the theory of the development from wave to vortex, is that of benevolent neutrality. He ends in expressing confidence that under the pressure of both of them the problem must yield. When—we hope within a short time—the next volume of Sir Napier Shaw's great "Manual" appears, we may perhaps find it to have yielded in that direction in which his historical diagram has been pointing as the first fingerpost. V. Bjerknes.

A Popular History of Mathematics.

Histoire des mathématiques. Par W. W. Rouse Ball. Édition française revue et augmentée, traduite sur la troisième édition anglaise par Lieut. L. Freund. Tome 1 : *Les mathématiques dans l'antiquité ; les mathématiques au moyen âge et pendant la renaissance ; les mathématiques modernes de Descartes à Huygens.* Pp. vii + 338 + 9 planches. (Paris : J. Hermann, 1927.) 40 francs.

Mr. Rouse Ball's "Short Account of the History of Mathematics" must be one of the most successful books of its kind that has ever appeared. Originally published in 1888, it reached a second edition in 1893 and a third in 1901. The fourth edition was stereotyped in 1908, and the

book has since been five times reprinted, though the preface to the stereotyped edition states that no material changes have been made since the issue of the second edition of 1893. Its success is to be accounted for by the fact that it is eminently readable and is not too technical to be easily followed by the amateur who wishes to get a general idea of the course of the history of mathematics through the ages. As the author explained in the original preface, it may serve as an introduction to more elaborate histories, but it was primarily intended to give a short and popular account of those leading facts in the history of mathematics which many who are unwilling, or have not the time, to study it systematically, may yet desire to know. Accordingly, it is not overloaded with detail or masses of references to authorities.

The greater part of the account is admittedly a compilation from existing histories or memoirs, and especially, so far as the history down to 1799 is concerned, M. Cantor's "Vorlesungen über die Geschichte der Mathematik." This fact brings with it a certain drawback, often inconvenient to the professional mathematician who makes use of the book, namely, that it is in general difficult to be sure whether, when a reference is given to some book or memoir, the author himself has consulted the original work or is merely giving a reference at second hand. This inconvenience, however, does not so much affect the non-professional reader, while the method adopted of dealing in chronological order with the lives as well as the writings of famous mathematicians gives a human interest to the narrative and so enhances the attraction of the book.

After a chapter on Egyptian mathematics, Ball divides his history into three periods: (1) Mathematics under Greek influence; (2) mathematics of the Middle Ages and of the Renaissance (Chaps. viii.-xiii.), ending with Galileo, Kepler, and Desargues; and (3) modern mathematics (Chaps. xiv.-xix.), beginning with Descartes, Fermat, and their contemporaries. In proportion to the wider range and increased complexity of the developments in mathematics as we approach recent times, the story necessarily becomes more 'sketchy,' so much so that the nineteenth chapter on the nineteenth century becomes little more than a list of names and titles of books.

The volume before us is vol. i. of the "Édition française revue et augmentée," translated from the third English edition. Arrangements were apparently made in 1903 for a translation into French, which duly appeared (in two volumes) in 1906-7, though no reference to it is made in the present edition. The translator, in an undated preface, merely states that Ball's work formed only one volume, and that it has been thought proper to complete it by additions "which clear up several important points in the history of science and show the course followed by certain illustrious savants in reaching their discoveries." These additions have, he says, made it necessary to divide the work into two parts. The first volume contains the translation of the first fifteen chapters, the second the last four, beginning with Newton; the division is an artificial one designed to make the two volumes about equal in bulk, the additions being more considerable in the second volume than in the first. We may hope that this will prove to be the case when the second volume appears, for the additions to the first are, so far as we can see, negligible. The period from 1903 until 1927 has been fruitful in new editions and fresh researches, and Ball himself added in the stereotyped edition a good number of references to such new works; it is a pity that the French translator, writing in 1927, has incorporated scarcely any of these new references or of others that might have been given, so that in this respect the new edition is much less valuable than it might have been made.

The translator has tried to keep as closely as possible to the original, but he should have exercised more care. Apart from a number of unnecessary misprints (for example, "Dialès" for "Diocles," p. 97) and incorrect spellings of names, for example, "Ænopides" for "Œnopides" and "Menœchmus" for "Menæchmus," there are several statements which will raise a smile. On p. 97 we are told that Dionysodorus found the radius of the earth to be about 42,000 stades, "ce qui correspond à environ 80,000^{km}.," whereas Ball says, correctly, "a little less than 5000 miles." On pp. 21-22 there is a story from Iamblichus about the Pythagorean pentagram, to which Ball applied the well-known remark, "Se non è vero, è ben trovato"; it will scarcely be believed that our French translator gives for this: "Si elle n'est pas vraie, elle est tout au moins intéressante" (!). The sense of a passage is sometimes destroyed by the mistranslation of a word, as when "partially" becomes "particulièrement." But the most glaring lapse is on p. 45, where we are told that Plato visited Egypt "in company with Eudoxus and Strabo," a remarkable feat, seeing that Eudoxus lived from about 408 to 355 B.C. and Strabo from about 66 B.C. to A.D. 24! The explanation is found on reference to the original, where Ball observes that "Plato visited

Egypt with Eudoxus, and Strabo says that in his time the apartments they occupied at Heliopolis were still shown." For the second clause the translator substitutes "On raconte que, de son temps . . .," regardless of the fact that this leaves "in his time" completely in the air.

Incidentally, we cannot but express regret that advantage is not taken of some re-issue to correct mistakes which in places disfigure the original work. Thus we are told that "Archytas taught that the earth was a sphere rotating round its axis in twenty-four hours, and round which the heavenly bodies moved." The second clause of this sentence is difficult to reconcile with the first; but in any case there is no ground for thinking that Archytas anticipated Heraclides of Pontus in holding that the earth rotates on its own axis in twenty-four hours. The error may perhaps be due to a confusion of the name of Archytas with that of an otherwise unknown person, Hicetas of Syracuse, to whom, alternatively with Heraclides, the discovery in question is attributed. T. L. H.

Sex and the Gene.

The Genetics of Sexuality in Animals. By Dr. F. A. E. Crew. (Cambridge Comparative Physiology Series.) Pp. x + 188. (Cambridge: At the University Press, 1927.) 10*s.* 6*d.* net.

THE chromosome theory of heredity has been of considerable value in advancing our knowledge of how characters are transmitted through the germ cells from one generation to another, but there is an important gap yet to be filled. We have little knowledge of the developmental processes involved. It is Dr. Crew's aim to place before the reader material derived from the study of sexuality in animals "in the hope that someone may be sufficiently stirred as to decide to devote himself to a subject which has always fascinated me . . . how the gene in its action produces its end result, the character." If the solution of this problem were the main end in view, the physiologist, to whom the book is primarily addressed, might question the advisability of selecting such a complex subject rather than one with more immediate prospect of quantitative treatment. However, sexuality is in itself of sufficient importance to justify extensive treatment, and much can be said in favour of it as a subject for the study of developmental physiology.

Goldschmidt, whose own contributions play a primary rôle in the theory developed by Crew, has already dealt extensively with the same subject in "The Mechanism and Physiology of Sex-Determination" (English Translation. Methuen, 1923). Some similarity of treatment was therefore to be expected, but it is disappointing to find in many passages how closely the two books resemble one another. This resemblance diminishes in places the value of Crew's book as an independent critique of the subject. In a work dealing largely with experimental material, more space might perhaps have been devoted to the exposition of original data. For the most part, general inferences only are given, and one gets little information on the relative significance of the actual results from which the inferences are derived. References are, however, amply given, and extensive bibliographies are a valuable feature. The book requires attentive reading, since not infrequently the writing is somewhat involved. On the other hand, the book gains considerably by the style being both emphatic and provocative.

The first two chapters give a compact account of the genetic evidence bearing on sex determination. The third is mainly devoted to Goldschmidt's work on *Lymantria* and his 'time law of intersexuality.' In extending this 'law' to amphibian development, Crew contributes to the simplification of the subject, but a similar extension to mammals in explanation of hermaphroditism is not so successful. The material described shows varying degrees of abnormality, and it is not unreasonable to assume that a time relationship is involved, but the genetic and embryological evidence seems insufficient to support the elaborate and somewhat lengthy treatment. Many very arbitrary assumptions are made, and the discussion, although not without interest, lacks objectivity.

In Chap. iv. it is shown that in a number of animals extrinsic changes may result in a deviation or reversal of the sexual characterisation primarily established by the genotype. In discussing plumage characterisation in the fowl, Crew abandons the orthodox theory of hormonic specificity of the gonads and advances the hypothesis that male and female types of plumage are expressions of different metabolic levels. The hypothesis accommodates many of the known facts and provides perhaps the simplest explanation of the henny-feathered cock which has yet been advanced, but the term 'metabolic level' is indefinite and allows considerable elasticity of interpretation. A critical test would be found in the results of gonadectomy and transplantation. Crew groups a series of 'results' in tabular form, but no specific references are given to the actual data. The majority of the

groups can be accommodated by either hypothesis. No detailed account whatever is given of those groups which are really crucial. It is claimed that the case of a single bird described by Greenwood and Crew cannot be accommodated by the orthodox hypothesis, but apart from the numerical inadequacy of the material, it is not free from objection on theoretical grounds. Since the publication of the book, Domm in America has obtained similar results with adequate material but does not consider it necessary to abandon the theory of hormonic specificity as applied to the normal animal. As the account stands in the book, Crew's hypothesis, although provocative of careful consideration, can only be regarded as highly speculative or intelligently prophetic.

Chap. v., on "Sex Reversal in the Adult," contains some interesting material. In the main the theoretical interpretation is similar to that advanced in earlier sections. The short chapter on the "Mode of Inheritance of Sex Dimorphic Characters" suggests that further work might be done on this subject. The book closes with a chapter on the "Sex Ratio." Differential mortality *post conceptionem* will in part explain the significant deviation from equality at birth and later stages, but an entirely satisfactory explanation has not been found to account for the deviation at conception which has frequently been assumed.

As one of the first of the Cambridge Comparative Physiology Series, the general editors are to be congratulated on the format. The printing maintains the high standard of the University Press.

ARTHUR WALTON.

London and Londoners.

The Earlier Inhabitants of London. By Prof. F. G. Parsons. Pp. 240. (London: Cecil Palmer, 1927.) 10*s*. 6*d*. net.

FOR the nonce, Prof. F. G. Parsons has laid aside his calipers and turned historian. These forty years and more he has sought to meet the needs of professional anthropologists by supplying them with data relating to the races and peoples who have lived in England in all periods of its history—from Palæolithic times to the present. He has now written a book to please himself on "The Earlier Inhabitants of London"; he has set down, in easy narrative, with many a sly allusion and pleasant digression, all he has succeeded in learning concerning the founders of his native city, London. Nor will readers have to proceed far to discover that their guide to ancient London is a frank outspoken Saxon whose inborn sympathies are enlisted in favour of that element of the British people which is fair in colouring and long in skull. He brings his history of London to a close just before the coming of the Normans; at that time he estimates that seven-eighths of the inhabitants of London "were of Nordic blood."

We have no direct testimony concerning the beginnings of London; all we know, or can hope to know, concerning its earlier history is, as Prof. Parsons reminds his readers time and again, circumstantial and inferential. He accepts the belief now current, that London began to come into existence between the landing of Julius Cæsar, 54 B.C., and the coming of the legions of Claudius, A.D. 43, and that it began as a port for the midland tribe—the Catuvellauni, whose capital town was the present St. Albans. Having accepted this much, he then infers that its earlier inhabitants must have been recruited in the main from the peoples who occupied adjoining regions—the Cymric Belgæ. His search for evidence bearing on the racial constitution of the people which Cæsar found in possession of England, takes Prof. Parsons far afield. He finds that they were in the main a Celtic-speaking people of Nordic origin, which had absorbed the still older racial elements of England—the round-headed 'beaker' people, the long-headed people of the chambered barrows, and a still older strain derived from Palæolithic times.

Nevertheless, on the evidence obtained from cemeteries of a pre-Saxon date, Prof. Parsons concludes that in the earlier days of London the home countries were inhabited by a people essentially Nordic in its racial constitution. The Saxons who began to invade England in the fifth century of our era found its eastern and south-eastern parts occupied by a people who, like themselves, were Nordic, or north-west European, in origin. No doubt merchants from abroad settled in London and brought their families with them; it may be, as Prof. Parsons hints, that foreign legions stationed near London did leave their mark on the 'earlier' Londoners, but if one may rely on the evidence of skulls of Romano-Britons preserved in the Museum of the Guildhall, the predominant Londoner in Roman times was, as Prof. Parsons suggests, of Belgic or Nordic origin. But the round-headed Gaul from central and southern France was not negligible.

After the departure of the Roman legions, the history of London is darkness, but Prof. Parsons gives reasons for his belief that the Saxon invaders

left the city alone until the seventh century, when the Saxons of Essex began to settle in it. In the ninth century, Alfred Saxonised it more effectually. Later still came the Danes and the Norse, to swell the North Sea element in the racial constitution of the Londoner.

Some day, perhaps, Prof. Parsons will give us a racial analysis of the modern Londoner. It is certainly very difficult to find a native of London who can claim that all four grandparents were born in or near London. London draws people to-day, just as it did in its earlier history, from all parts of Europe, and yet, we believe, when full inquiry is made, that even to-day London is still essentially a Nordic city. However this may be, there can be no doubt of our present indebtedness to Prof. Parsons; the book is manifestly a labour of love—a rebound from the repression that our modern methods of investigation impose on all anthropologists. Who has not wished, in the midst of the dry narration of facts—just for a glorious hour in which to set down what is surmised, as well as that of which we have proof? It is just because Prof. Parsons has 'let himself go' that he has succeeded in writing a book which is at once interesting and stimulating.

Our Bookshelf.

Reports of the Progress of Applied Chemistry. Vol. 12, 1927. Issued by the Society of Chemical Industry. Pp. 743. (London: Society of Chemical Industry, 1928.) Members of the Society of Chemical Industry, 7*s.* 6*d.*; Others, 12*s.* 6*d.*

WITH the exception of the chapter on explosives, on which it is evidently intended to report in alternate years, the present issue of the "Annual Report on the Progress of Applied Chemistry" again constitutes a reasonably complete and most valuable survey of a year's achievement. The general form of the reports, with their copious references to the original information on which they are based, their name and detailed subject indexes, is of course perfectly familiar to chemists the world over. This year the chapter on non-ferrous metallurgy is perhaps noteworthy in two respects: it gives the impression of being based to a special degree on experience (although the inclusion of literature references wherever possible is always much to be desired), and, being written by Prof. G. A. Guess, of Toronto, it originates from outside Great Britain. The chapters on plant and machinery, fuel, gas, etc., electrochemical industries, rubber, soils, and sanitation are also provided—with every success—by authors who did not report last year.

Discussion of any part of the subject matter would be of doubtful profit, so great is its wealth of detail and diversity of interest. Since, however, the chemical control of food must so closely concern everyone, whether chemist or not, and since the reviewer's copy has fortuitously been opened at the page dealing with this subject, the contents of this section of thirty-one pages may be indicated. Vitamins, from the chemical, biological, and industrial points of view, are first considered (8 pages), their origin, production, and evaluation being discussed; then follows an account of milk and dairy products (5 pages), in which not only new and modified analytical methods, but also the results of surveys and researches on dairy troubles are recorded. Sections on fruit and vegetable products (3 pages), canning and storage (5 pages), cereal products (4 pages), preservatives and colouring matters (3 pages), and miscellaneous information (3 pages) complete the chapter, in the course of which 161 references to original papers are quoted.

It is unlikely that many chemists, either in the British Empire or the United States of America, are unaware of the existence of this series of reports; so much general information is brought under review, however, that industrial chemists will not be alone in welcoming the appearance of yet another annual volume.

A. A. E.

(1) *Methods of Applied Geophysics: for the Exploration of Oil, Ores, and other Useful Deposits.* By Dr. Erich Pautsch. Pp. iv + 82. (Houston, Texas: Gulf Publishing Co., 1927.) 6.50 dollars.

(2) *Die magnetischen Verfahren der angewandten Geophysik.* Von Dr. Hans Haalck. (Sammlung geophysikalischer Schriften, herausgegeben von Prof. Dr. Carl Mainka, Nr. 7.) Pp. viii + 150 + 3 Tafeln. (Berlin: Gebrüder Borntraeger, 1927.) 12 gold marks.

(3) *Elektrische Bodenforschung: ihre physikalischen Grundlagen und ihre praktische Anwendung.* Von Dr. Walther Heine. (Sammlung geophysikalischer Schriften, herausgegeben von Prof. Dr. Carl Mainka, Nr. 8.) Pp. xi + 223. (Berlin: Gebrüder Borntraeger, 1928.) 18 gold marks.

(1) THE rapidly growing importance of geophysical methods of prospecting for oil, ores, and other deposits is stimulating the production of numerous books on the subject. Of the three here noticed, that by Dr. Pautsch attempts to cover the whole field, and has chapters on the various classes of method, gravitational, seismic, acoustic, magnetic, electric, and radioactive. The treatment is very cursory. The book deals with the subject rather after the manner of an engineer's pocket-book or collection of formulæ; it seems scarcely likely to be of serious use to anyone desiring to apply geophysical methods in practice.

(2) (3) The two German books are in a different category; each deals carefully and in detail with the underlying principles, the practical applications, and the instrumental equipment connected with a single class of geophysical methods, electric or magnetic. They should be of real value to applied geologists, but it need scarcely be said that success

in the use of geophysical methods of prospecting depends very largely on the possession of sound judgment and experience in interpreting the physical measurements in the light of the geological data for the district.

A Descriptive List of the Printed Maps of Norfolk, 1574–1916: with Biographical Notes and a Tabular Index. By T. Chubb. *And a Descriptive List of Norwich Plans, 1541–1914.* By Geo. A. Stephen. Pp. xvi + 289 + 26 plates. (Norwich: Jarrold and Sons, Ltd., 1918). n.p.

THIS is a useful and scholarly handbook for the geographer, antiquarian, and historian to retain for reference on their shelves. Norfolk was favoured by the old cartographers; moreover, the pioneer work on soils and geology which emanated from the county at a later date helped to maintain contemporary interest in its maps. After an interesting introduction, in which due credit is given to the work of John Norden and others in the sixteenth century, when Norfolk was an active manufacturing county, Mr. Chubb gives a catalogue of Norfolk maps from 1574 until 1916. Each entry is accompanied by informative notes which are bibliographically valuable. Well-selected examples of maps published at intervals of about twenty years help the reader to visualise the advance in the art of cartography, and in the development of the county. But for the fact that reference has been made to geological maps (for example, Samuel Woodward's early map of 1833) and to soil maps, it might be invidious to point out that the first map showing Glacial Drift, that of part of Norfolk and Suffolk, by S. V. Wood and F. W. Harmer (Mon. Palæontograph. Soc., 1872), has not been mentioned. As it was the first of its kind in the world, it is certainly worthy of a note.

The latter half of the book is contributed by the City Librarian of Norwich, who has catalogued and added notes on the various plans of Norwich contained in the Norwich Public Library, Castle Museum, and the British Museum. A compilation of this kind for so ancient and ecclesiastical a city as Norwich was worth doing, and the author has done it well. The tabular index of the whole book, arranged under the cartographers' names, is to be specially commended for its usefulness.

Lehrbuch der analytischen Geometrie: Grundlagen, Projektive, Euklidische, Nichteuklidische Geometrie. Von Prof. L. Heffter und Prof. C. Koehler. Band 1: *Grundlagen, Grundgebilde I. Stufe, Euklidische Ebene.* Zweite wesentlich umgearbeitete und vermehrte Auflage. Pp. xvii + 477. (Karlsruhe: G. Braun, 1927.) 20 gold marks.

THIS is a book for which there is not likely to be any great demand in Great Britain. Yet it may be questioned whether more attention ought not to be paid to this kind of work in the ordinary honours course. For example, there are students who specialise in geometry without learning anything about the modern theory of its foundations. Perhaps some knowledge of the subject matter of the introduction of this volume might be required of them. Again, projective geometry is a subject of increasing reputation, in that its foundations are secure against some of the attacks which are destroying our confidence in anything that depends upon measurement. Lastly, the physicist can no longer afford to regard the non-Euclidean systems as an idle fancy of the mathematician's brain. It is not suggested, of course, that this particular book could be adopted for general use in Great Britain; but rather that something of the same kind, perhaps less elaborate, may before long be considered as part of the general education of the mathematician.

A. R.

The Statesman's Year-Book: Statistical and Historical Annual of the States of the World for the Year 1928. Edited by Dr. M. Epstein. Sixty-fifth Annual Publication: Revised after Official Returns. Pp. xxxvi + 1538. (London: Macmillan and Co., Ltd., 1928.) 20*s.* net.

WITH the exception of the usual careful revision in fact and figures, this valuable publication in its present issue has undergone few changes. The plan of the book, with its many subheadings and full index, greatly facilitates its use. Although it is some twenty pages larger than last year, the volume has been slightly reduced in bulk. Iraq has now been removed from the mandated Territories in the section on the British Empire and added to the independent States. A new paragraph on the Saar, and a much-expanded section on the Ægean Islands of Italy, have been added. There are the usual introductory tables of statistics and sections on the International Institute of Agriculture and the League of Nations. Two coloured maps show respectively French, Spanish, and International zones of influence in Morocco, and the new boundary between Canada and Labrador in terms of the Privy Council's report.

Hand-List of Catalogues and Works of Reference relating to Carto-Bibliography and Kindred Subjects for Great Britain and Ireland, 1720 to 1927. By Sir Herbert George Fordham. Pp. 26. (Cambridge: At the University Press, 1928.) 2*s.* 6*d.* net.

SIR GEORGE FORDHAM has laid students of cartography under an obligation by the publication of this volume. In the list he gives the titles of ninety-one works, from "The English Topographer" of Dr. Rawlinson, printed in 1720, to Mr. H. A. Sharp's "Historical Catalogue of Surrey Maps," of 1928. The stream of publication seems to have been fairly continuous during the two hundred year period in question, except for gaps of no publication from 1736 to 1768; from 1780 to 1814; and 1840 to 1870; gaps curiously equal. There seems no probability of the stream drying up now, for no fewer than sixty-seven of the works catalogued have been published during the present century. Sir George Fordham himself, and Mr. Thomas Chubb, have an honourable pre-eminence amongst the modern workers at this subject.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Helium and the Genesis of Petroleum.

VARIOUS hydrocarbons, but more especially methane, are common constituents of the natural gas effusions in many parts of the world, and another very common constituent is helium, though in relatively small quantities, which vary from simple traces to about 1 per cent or more. In the mid-United States of America, where large oilfields exist, and for which more complete information is available, it appears that the region in close proximity to the oil field is also a region of relatively high helium content in the gases (G. S. Rogers, *Professional Paper*, 121, U.S. Geological Survey, Washington, pp. 68-91; 1921).

Lind and Bardwell have investigated the effect of alpha particles upon hydrocarbons, and have found that these hydrocarbons undergo chemical change when subjected to such bombardment, the hydrocarbon molecules becoming more complicated. They have found that for methane two molecules undergo change per ion pair formed, or M/N is 2, whilst for acetylene $M/N = 20$, for ethylene 5·1, and for cyanogen 7·4 (*Jour. Amer. Chem. Soc.*, vol. 48, pp. 2335, 2351; 1926). The effect of alpha rays upon methane was to produce the higher saturated hydrocarbons and liquid olefines, whilst from ethylene a colourless liquid resulted, and acetylene gave rise to a white solid.

It will be assumed that helium arises from alpha particles ejected by radioactive substances. Since each alpha particle produces 2×10^5 ions approximately, one cubic foot of alpha particles ionises 2×10^5 cubic feet of gas. Now each alpha particle eventually becomes a helium atom, and therefore one cubic foot of helium is, in its process of formation, capable of ionising this amount of gas. Taking Lind and Bardwell's result that for methane M/N is 2, each cubic foot of helium may alter 4×10^5 cubic feet of methane (weighing 8 tons) into higher and more complicated hydrocarbons.

The action follows the equations

$$2CH_4 = C_2H_6 + H_2$$
$$\text{or } 2CH_4 = C_2H_4 + 2H_2$$

(Lind and Bardwell, loc. cit.).

Considering liquid hydrocarbons more specifically, it has been calculated from the results already mentioned, that 1·2 milligrams of these resulted from the formation of 0·000015 c.c. of effective helium, or nearly two tons of liquid per cubic foot of helium.

The average helium content of 142 Canadian sources of natural gas is about 0·25 per cent (R. J. Elworthy, Canadian Dept. of Mines, 1926), and from 325 United States sources it is about 0·5 per cent (Rogers, loc. cit.). Since many of these gas wells produce enormous volumes of gas, it is to be expected that radioactive disintegration as measured by the helium produced during long periods of geological time may have played an important part in the formation of petroleum. It is true that, owing to the paucity of experimental results, the figures arrived at may be to some extent a matter of opinion, and it is also a long way from 1·2 milligrams to millions of tons, yet it would seem (if the results of Messrs. Lind and Bardwell are to be relied upon) that in the Petrolia gas field, where the original helium has been estimated at 10^9 cubic feet (cf. Rogers' Report, p. 62), millions of tons—indeed, according to the above calculation, two thousand millions of tons—of liquid hydrocarbon may have resulted in this area.

In view of these figures the question of the origin of petroleum naturally arises. The percentage of helium content in the prolifically oil-bearing tertiary series is generally small, but Lind states (*Nat. Acad. Sci.*, vol. 11, p. 772; 1925) that recent then unpublished estimates show that helium is confined to no particular age of strata but depends rather on the retentiveness of the sands. It might also be mentioned here that the helium in the atmosphere, assuming it to be entirely of subterranean origin, corresponds, under proper conditions of production, to 4×10^{15} tons of liquid hydrocarbons.

The presence of dense compounds in petroleum and of bitumen in meteorites, the high solubility of radon in petroleum, and the wide distribution of the radioactive elements, together with the formation of both paraffins and olefines in the experiments quoted, seem to make these questions worthy of further investigation.

If the reactions quoted above are in progress, it might be expected that hydrogen would be a common constituent of natural gas in some other form than as simply appearing in the hydrocarbons.

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Active Nitrogen.

THE function of impurities which seem necessary to the formation of the afterglow in active nitrogen has been interpreted as being in the poisoning of the surface to the combination of nitrogen atoms. Experiments were commenced to study the rôle of the impurity oxygen. It was felt that the possibility could not be entirely excluded that oxygen was necessary in some physical action to induce the afterglow in the gas phase. Accordingly pure *glowless* nitrogen was introduced into a litre bulb, into the centre of which pure oxygen could be admitted more or less uniformly in all directions. In impure nitrogen the active species which eventually give rise to the glow are created in the discharge and remain for some time after cessation of the latter. If the same occurs in pure nitrogen, and if merely the presence of ordinary oxygen is required for the afterglow formation, then the afterglow may be expected to appear if oxygen is introduced into glowless nitrogen immediately after discontinuing the discharge (electrodeless). Pure nitrogen was prepared by two methods: (1) from bromine water and ammonia (Kenty and Turner, NATURE, **120**, 332; 1927; also, Waran. *Phil. Mag.*, **42**, 246; 1921); (2) from sodium trinitride (NaN_3).

For some time it was impossible to produce absolutely glowless nitrogen (although the afterglow was very weak and of very short duration), even though the utmost precaution had been taken to ensure the complete absence of oxygen and other impurities. Only after continued baking out of the bulb at high temperature and under high vacuum was glowless nitrogen obtained. Upon the introduction of pure oxygen (1 per cent) in the manner described above, *no glow was produced.* This was repeated several times with nitrogen from both sources with the same results. Furthermore, after the oxygen had been admitted and the mixture now subjected to the discharge, little or no glow was discernible. This seemed very strange indeed. I publish these results in view of the recent work of Herzberg (*Z. für Physik*, **46**, 878; 1928), whose

investigations offer an explanation of these effects. Herzberg, in some very pretty experiments, finds that freedom of the walls from gases such as water vapour or hydrogen is a factor in the elimination of the afterglow. Even with nitrogen containing more or less oxygen, he reports no afterglow if the vessel has been well baked out. The addition of a small quantity of hydrogen to pure or oxygenated nitrogen, which cannot be made to glow itself, again produces a very intense afterglow. In this connexion Bonhoeffer and Kaminsky's observations (*Z. für phys. Chem.*, **127**, 385; 1927) that impurities, whatever they are, have no effect on the character of the afterglow spectrum, suggests that the impurities as such take no part in the excitation process which produces the luminosity. This is in agreement with conclusions to be drawn from the experiments described above.

The optimum amount of oxygen for production of the afterglow has been given as about 0·23 per cent, while 2 per cent completely obliterates it (Bonhoeffer and Kaminsky, *loc. cit.*; Strutt, *Proc. Roy. Soc.*, **88**, 539; 1913). I have been able to obtain very intense nitrogen afterglows in air (21 per cent oxygen), and even in mixtures up to about 57 per cent oxygen (although with decreased intensity but observable with a spectroscope), in the electrodeless discharge at a pressure of about 0·2 mm. Hg and below. At higher pressures the type of afterglow changes until at about 1 mm. and up to 2 mm. (in air) only the continuous afterglow spectrum of oxygen first noticed by J. J. Thomson (*Phil. Mag.*, **32**, 321; 1891) is observable. The nitrogen and oxygen afterglows were so strong as to be easily distinguished with an ordinary spectroscope. Herzberg reports similar findings. These differences from the results of other workers are readily explained by the differences in the experimental pressures employed. Studies have been made of the afterglow at different pressures with varying mixtures of nitrogen and oxygen and will be published in the course of time.

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Does Methylene Blue penetrate Living Cells?

IN NATURE (vol. 121, No. 3053, p. 726) the following statement was made under "Research Items" (in connexion with the identification of dye found in the vacuole of cells of *Valonia*): "The methylene blue, moreover, penetrates as such, and it is not the lower homologue, trimethylthionine, that penetrates as Irwin thought. The latter is found in sap which has stood for some time after being expressed and arises from oxidation of methylene blue."

The matter is of far greater importance than would appear on casual reading, since methylene blue is widely used as a vital stain and as an indicator for the oxidation reduction potentials of cells. It therefore seems worth while to direct the attention of readers of NATURE to the fact that the problem of methylene blue penetration is by no means so nearly settled as would be gathered from the above statement.

In my publication (Irwin, M., *Proc. Exp. Biol. and Med.*, **24**, 425; 1926–27. *J. Gen. Physiol.* **10**, 927; 1926–27), I have shown by spectrophotometric measurement (made in collaboration with W. C. Holmes, of the Bureau of Chemistry, Washington, D.C.) that it is chiefly trimethylthionin or azure B that is present in the sap extracted from cells placed in methylene blue solution at pH 9·5. These measurements were made immediately after extraction of the sap from the cells. This shows conclusively that the trimethylthionin was present in the sap and was not formed from demethylation of methylene blue after the sap had stood in air for some time, as is intimated in the sentences quoted above.

Moreover, it was shown that methylene blue was found in the vacuolar sap of cells (placed in methylene blue solution at pH 9·5) *only* (1) when the cells were injured, or (2) when the contamination of the sap by the stained cell wall occurred at the time of extraction of the sap.

The penetration at low pH values (namely, at pH 5·5) was too slow for analysis unless the cells were injured.

Furthermore, the experiments described in these papers were repeated by me at three different seasons, covering over a year, and using various samples of methylene blue, and identical results were obtained. The necessary optical measurements were made either by W. C. Holmes or by K. S. Gibson, of the Bureau of Standards, Washington, D.C. These additional results have not been published as they bring out no new facts.

Such results are not limited to *Valonia*, since experiments with a freshwater plant, *Nitella*, led to the same conclusions (Irwin, M., *Proc. Soc. Exper. Biol. and Med.*, **25**, 563; 1928).

It is still somewhat uncertain as to whether the trimethylthionin penetrated as such from the external methylene blue solution containing this dye as impurity (in too small concentration for detection by a spectrophotometer but detectable by extraction with chloroform) or whether it has formed from methylene blue after the latter has penetrated the cell. I am, however, from the evidence in hand, inclined to favour the former explanation.

All the results were obtained by examining the sap in the vacuole (that is, the central space in the cell which is surrounded by the protoplasm and filled with sap). The experiments do not show whether or not methylene blue penetrates the protoplasm. The latter question cannot be tested experimentally, since the protoplasmic layer is extremely thin.

There is, therefore, real danger that false theoretical conclusions may be drawn from data based on penetration of blue dye from methylene blue solution.

MARIAN IRWIN.
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Research on the Control of Aeroplanes.

IN his most interesting paper, "Research on the Control of Aeroplanes"—published as a supplement to NATURE of May 12—Prof. Melvill Jones says, "they [the Wrights] must have experienced the stall or the approach to the stall." In point of fact, during their gliding experiments of 1900 and 1901, they were puzzled by the fact that on a turn the warped wing would invariably touch the ground first, or in other words, they found, as modern science has rediscovered, that increasing the angle of the lower wing accentuates instead of curing the tendency to stall. Their remedy was to fit a vertical surface at the rear of the machine, which before the end of the 1902 experimental season was converted into a movable rudder. The point here is that the Wrights originally fitted a rudder not as a directional organ, but as an aid to the wing-warp in maintaining lateral balance.

Actually they first definitely experienced the phenomenon of the 'stall' in their power-driven machine of 1904, when they found that the machine persisted in sliding down to the ground on one wing

tip in spite of all attempts to right it with the combined rudder and wing-warping control. They eventually discovered that the only remedy was to put the nose of the machine down, and quite rightly attributed the trouble to loss of speed causing the controls to become inoperative.

If I may be forgiven criticising so sound an authority as Prof. Melvill Jones, I think he is wrong in lumping all the early experimenters with the Wrights in what I have always called in my own mind the 'acrobatic' as opposed to the 'stability' school. Surely the early French pioneers—such as the Voisins and Santos Dumont—quite definitely tried to produce a stable aeroplane, seeking to attain this end by such devices as 'curtains' between the wings and exaggerated dihedral angles. That their methods proved unsuccessful does not alter the fact that that was their *aim*. The greater success *aerodynamically* of the Wright machine gradually brought the French school to the view that stability must be sacrificed to control, but it has always seemed to me that originally they started from the other of the two extremes Prof. Melvill Jones so graphically describes. It was to me absorbingly interesting in the early days to watch the two 'schools' gradually converging. The French machines discarded their 'stability' devices, while the Wrights in time gave up the front elevator and fitted a wheeled undercarriage, until the Wright biplane of 1910 was in appearance scarcely distinguishable from, for example, the Farman of the same period.

W. LOCKWOOD MARSH.

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London, W.C.1,
May 21.

IN referring to the Wrights' use of a powerful rudder as a means of dealing with the stall, I had mainly in mind its use to control the lateral rolling of the aeroplane in the manner indicated in Figs. 6 and 7 of my article. I am much interested to hear from Lieut.-Col. Lockwood Marsh that the Wrights, as I had surmised, deliberately fitted it with this object in view.

My statement that on the whole the men who tried to fly were themselves interested in control, whilst the theorist and model constructor were more interested in stability, was intended to be read in a broad sense only, and in that sense I still think it is correct, bearing in mind such men as Lilienthal, Cody, and a host of others both before and after the Wrights. I had not, however, realised the extreme interest in stability of the French pioneers, and am grateful to Col. Lockwood Marsh for pointing it out.

B. MELVILL JONES.

Base Exchange and the Formation of Petroleum.

I HAVE read with great interest Dr. McKenzie Taylor's letter entitled "Base Exchange and the Formation of Coal" which appeared in NATURE of May 19, and am particularly interested in his description of the experiments conducted by him concerning the bacterial decomposition of fats under a roof containing hydrolysing sodium clay. Fats, as a body, are lighter than water, and I am wondering whether Dr. McKenzie Taylor has conducted any experiments, or has any evidence, to show that in Nature solid fats could be a sedimentary deposit in water and accumulate as such together with sand. Some eighteen years ago I demonstrated that oils can be deposited in considerable quantity as an aqueous sediment together with mud or clay, but my experiments indicated that oils could not be similarly deposited by, or together with, sand. For a full description of the phenomenon and my experiments, and also how in Nature the oil would afterwards be squeezed out of the clay into a sand bed, reference may be made to my book, "The Geology of Oil, Oil-Shale, and Coal."

I gather from Dr. McKenzie Taylor's description that in his experiment the bacterial decomposition under alkaline anaerobic conditions of the fat which was distributed through a sand layer at the bottom of the beaker took place in fresh rather than in saline water. If so, this may possibly account for the yield of methane rather than of higher members of the paraffin series. Connate oilfield waters which occur, together with oil, sealed up in oil-sands, have a distinct resemblance to ordinary sea water. They differ from ordinary sea water in increased salinity and deficiency in sulphates and magnesia. Two years ago I deduced that natural petroleum oil owes its origin to the bacterial decomposition under anaerobic conditions, in some cases of vegetable oils, and in others of protoplasm, by sulphate-reducing bacteria in sea water, and that the differences between connate oilfield waters and normal sea water were just the differences which would be produced by the action of such bacteria. The actual discovery of sulphate-reducing bacteria in the connate oilfield waters of the Illinois, Sunset-Midway, and Coalinga oilfields of America, by Dr. Edson S. Bastin, affords a certain amount of support for my deductions. If, parallel with the experiments which he is conducting, Dr. McKenzie Taylor would conduct a second set of experiments to determine the effect of the bacterial decomposition in sea water under anaerobic conditions by *Microspira aestuarii* (van Delden) and its associates, of protoplasm on one hand, and of vegetable oils on the other, incorporated as sediments in clay, a comparison of the results obtained would be extremely valuable.

MURRAY STUART.

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The Nierenstein Reaction.

DURING the past thirteen years, and in conjunction with several different collaborators, I have studied the reaction which takes place when diazomethane is added to various acyl chlorides, and I have shown that the change which takes place is always of the type represented by the equation,

$$R.CO.Cl + CH_2.N_2 = R.CO.CH_2.Cl + N_2.$$

The details of the method are described in my first paper (*Jour. Chem. Soc.*, **107**, 1491; 1915) on the subject, and it suffices to state here that the reaction was conducted by passing the diazomethane into the acyl chloride, the latter reactant being always in excess during the reaction. This is commonly known as the Nierenstein reaction.

Quite recently Arndt (*Ber.*, **61**, 1122; 1928) has confirmed my experimental results, and has also shown that if the method of conducting the process be reversed, and the acyl chloride added to the ethereal solution of diazomethane, so that the latter remains in excess, a change takes place which is represented by the equation,

$$R.CO.Cl + CH_2.N_2 = R.CO.CH.N_2 + HCl,$$

the main product being of the type, $R.CO.CH.N_2$, instead of the type, $R.CO.CH_2.Cl$.

In a paper published in the *Journal of the Chemical Society* a few days ago (p. 1310), Bradley and Robinson state that when diazomethane is treated with benzoyl

chloride the main product is diazoacetophenone, and they therefore suggest that I and my collaborators, in this case Clibbens, have published statements which cannot be corroborated. I would point out that since they conducted the experiment in accordance with the second alternative method of Arndt, it is not surprising that they obtained the result which they might have anticipated had they been acquainted with Arndt's work, and not the result which would have been arrived at if they had followed the procedure of the Nierenstein reaction, as confirmed by Arndt.

I also take this opportunity of correcting a somewhat serious mis-statement which the same authors make in reference to my work. They express surprise that I should have stated that a certain substance containing two active Ph . Br . CO . groups should "crystallise unchanged from alcohol" (*J. Am. C. S.*, **47**, 1730; 1925), referring to this alleged statement as an "unconventionality." Reference to the paper will show that the substance is said to "crystallise in long needles from benzene," and that alcohol is not mentioned as a solvent from which the substance can be crystallised.

M. NIERENSTEIN.

The University, Bristol.

Infra-red Emission of Carbon Dioxide.

DURING the course of an investigation into certain infra-red emission spectra, we re-examined that of burning carbon monoxide. In the absorption spectrum of carbon dioxide it is necessary to presume the existence of three fundamental vibrations in the near infra-red; in this way the other bands observed in the so-called rotational-vibrational spectrum can be accounted for as a system of harmonics and combinations: nevertheless the observed values depart from those calculated by several units per cent.

If the emission spectrum is analysed, it is found that most of the bands have shifted towards the longer wave-lengths and so become exact multiples of a frequency, $\nu = 16 \times 10^{11}$, in the far infra-red. Our observations are recorded in the following table: the values for the absorption spectrum are taken from the work of Schaefer and Philipps (*Zeit. f. Physik*, **36**, 641, 1926).

No.	Emission.				Absorption.	
			$\nu \times 10^{-11}$.			$\nu \times 10^{-11}$.
	λ.	$n\nu_0$.	Calc.	Obs.	λ.	Obs.
1.	1·70μ	$110\nu_0$	1760	1764	1·61μ	1864
2.	1·99	$94\nu_0$	1504	1508	2·02	1486
3.	2·40	$78\nu_0$	1248	1250	..	..
4.	2·79	$67\nu_0$	1072	1074	2·69	1115
	2·84	$66\nu_0$	1056	1056	2·72	1102
	2·87	$65\nu_0$	1040	1045	2·76	1086
5.	4·46	$42\nu_0$	672	673	4·25	706
6.	[15·6]	$12\nu_0$	192	..	14·87	202
7.	[187·4]	ν_0	16	..	..	..

No. 3 is new, not having been previously observed either in absorption or emission; No. 4 is a double doublet which can just be resolved with a rock-salt prism spectrometer; No. 5 is generally quoted as 4·40μ, but most careful calibration of the two spectrometers used, together with frequent repetition, confirms our result, the corresponding value for the bunsen flame at a lower temperature being 4·44μ.

Many interesting theoretical points present themselves, but it seems that here we are dealing with a pure rotational spectrum; it is suggestive that the Krüger gyroscopic molecule (founded on the earlier Bohr atom) executes a regular precession at low temperatures which changes to a true rotation at more elevated ones.

A corresponding simplicity underlies the water vapour *emission* spectrum which we have also investigated.

C. R. BAILEY.
K. H. LIH.

Sir William Ramsay Laboratories of
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May 25.

The Spectrum of Ionised Sodium.

IN a noteworthy article with the above title (*Phil. Mag.*, **5**, 150; 1928), Prof. F. H. Newman has given a new list of wave-lengths of the spark spectrum of sodium, which had previously been investigated by Foote, Meggers, and Mohler. The lines in question lie mainly in the near ultra-violet, between 2300 A. and 4800 A. No analysis of the Na II spectrum is attempted in the above-mentioned paper, but a number of pairs showing constant differences are given. I wish to show that using one of those differences (most of the others seem to be accidental) it is possible to arrange numerous strong lines as combinations of four s terms with ten p terms, corresponding to the transition ($3s^{1\,3}P - 3p^{1\,3}(S, P, D)$). The wave-length arrangement is the following:

	$(s_5)^3P_2$	$(s_4)^3P_1$	$(s_3)^3P_0$	$(s_2)^1P_1$
p_{10}	3533	3631	3711	...
p_9	3093			
p_8	3056	3130		3463
p_7	3008	3079	3136	3400
p_6	2918	2984	...	3286
p_5	2860	2924	2975	3212
p_4	2842	2905		3190
p_3		2881?		...
p_2	2810	2872	2921	3150
p_1		2586		2810

The frequency differences between the four lower levels $^3P_2$, $^3P_1$, $^3P_0$, $^1P_1$ are respectively: 765, 592, 2481 cm.$^{-1}$. The sum of the second and third of these is the difference 3073 cm.$^{-1}$ the occurrence of which was found by Prof. Newman. It is noteworthy that the difference $^3P_2 - {}^3P_0 = 1357$ cm.$^{-1}$, which may be interpreted as an L doublet yields, when inserted into the relativistic doublet law, exactly the same screening constant, 3·20, as the corresponding difference 780 of Ne I. For the comparison of the four differences of Na II with the corresponding ones of Ne I (417, 360, 1070), reference may be made to a paper by Mack, Laporte, and Lang (*Phys. Rev.*, June 1928). In every respect the above arrangement is similar to the first member of the principal series of Paschen's famous neon classification. As is easily seen, the next member of this system of series must lie deep in the Schumann region.

Parts of the diffuse series

$$3p^{1\,3}(S, P, D) - 3d^{1\,3}(P, D, F)$$

have also been found. All the strong and many of the weaker lines have thus been classified. The complete numerical material will be published soon.

OTTO LAPORTE.

Department of Physics,
Imperial University,
Kyoto, May 6.

A Nitrogen After-glow.

IN the course of evacuating glass vessels which were to be used for experiments on the maintenance and starting potentials in argon for continuous high frequency oscillations, we observed that a nitrogen after-glow appeared when a discharge was passed through a mixture of air and argon at low pressures. For pressures greater than two millimetres it is very difficult to pass a discharge through air using external electrodes and a small valve oscillator giving a wave-length of the order of 20 metres. But when the pressure is less than one millimetre a discharge takes place easily in air. A great many experiments have been made on the residual air contained in glass vessels, and in no single case of a discharge of this type have we noticed a nitrogen after-glow, whether or not the more volatile gases were frozen out with liquid air. Even in the preparation of pure nitrogen a glow was noticed in a discharge of this type only on one or two very rare occasions when there were impurities present in small quantities.

If, however, pure argon at about a millimetre pressure be admitted to a vessel containing air at a pressure of the order of 1/10 of a millimetre, a glow at once appears. We have not yet had the opportunity to investigate the relative proportions of the mixture over which this phenomenon may be produced, but they may be varied over a fairly wide range. Mixtures of neon and helium at about the same pressure do not show this effect. The after-glow is greenish-yellow in colour, and under the best conditions will persist for some seconds after the discharge has ceased to pass.

We have tried a Tesla discharge through the mixture, but such a discharge gave no sign of an after-glow. All the experiments with the usual methods of production seem to agree in showing that argon has no effect on the nitrogen after-glow and that the nitrogen after-glow is not produced when the proportion of oxygen and nitrogen is the same as that in the atmosphere. The mixture retains its properties over long periods; for example, we have a sealed-off glass tube in the laboratory which has been used to show this effect for a period of two months.

This method of production should be exceedingly useful in some types of research.

S. P. McCALLUM.
W. E. PERRY.

Electrical Laboratory,
Oxford.

Thames Floods.

THERE is one possible cause of exceptionally high tides which is not always kept in mind. The effect of a system of low atmospheric pressure may be cumulative if the centre is moving in the same direction as the tidal wave and at the same speed. If the centre is at the correct distance in advance of the crest of the wave an exceptionally high tide may be experienced; and it may be inexplicable from consideration of wind and static barometric pressure alone.

I can give an example. A few years before the War, and about the month of June, a well-defined line squall passed up the English Channel. I happened to be in a 3-ton boat about 15 miles west of Portland Bill when it passed, and so I can definitely state that the wind effect was negligible. We had a barograph on board, and it indicated a sudden fall of 0·2 in. and a sudden rise of about 0·1 in. about 10 minutes later. That happened on a Saturday afternoon, and the Monday papers had reports from various parts of the south coast of a rise in the tide after the ebb had started, and of boats refloating after they had taken the ground.

Where the depths are about 20 or 30 fathoms, corresponding with tidal wave speeds of 36 or 45 knots, the *movement* of atmospheric depressions should always be taken into account.

P. J. H. UNNA.

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May 18.

The Pure Rotation Spectrum of Ammonia.

WITH the assistance of Mr. C. H. Cartwright, I have recently investigated the absorption of ammonia gas in the region of the far infra-red lying between 55μ and 130μ, and have observed an unexpectedly simple spectrum. Six lines were discovered which are approximately equally spaced in the frequency scale, and five of these were accurately measured. Within experimental error all of the lines may be represented, in terms of wave number, by means of the following equation,

$$1/\lambda_m = 19{\cdot}957m - 0{\cdot}00508m^3.$$

A thorough search failed to reveal other lines in the region investigated, and within the resolving power of the spectrometer those observed appeared to be singlets.

Presumably this spectrum is due to changes in the rotational energy of the ammonia molecule, as it rotates about one axis. According to the new theories it is not possible from the observed data alone to calculate the moment of inertia about this axis, for the molecule at rest. The estimate of $2{\cdot}77 \times 10^{-40}$ gm. cm.^{2}, however, is probably not greatly in error. The magnitude of the second term in the equation above shows that the molecule is relatively elastic and stretches considerably in higher rotational states.

A study of the absolute intensities of absorption was also made and will be published shortly.

RICHARD M. BADGER.

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Pasadena.

Uncommon Common Salt.

THE top three crystals of sodium chloride shown in the photograph were formed in a gel prepared by addition of sodium silicate to hydrochloric acid.

FIG. 1.

The crystals are cubes with hollow faces and bevelled edges, the form being {110}.

In the 'hopper' crystals shown for comparison similar faces are simulated by parallel growth of {100}.

A. F. DUTTON.
C. G. WEBB.

Building Research Station,
Garston, Herts., May 23.

The Sun's Outer Atmosphere.[1]

By Prof. E. A. MILNE, F.R.S.

AT a total solar eclipse, when the moon touches the sun's limb internally, a thin crescent of atmosphere is exposed. Its spectrum is a series of bright lines—general absorption at these levels has vanished. By measuring the lengths of the crescents from tip to tip, astronomers have estimated the heights to which the atoms of different elements exist. The following table gives samples of the observed heights:

HEIGHTS OF ELEMENTS IN CHROMOSPHERE AS SHOWN BY LENGTHS OF ARCS AT DIFFERENT TOTAL ECLIPSES.

	Lockyer. 1898.	Mitchell. 1905.	Davidson and Stratton. 1926.
	Km.	Km.	Km.
H λ6563 (Hα)	7,500	..	8,400
4861 (Hβ)		8,000	8,400
4341 (Hγ)		8,000	8,000
4101 (Hδ)		8,000	7,400
3889 (Hε)		8,500	7,000
He λ4713 ($1^3P - 3^3S$)	..	3,900	6,000
5876 ($1^3P - 2^3D$) (D_3)	..	7,500	7,500
4471 ($1^3P - 3^3D$)	6,500	7,500	7,400
4026 ($1^3P - 4^3D$)	4,500	6,000	4,400
4922 ($1\ P - 3\ D$)	..	1,000	2,500
4388 ($1\ P - 4\ D$)	..	2,000	2,000
4144 ($1\ P - 5\ D$)	..	1,500	2,200
He^+ λ4686 ($3D - 4P$)	..	2,000	2,500
Na λ5896, 5890 ($1^2S - 1^2P$) (D_1, D_2)	..	1,200	1,000
Ca λ4227 ($1S - 1P$)	3,500	5,000	2,500
Ca^+ λ3933, 3968 ($1^2S - 1^2P$)	9,500	14,000	9,200
Sr^+ λ4215, 4077 ($1^2S - 1^2P$)	4,500	6,000	5,200

It will be seen that the thickness in each case is of the order of thousands of kilometres. Roughly speaking, the sequence is: photospheric layer of the order of tens of kilometres, reversing layer of the order of hundreds of kilometres, chromosphere of the order of thousands of kilometres. We may complete the sequence by mentioning that the solar prominences are of the order of at least tens of thousands of kilometres and that the corona is of the order of hundreds of thousands of kilometres.

The mere size of this thickness shows that we are compelled to introduce a new force other than gravity and gas pressure. In ordinary gravitational equilibrium, under solar conditions, the pressure would decrease by a factor 0·07 in 10 km. In 10,000 km. it would decrease by a factor 10^{-1140}. At this pressure there would be no atoms at all at 10,000 km., and the pressure would have fallen to 10^{-18} atmospheres in 100 km. from the limb. When selective radiation pressure is introduced the pressure decreases much more slowly.

To see how this arises we must return to our arguments about selective radiation pressure near the boundary. We have still to explain what was wrong with our former assumptions. It will be remembered that we assumed 'local thermodynamic equilibrium.' This means that we assumed a definite temperature at each point. In strict thermodynamic equilibrium, as in an enclosure at a uniform temperature, the matter is traversed by radiation corresponding to its own temperature. At any point in a star the matter is traversed by radiation arising from places at a variety of temperatures, and strict thermodynamic equilibrium does not occur. But for many purposes the matter behaves as though it had a definite temperature. It can be shown, in fact, that when the density is sufficiently high, that is, when the atoms are sufficiently battered about by collisions with other atoms, the matter behaves according to the laws of Kirchhoff so far as the emission and absorption of radiation are concerned. The ratio of emission to absorption at any point is determined by Kirchhoff's universal function (Planck's function), which contains the temperature as a parameter. When we calculate the laws of transfer of radiation under these conditions, using Schwarzschild's equations, we find first the laws of selective radiation pressure mentioned earlier. We find also that energy is continually being transformed to longer and longer wave-lengths as it runs down the temperature gradient, the mechanism being inelastic and hyper-elastic collisions. Hyper-elastic collisions remove energy of shorter wave-lengths, and inelastic collisions introduce radiation of longer wave-lengths.

As, however, the density decreases, collisions become less important. Radiation, instead of being transformed in wave-length, tends to be handed on at the same wave-length. Ultimately, at sufficiently small densities, the whole of the radiation passes unchanged in wave-length. We call this state of affairs 'monochromatic radiative equilibrium.' Each portion of matter then emits as much radiation of the wave-length in question as it absorbs. Since there is no gain or loss of radiation of the given wave-length at any point, the net amount of λ-radiation crossing any one level—the difference between the inward and outward streams—is the same as that crossing any other level—for otherwise there would be either an accumulation or a loss of energy between the two levels. The net flux in a given wave-length is therefore constant. Hence if the absorption coefficient is constant, the selective radiation pressure will be constant.

We can now trace the origin of our previous contradiction. First, we erroneously assumed local thermodynamic equilibrium to hold right up to the boundary of the star. This led to the possibility of an uncompensated radiation pressure at the boundary. This, we saw, must cause the formation of an outer atmosphere, a chromosphere.

[1] Continued from p. 918.

Secondly, we ignored the inward stream of radiation arising from this outer atmosphere; we calculated the selective radiation pressure at the boundary of the layer in local thermodynamic equilibrium as though there were no inward stream there.

When we now take account of the inward stream from the outer atmosphere, we see that all contradictions are removed. The boundary of the region in local thermodynamic equilibrium is not the boundary of the star as a whole. Outside this there will exist in general, for each particular kind of atom, a region not in local thermodynamic equilibrium but in monochromatic radiative equilibrium. This acts as a cushion, gently pressing on

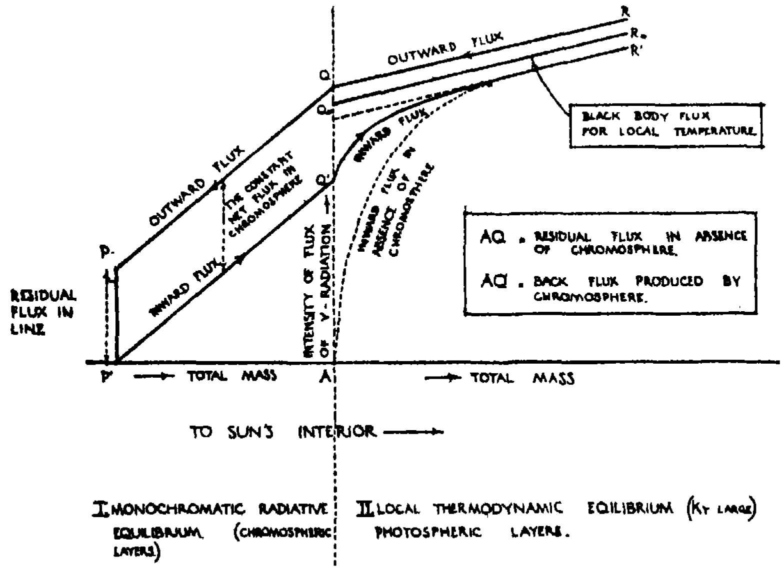

FIG. 3.—The transition from local thermodynamic equilibrium to monochromatic radiative equilibrium, and its influence in the formation of the chromosphere. The slope of PQ and P′Q′ is determined by the theory of radiative equilibrium. The length of PP′ (residual intensity) is determined by the weight of the atom and the atomic absorption coefficient. These two data serve to fix the position of P′. The slope of Q_0R_0 is determined by the temperature distribution, which in turn is determined by the equilibrium of the integrated radiation of all frequencies. Different horizontal scales are used for I. and II. Actually there is no discontinuity between I. and II.; a discontinuity is introduced merely for illustration purposes, to show up the different factors at work. In the absence of the chromosphere, the residual flux AQ would cause expulsion of atoms. The chromosphere grows from A to P′, until its back radiation AQ′ reduces the net flux to QQ′ = PP′ = residual intensity in centre of line.

the region beneath and keeping it in equilibrium, to a slight extent by its weight, but principally by its back radiation.

In this region, the chromosphere, we can now see that the density is likely to fall off very slowly. A decrease of density upwards means a decrease of pressure, and hence a pressure gradient. This balances part of the weight. But we have seen that the creation of the outer atmosphere will go on until its weight is just sufficient to balance the otherwise uncompensated radiation pressure from the region beneath. In this equilibrium there is no part left for pressure gradients to play, and they will be practically non-existent. In other words, the density will be practically constant.

Actually this overstates the case. The density must, in fact, decrease slightly outwards. For it to be accurately constant, the radiation pressure would have to be accurately constant. We have seen that the net flux is accurately constant. But the radiation pressure is proportional to the net flux and the absorption coefficient, and the latter is not accurately constant. It must be smaller at lower levels, because owing to the increased density of radiation there (forward plus backward stream) more of the atoms at any instant will be excited and so not in a condition to absorb; thus the average absorption coefficient will be smaller. The consequence is that at least at the lower levels there must be some pressure gradient to take care of the uncompensated portions of gravity, and so there will also be a density gradient.

Theoretically, the density should fall off as the inverse square of the height measured from a certain datum level.

A further point is, that though we have demonstrated the possibility of the existence of an extended low-pressure outer atmosphere with small density gradient, we have not proved that this is the only type of outer atmosphere. There are a whole range of other possibilities. If, after expelling enough atoms to form an outer atmosphere, the lower regions exude for some reason more atoms, radiation pressure will further diminish. There will be too many atoms to be fully supported by radiation pressure, and the outer atmosphere will partially collapse on to the lower regions. It will then be strongly condensed towards its base. Nevertheless, an all but fully supported outer atmosphere is what is observed in the case of ionised calcium atoms on the sun. The spectral observations made by Col. Stratton and Mr. Davidson at the eclipse of 1926 (Sumatra) have been analysed by Mr. P. A. Taylor. He first extended the theory so as to allow for the curvature of the sun, and then compared the observed outward decrease of intensity of the flash spectrum with the calculated decrease. It appeared that all but about one ten-thousandth of the weight of the calcium chromosphere was supported by radiation pressure. Why this is so we cannot exactly say. One suggestion is that it appears possible that a strongly condensed 'partially supported' chromosphere would tend to re-introduce local thermodynamic equilibrium, in which case atoms would be once again expelled and a fresh chromosphere would be grown. This is a mere conjecture, and such calculations as I have been able to make do not confirm it. We must await further investigations.

Each species of atom occurring in the chromo-

sphere should produce its own radiation gradient, independent of the others, and the complete chromosphere arises from the co-existence of the separate outer atmosphere for the separate species of atom.

We have arranged our argument as though the region of local thermodynamic equilibrium ends abruptly, and is superposed by a region in monochromatic radiative equilibrium. Actually, the two must shade into one another. The precise pressure at which the one set of conditions gives place to the other depends on the effective cross-section of the atom for collisions that are capable of exciting it, and if this cross-section is of the order of magnitude of the cross-section given by the dynamical theory of gases, then the transition pressure where an intermediate state holds is of the order of 10^{-3} atmospheres. If this is to be trusted, it would mean that all lines in the reversing layer are produced under conditions where, on the whole, the state is one of monochromatic radiative equilibrium rather than one of local thermodynamic equilibrium.

As a corollary it would follow that all lines except those due to very heavy atoms should appear in the chromosphere. Roughly speaking, this is what is observed.

The more nearly an outer atmosphere, in a particular kind of atom, is in monochromatic radiative equilibrium, the more nearly the ratio of the residual intensity in the line-centre at the limb to that at the centre of the disc should approach the value $\frac{2}{3}$. It will be a matter of interest to see to what extent this holds—investigations are now in progress at a number of different observatories. Schwarzschild pointed out long ago that on local thermodynamic equilibrium all absorption lines should vanish in the continuous background at the limb, and inferred that since they do not do so there must be a measure of monochromatic radiative equilibrium. Our general theory bears this out. For all atoms, local thermodynamic equilibrium must give place to monochromatic radiative equilibrium at low densities, and the more completely this holds the more completely should the limb-centre ratio approach $\frac{2}{3}$. Schwarzschild found that the ratio was in fact about $\frac{2}{3}$ for the H and K lines of calcium, for which lines the existence of a high level chromosphere makes it very probable that monochromatic radiative equilibrium holds strictly.

It is perhaps scarcely necessary to add that in the atmospheric structure we have sketched we have highly idealised the problem at a number of points. We have simply attempted to construct a model of the solar atmosphere useful for the points under discussion. It will not necessarily be useful for other points. Even as it stands it is not a complete model. For one thing, we have tacitly dealt only with electronic transitions as the origin of lines—we have ignored the effects of selective scattering as the cause of line-widening, as suggested by Stewart and brought into prominence by the recent work of Unsöld. Again, we have argued as though the boundary between monochromatic radiative equilibrium and local thermodynamic equilibrium coincided with the boundary between the low-pressure chromosphere and the higher-pressure reversing layer. Actually, we have found that monochromatic radiative equilibrium is coming into being at about 10^{-3} atmospheres, whilst, for example, the partial pressure of calcium at the base of the chromosphere can scarcely exceed 10^{-12} atmospheres. This involves no intrinsic self-inconsistency. It is merely that we have not dealt adequately with the few hundred kilometres in which this transition occurs. Somehow or other the sun knows how to arrange its layers in this region in accordance with the laws of physics, and in so doing it propounds an attractive puzzle for the mathematician and the solar physicist.

Centenary Conference of the Institution of Civil Engineers.

THE engineering conference held during the first week in June as part of the celebrations of the centenary of the incorporation of the Institution of Civil Engineers, proved a very successful function. Monday, June 4, was devoted to a reception of the many delegates representing kindred institutions and universities at home and abroad, and to the delivery of the James Forrest Lecture, the main part of which appears as a Supplement to this week's issue of NATURE. Such an occasion affords a very suitable opportunity for a general review of the developments which have taken place in this branch of applied science during the past hundred years. In his lecture Sir Alfred Ewing gave a masterly exposition of these developments, taking as his main thesis the prediction of Tredgold made in 1828 that "the scope and utility of civil engineering will be increased with every discovery in philosophy, and its resources with every invention in mechanical science," and emphasising at the same time the extent to which advances in engineering have been associated with many of the most noteworthy advances in physical science.

The mornings of June 5 and 6 were devoted to the presentation and discussion of a series of professional papers. The scope of the subjects chosen for discussion by the selection committee indicates in a striking manner the catholicity of the Institution, the majority of the papers dealing with matters which are commonly understood as coming within the purview of the mechanical or electrical engineer, and relatively few dealing with those branches of constructional and structural engineering with which the members of the Institution are commonly supposed to be most intimately concerned.

Since the papers were chosen with the view rather of considering recent developments in engineering, this is perhaps unavoidable, for there can be little doubt that modern developments in what may perhaps be termed the more dynamical branches of engineering have been much more marked than in those branches which deal with such constructions

as railroads, docks and harbours, and bridges. It is somewhat surprising, however, in view of recent developments in this direction, that there should have been no paper dealing specifically with modern dams of the arch type. It is true that this type has been almost exclusively developed abroad, but in view of its interest and importance it would appear to be a subject well meriting discussion at such a conference.

It is worthy of note that no fewer than ten of the papers presented for discussion deal with one or other aspect of the generation of power from solid or liquid fuels. The possibilities embodied in the use of steam at high pressures, especially at high temperatures, are attracting much attention at the present time; and keen interest in this subject was evidenced in the discussion of papers dealing with such various aspects of the problem as the properties of the materials suitable for use in the construction of boilers for very high pressures; the design of such boilers, both for land and for marine use; and the design of steam turbines for utilising these pressures. The general trend of the papers and of the discussion would indicate that developments in this direction are likely to be far-reaching and important in the near future. At present, the difficulty of obtaining a steel which is at once fairly cheap and well adapted for use at high temperatures forms a serious handicap, but when this problem has been satisfactorily solved—and, in view of the attention now being devoted to it, the solution cannot be long delayed—the high-pressure installation is likely to become the rule rather than the exception both for land and marine work.

Discussions on the use of internal combustion engines, and of high-pressure steam for marine propulsion, show that the marine steam plant is very far from being dead, and its advocates see every reason to believe that the use of high pressures on shipboard may do much to bring the balance of advantages once more on to the side of steam propulsion. A paper on the latest types of steam and internal combustion locomotives shows that the battle between the steam and the internal combustion engine is being waged with some intensity here also.

Some interesting facts were brought out in a paper on light high-speed internal combustion engines, and in the resultant discussion. Thus it is probably not generally realised that the output of such engines to-day, measured in horse-power, is more than ten times that of all existing power stations, ships, and railways. Largely owing to its application to aerial flight, this branch of engineering has engaged the attention of some of the most skilful and scientific British designers during the past fifteen years; and the progress during that time has probably been more marked than in any other branch of motive power engineering. The highest thermal efficiency yet recorded by any heat engine, namely, 39·5 per cent on the brake-horse-power, was obtained on the Napier aero-engine which won the Schneider Cup trophy in 1927, while almost, if not quite, the highest thermal efficiency ever recorded on a Diesel engine was obtained by the Royal Aircraft Establishment on a small high-speed Diesel engine of 8 inches bore running at 1000 rev. per minute.

The design of such an engine sufficiently light to be used in an aeroplane is still some way from solution, but in view of the progress already attained in this direction, it would appear extremely probable that the Diesel engine will at no remote date form the power unit for moderate speed heavy aeroplanes intended for long-distance flights.

The general interest shown in the work of the Electricity Commission is reflected by papers on prospective developments in the generation of electricity; on the electric transmission of power as applied to large areas; and on domestic lighting and heating and its influence on the load factor of supply. This forms a very interesting and suggestive trilogy of papers.

Two papers on water power were discussed, one dealing with recent progress in hydro-electric installations of conventional type and one with tidal power. In the former paper the remarkable rate of development of water power is emphasised. The total world development now amounts to about 35 million horse-power, practically all of which has taken place in the last thirty years, and this is increasing at the rate of about 1·5 million horse-power per annum. The capacity of the hydro-electric plants now operating in Great Britain, however, does not exceed 100,000 horse-power, which is almost negligibly small compared, for example, with the 12 million horse-power of the United States. At the same time, it is encouraging to know that Great Britain takes a share in the design and manufacture of hydro-electric plants altogether out of proportion to its own meagre water-power supplies.

In view of the investigation of the possibilities of a tidal scheme on the Severn; of the published particulars of a proposed tidal development on the Wash; and of the tidal scheme on the French coast at Aberv'rach, the discussion on tidal power was timely and of interest. Such a development probably involves more diverse problems than are to be found in any other single engineering development. There can be little doubt that these problems are on the way to solution, and that sooner or later large-scale tidal development will provide a very large source of energy supply. One can, indeed, visualise the time when water-power development from tides will be relatively as important in Great Britain as is water-power development from rivers in such a country as the United States.

Papers on recent developments in concrete for engineering structures, and on developments in the use of materials in railway engineering, indicate the extent to which the use of concrete, especially in conjunction with steel reinforcement, is extending. Even in the most conservative of engineering circles, interest is now being shown in the possibilities of reinforced concrete, and its use is rapidly extending. The introduction of reliable rapid

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A Century of Inventions.[1]

By Sir JAMES ALFRED EWING, K.C.B., F.R.S.

THE Council of the Institution of Civil Engineers, when inviting me to deliver the James Forrest lecture as an item in the celebration of our centenary, suggested a very comprehensive text, namely, a prediction which Thomas Tredgold added to the definition of civil engineering which he drew up for the petition for a Royal Charter presented in 1828. It ran thus :—

"The scope and utility of Civil Engineering will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical science."

Seldom, surely, has a prophecy been so justified in the event. The history of engineering during the century which has passed since these words were written is in its main features the story of their fulfilment. Every advance in scientific theory has increased the engineer's mastery of the material world. Discoveries, which at first may have seemed wholly unserviceable to him, have in fact furnished new points of departure, leading in ways that were often unforeseen to enlargements of his many-sided art.

It may be doubted whether even Tredgold, with all his vision, saw the outer side of the picture; whether he realised the beneficent reaction by which science was itself to profit. But we, at any rate, see it now. We see how developments in science are fostered and even initiated by industrial requirements, by engineering enterprise; how inventions that were made for the purpose of serving a public need have widened the outlook of science and given it new tools for research. Nowadays theory and practice march together in such close association that it is often difficult to distinguish them as separate figures in the procession. In chemistry, in metallurgy, in thermodynamics, in electricity, who would venture to apportion the credit for progress, as between the man who pursues abstract truth and him who strives after technical application? Looking back, we may assert that there has from the first been some mutual obligation, not indeed so constantly operative as it is to-day or so clearly admitted, but often very influential. From modest beginnings physical science and engineering have advanced, side by side, and in the advance their intimacy has developed; they have discovered the benefit of relationship and the relationship has itself become closer. A century ago they were both sturdy infants, playing, one may say, in more or less separate nurseries, sometimes meeting and perhaps sometimes quarrelling a little. Now, adult and masterful, they are partners in one firm, still conscious—as partners may be—of differences in temperament and taste and viewpoint, but very conscious also of the strength that comes from co-operation.

To-day we can take no more than an aviator's survey—what used to be called a bird's-eye view. For this purpose I may claim the doubtful advantage of having seen more than half a century pass since I began to teach engineering. I recall as a boy finding inspiration in an account of the doctrine of the conservation of energy then published as a new gospel—a doctrine which flooded with light much that had been very dark in earlier attempts to co-ordinate mechanical ideas. My recollections go back to a period before the coming of the oil engine, of the dynamo, the electric motor, and the transformer, when the only practical application of the electric current was in telegraphy, when the arc lamp was a scientific curiosity and the telephone had still to be born. It is something to have witnessed the whole pageant of electrical engineering display itself before one's own eyes, from tiny beginnings to its present greatness; to have seen the dream realised of a distribution of power from central stations; to have watched each stage in the development of the steam turbine and its use on land and sea; to have observed the internal combustion engine arrive as a modest ally to steam, and gradually turn into a serious rival, after effecting a social revolution by making transport by road easy and transport by air possible. These things are familiar to everyone; but it is

[1] From the Thirty-fourth James Forrest Lecture, delivered before the Institution of Civil Engineers on June 4, on the occasion of the celebration of the centenary of its incorporation.

perhaps to the old, who saw their first coming, who knew a simpler, homelier world before they came, that they make their strongest appeal. To me, who began engineering experience with the telegraphy of the early 'seventies, it is much to have been a spectator of the wizardry which has so transformed the art of communication that the spoken word literally goes forth to the end of the world.

In this review, however, we have to go back farther than the reach of even the longest individual memory. Try to realise what engineering meant in 1828, what was its relation to the science of the day, and what in fact was, in that day, the state of science. The engineers of that period were mainly concerned with roads, bridges, and canals; the era of railways was about to begin. The steam engine, which first served as a device for pumping water out of mines, had been adapted by Watt and his followers to the driving of machinery in factories, and had thereby become a potent agent in the industrial revolution which followed the Napoleonic wars. It had been applied experimentally to drive carriages on roads, and had established its position, especially in America, as the motive power of paddle-boats for river traffic. To a small extent steam was being adopted as an auxiliary in sailing ships, and reformers were urging that the Navy should give it a trial—alleging what seems to us the curious reason that a steamship would cost less to build than a sailing ship. We have not found the *Hood* cheaper than the *Victory*.

Watt's prejudice against the use of high-pressure steam for a long time dominated English practice. Nevertheless, Jacob Perkins, rightly described by a contemporary as "an experimenter of no common cast," ventured even before 1828 on pressures such as would still be considered very high. He exhibited a piece of steam artillery which, under a pressure of sixty-five atmospheres, projected nearly one thousand musket balls per minute. But Perkins was one of those unfortunate inventors who are born before their time. What is relevant for us to notice is, that in those days the theory of steam was even more rudimentary than the practice; the early development of the steam engine proceeded without the guidance which it would have had if the properties of steam had been known. Carnot had already written his wonderful essay on the motive power of heat. But it had fallen flat. Its meaning was not appreciated; and at the time of which I speak the very alphabet of thermodynamics had still to be framed.

Remember that these early steam engineers had no idea that what they were doing was to convert heat into mechanical work. Many years were to pass before the notion of energy, as a thing neither produced nor destroyed, was to become an established part of natural philosophy; before Joule determined the mechanical equivalent of heat, and the first principles of the subject were formulated by Kelvin and Rankine and Clausius. But it may fairly be claimed that the way was prepared for these conceptions by the work of the engineers, by the invention and frequent use of the indicator, by Watt's numerical definition of the term 'horse-power,' and by the sporting interest of the Cornish mine managers in the 'duty' of their engines, a figure which expressed the relation of what we now call the work done to the coal consumed.

When one looks into the technical literature of that period one is sorry for the early student of engineering. Physicists and engineers alike were groping their way, confusedly, towards mechanical ideas which were as strange then as they are familiar now. The mathematical theory of elasticity is described by its historian Todhunter as having had its birth in 1821, when Navier first gave the equations for the equilibrium of elastic solids. Navier had brilliant colleagues among the other mathematicians of France. But between them and the stolid practicians of Westminster there was a wider difference than one of language or political sentiment. Their ways were not as our ways. Tredgold, in a preface to his "Essay on the Strength of Cast Iron," which discusses the stresses in beams, goes so far as to repudiate the use of fluxions as unsound. He appears to have regarded a differential coefficient as a device for "forcing the assent rather than convincing the judgment." This prejudice against the calculus remained for long a serious handicap to the British student of engineering.

Not less than mechanics and heat, the science of electricity was still in its infancy. Chimerical ideas found vent in engineering papers about the possibility of driving ships by the consumption of a little zinc in a galvanic battery. One sanguine inventor estimated the cost of propelling a ship in this way at 3*s*. 4*d*. a day. Ohm's Law had been formulated in 1825, but in the absence of units and instruments of measurement its significance could not be understood. It was not until the requirements of the telegraph had to be met that engineers and physicists together attacked the problem of framing a logical system of electrical units, determined their magnitude, set up standards, and established practical means of comparing

electrical quantities with them. The work was begun in the early 'sixties, mainly at the instigation of William Thomson, afterwards Lord Kelvin. It was done under the auspices of a committee of the British Association, of which the secretaries were Clerk Maxwell the physicist, and Fleeming Jenkin the engineer. What it accomplished was an incalculable boon to the investigator in pure science no less than to the technician.

Not in electricity only, but also in mechanics, in heat, in all the properties and actions of matter where engineers and physicists find common ground, it is through the alliance between practice and science that the art of measurement has been evolved. It was to meet the needs of engineers that Whitworth brought precision into mechanism by laboriously creating for the first time a true straight-edge, a true plane surface, a satisfactory screw. This was no less a service to science: it made practicable the scales and standards and gauges that are now familiar alike in the laboratory and the workshop.

It was to meet the rapidly growing needs of steam engineering that Regnault undertook his researches into the properties of steam, which led to the publication, in 1847, of tables and data which for long remained a classic of the engineer. Now, thanks to Callendar, Mollier, and other workers, we enjoy a fuller and more accurate knowledge of these properties than Regnault could achieve, hampered as he was by the uncertainties of early thermometry. The science of thermometry became definite only after Kelvin introduced the absolute scale of temperature—a brilliant philosophical conception which runs through all physical and chemical science like a thread of gold in a woven fabric. It guides the engineer to the ultimate standard of thermodynamic efficiency; and it was from meditating on the action of heat-engines that the inspiration came.

It was to meet the requirements of the naval architect that William Froude attacked the problem of ship resistance, devised the method of the experimental tank, and showed how measurements on the drag of small models might, through application of what is now called the principle of dynamical similarity, furnish data from which to determine the power required at any speed to drive the largest ships. In more recent days the same principles, applied by aid of experimental wind channels to study the forces which air currents exert on model objects, have been a powerful factor in the development of aeronautics—an art the beginnings of which many of us have witnessed and the progress of which, sensationally rapid, compels attention from day to day.

A new art, such as flying, becomes inevitably and at once a branch of applied science; it advances like a fire-engine in a crowded thoroughfare; it escapes the long period of empiricism through which the older arts had to pass while they were laboriously making their way into the light.

It is to aid engineering no less than pure science that we now supplement private enterprise by the official organisation of research. In this it must be admitted that we followed somewhat slowly the example set by continental neighbours. The National Physical Laboratory was promoted by the joint efforts of physicists and engineers. It was, from the first, fortunate in having for its head a man in the fullest sympathy with both schools of thought, who for many years, and with the happiest results, applied his faculty for leadership to build up an establishment the work of which is accepted as authoritative and the influence of which on the scientific development of engineering has been, and continues to be, profound. Sir Richard Glazebrook has himself dealt with "The Interdependence of Abstract Science and Engineering" in a James Forrest Lecture delivered five years ago. No man could speak with a closer personal understanding and experience of the subject. In his hands the value of the Laboratory was so fully demonstrated that after a time, from being semi-official, it was made official—becoming a truly national laboratory, administered by a new Government office, the Department of Scientific and Industrial Research.

That Department, established in 1916, remains with us as a beneficent legacy of the War. It is a notable item on the credit side of an account that is mainly one of debit. The War turned men's thoughts, as never before, to mechanical problems. From being questions of mere luxury or convenience, such problems became, almost suddenly, questions of national life or death. Physicists and mathematicians whose interests had been wholly abstract were brought, as it were, from the clouds to earth. They faced facts—often, one should add, to excellent purpose. With the community generally, applied science took on a new significance; until then it had meant little to them; they now saw it as a man struggling in the water sees a plank within his reach. Research, and the adaptations of research, from being treated with general indifference, were hailed as a way to public salvation—salvation not only from the immediate menace of the struggle itself, but (after that was past) salvation from the abiding danger of international competition and the

burden to industry through waste and debt. The national intelligence was stirred; blind eyes were opened. They have remained open, and the Department does much to keep them open.

The Department works largely through committees where experts in industry co-operate with men of scientific habit. It also subsidises young research workers. For a young worker to attempt research is often educative, and he may discover a real aptitude. But we must not forget that researchers, of the best sort, are like poets; they are born, not made. You may produce in this field competent hewers of wood and drawers of water, men who will usefully assist or follow a real leader. But the wind bloweth where it listeth; no man who says, "Go to, I will research" can count on inspiration, and not even the draught in an air-channel will make dry bones live. On the other hand, when the right man is found, there is no limit to his potential achievement. He may give the world a new idea; he may create a new industry; he may make for himself a name; he may make, generally for others, a fortune.

From time to time in the history of engineering we find a new idea born, resembling what biologists call a 'sport,' which gives an unexpected turn to the process of inventive evolution. No one can confidently extrapolate the curve of engineering progress; its equation is liable to capricious change. Besides those occasional fresh departures we find, especially in modern times, that the scientific method is continuously at work, acting always as an auxiliary to experience in improving what is already familiar. Thus the influence of science is felt in two ways; in occasional spectacular events which open up channels where the stream did not flow before, and also in constant guidance of established currents, giving them greater volume and a more favourable course.

Take an illustration or two from the history of metallurgy. In 1828 the only forms of iron available for construction on a large scale were pig-iron, the product of the blast furnace, and puddled iron, the same product decarbonised in the reverberatory furnace. When railways began there was doubt whether rails should be cast or wrought. Wrought iron had Stephenson's support and won the day. But it was not easy for the output of puddled metal to keep pace with the rapidly increasing demand which arose for rails, for boiler plates, and presently also for ship plates when iron came into use as the material for building hulls. It became urgent to find some other way of obtaining iron in the malleable state. In 1856, Bessemer attacked the problem as an outsider who broke away from the traditions of the trade. His method was a 'sport,' but no accident; it was an outcome of scientific thought. His first success was quickly followed by failures which only stimulated him to investigate their cause and cure. The difficulties were overcome, and mild steel began slowly to take its place as the most valuable of all constructive materials known to the engineer.

A few years later the alternative process of the open hearth was developed by Siemens, not less novel, and not less an offspring of scientifically trained intelligence. Regenerative heating—an idea which had already found engineering expression in the Stirling air-engine—secured the high temperature necessary for the molten bath. Less simple and less rapid than the process of Bessemer, it had the advantage of easier control; it could be made static. Each method has its own field of usefulness; together they supply the world with nearly a hundred million tons of steel a year.

In more recent times electricity, which is the handmaid of every branch of engineering, has given the steel-maker additional types of furnace with large application in the blending and refining of special steels. Steel has become a word of many meanings. We have learnt, and are still learning, the amazing variety of characteristics which can be produced in a metal by adding regulated quantities of other substances. The study of alloys, both ferrous and non-ferrous, is an immense field of research in which the resources of chemistry and physics are placed at the service of the engineer. By their aid he learns how to obtain a product that will fit a special purpose. It is, in each case, a question not simply of composition but of heat treatment, for the atoms are like a community of alien races, subject to collective excitement and liable in their stormy moments to assume new groupings which largely and permanently affect the properties of the piece.

By means of such study the engineer is now provided with cutting steels which have revolutionised workshop practice; stainless steels the use of which goes far beyond the requirements of the cutler; mechanically strong and wear-resisting steels in a profuse variety; magnetically hard steels which are retentive of magnetism to a degree not approached before. It would seem you have only to specify a new requirement, and the metallurgist finds an alloy that will meet it. You want a metal which will not change its dimensions with temperature, and he discovers invar. You want a steel which will refuse to take up any magnetism at

all, and he discovers manganese steel. You want a metal immensely susceptible to weak magnetic fields, with which to 'load' a telegraph cable, and he discovers permalloy. You want a metal which will combine the lightness of aluminium with something of the strength and ductility of mild steel, and he discovers duralumin and the Y alloy.

It is a scientific process of high-temperature electrolysis that has made aluminium a commercial product. The designers of aircraft and of motor cars appreciate its value, in the alloyed state, and one may conjecture that in many fields of engineering construction we are on the threshold of an aluminium age. A material, not too costly, which has nearly the strength of mild steel, with little more than one-third its weight, ought to have an unlimited future. It has even been suggested that for the new age we should look to the alloys of another and still lighter metal, magnesium. Research in these directions proceeds apace.

A century ago the development of the steam engine had not emerged from the empirical stage. A change came soon after 1850, when men began to think of energy as protean and imperishable. The mechanical theory of heat was established, and in 1859, Rankine published his "Manual of the Steam Engine." Kelvin rediscovered Carnot, and the Carnot cycle came to be recognised as an ideal criterion of performance which no engine could conceivably surpass. Engineers strove to bring their engines nearer to that standard by compound expansion, by superheating, and by other means of reducing avoidable waste. They also strove to widen the interval between the temperatures at which the working substance took in and rejected heat, for the 'heat drop' between these limits determines how much of the supply of heat is ideally capable of conversion into work. Boiler pressures went up and up: they are rising still. A committee of this Institution helped to spread a sound gospel by recommending the Rankine cycle as a basis of comparison with the results of tests, a cycle which differs from that of Carnot only by assuming that no reversible process is followed in the return of the condensed water to the boiler. But it is interesting to notice that modern steam plants of the most efficient type have introduced a reversible process through the device of 'bleeding,' which enables the condensate to be heated step by step on its way back to the boiler, in a manner so nearly reversible as to make the whole cycle approximate to the ideal of Carnot.

All this exemplifies the continuous steady pressure of scientific ideas in improving the procedure of the practical engineer. In a different category I would place the invention, by Parsons, of the steam turbine. That too was an application of scientific ideas, but it is an example of what I have called a 'sport.' It broke away from established lines, and we may say that in the world of engineering the genius of Parsons opened up a new kingdom. He gave us a power producer, wholly novel in action and design, capable of immensely augmented efficiency, with a concentration and magnitude of effect never even imagined before.

Another 'sport' was the internal combustion engine. Time would fail me to trace its development from primitive forms; to tell of the steps, big and little, but all essentially scientific, which brought into operation the cycles of Otto and Clerk and Diesel; of the multitude of engines which have turned the man in the street into an engineer, crowding the highways, dotting the seas, and achieving in some sense a conquest of the air.

Reverse a heat-engine and you have a heat-pump, which means that by expending power from outside you can make a body colder than its surroundings and keep it colder. From this simple piece of thermodynamics has sprung a branch of engineering with great and growing economic importance. Refrigeration makes the whole world our orchard, our sheep farm, and our cattle ranch. Perhaps in no other field do so many scientific problems arise for solution as in the transport and storage of foodstuffs under such conditions of cold as will, without substantial damage, preserve them from bacterial attack.

The science of refrigeration, too, offers a conspicuous example of how an industrial process, strikingly novel, may take its origin from an apparently insignificant physical fact, and then repay the debt to pure science by promoting the progress of research. Long ago, Kelvin and Joule, in experiments on the properties of gases, discovered that when air escapes under pressure through a throttling orifice it undergoes a small drop in temperature—about one-fourth of a degree for each atmosphere. Years afterwards, Linde and others, by applying a regenerative interchanger to transfer the cold from the escaping air to the stream that was approaching the orifice so as to obtain a cumulative effect, used this as a practical means of liquefying air, and of separating its oxygen and nitrogen, with the result that each of the two may be commercially utilised. This is now the foundation of more than one considerable industry; moreover, it has given to physicists a new tool of research, enabling them to bring

temperatures down to an extreme never before reached in any terrestrial laboratory.

In the region of applied electricity, perhaps more than in any other part of engineering, examples multiply themselves of the exchange of benefits between practice and science. One may, of course, say, with perfect truth, that all the applications of electricity are in their origin fruits of scientific research. If we trace, for example, the history of the dynamo, we go back through Hopkinson's formulation of the principle of the magnetic circuit to an experiment of Faraday, which, in 1831, first showed that the movement of a conductor across a magnetic field generates electromotive force. The very language in which one describes this fundamental discovery is language we owe to Faraday himself. From that experiment what a progeny has sprung! May it not be fairly claimed that all the practical devices of electrical engineers, the dynamo, the motor, the transformer, the storage battery, the arc lamp, the vacuum bulb, the electrolysis bath, the electric furnace, the telephone, and many more have advanced the purely philosophic study of electricity? With their help the physicists have now discovered that in positive and negative electrification—in the protons and electrons, which together compose the atom—we have the primitive brick-bats of which the whole material universe is built. Perhaps some day the philosophers, who have analysed matter into these brick-bats, teaching us how many of each kind are in the atom of any element, and the engineers, who are always searching for sources of power, may put their heads together and discover a means of tapping, in some sufficiently controllable manner, the huge stores of internal energy which the atoms are known to conceal. That would, indeed, be a new departure, but I dare not predict that it will ever happen. Prophecy, as George Eliot said, is of all forms of human error the most gratuitous.

When Kelvin, in 1853, discovered as a piece of mathematical reasoning that under certain conditions as to resistance, self-induction, and capacity, a discharge of electricity would be oscillatory, he little knew what he was letting the world in for. From that seed has grown a great tree. The branches, one may say, are visible over many housetops. Through Clerk Maxwell, Hertz, Lodge, Marconi, Fleming, de Forest, and many others, discovery and invention have proceeded, hand in hand, to accomplish what seems to me the most wonderful of all the wonders of applied science. The telephone of Graham Bell, the microphone of Hughes, the phonograph of Edison were arresting marvels the first coming of which I vividly recall. But wireless broadcasting still more impresses the imagination. It gives other marvels an added value, and works an even greater social change.

Towards the end of last century, when physical science seemed to some of its votaries to have settled into a groove, suddenly there was an astounding outburst of discovery. The X-rays, radioactivity, the electron—these followed one another in bewildering succession; discoveries wholly unexpected and pregnant with uses to mankind. Each in turn was a revelation to the philosopher; it gave a fresh direction to his concepts of Nature, and it enriched him with novel methods of research. Each of these discoveries also offered an untrodden avenue of practical application. Let me for a few minutes speak of what engineers have done to harness the free electron.

About 1895, Sir J. J. Thomson, examining the discharge which proceeds from the cathode or negative pole of a Crookes' vacuum tube, established the fact that it consists of a stream of separate particles—corpuscles he called them—of negative electricity, independent and all absolutely alike. These corpuscles are now called electrons; normally, in the absence of electrical disturbance, they make up, as it were, the crinoline or fender of a material atom; but when streaming from the cathode they have escaped from domestic ties. Each electron is a definite quantity of disembodied electricity—an irreducible unit—delightfully free to respond to any electric force, for its inertia is barely the eighteen-hundredth part of that of the lightest atom of ordinary matter. Free electrons are known to be given out by highly heated substances, such as the glowing filament in the vacuum bulb of an electric lamp.

This fact was turned to account by Fleming in an invention which one may, with no exaggeration, call epoch-making. He was in search of a sensitive detector of wireless signals, a detector more sensitive than the types Marconi originally employed. When a telegraphic signal sent by wireless strikes the receiving aerial it sets up a group of electrical oscillations, where crests and hollows alternate in very rapid succession—many thousands of times per second. To get them to make a signal which will be heard on a telephone or shown by a galvanometer, you must rectify the group, cutting out the hollows, one may say, and leaving only the crests. Fleming, in 1905, had the happy inspiration to employ the electrons which are given off by the hot filament in a vacuum bulb as agents in the

work of rectification. For this purpose he fitted the bulb with a second conductor, now called the plate or anode, to which the stream of electrons from the hot filament may pass. He connected the bulb with the receiving aerial in such a manner that oscillations due to the wireless signal endeavoured to bridge the gap between filament and plate. When this is done, the crests—as we may call those parts of the oscillating current which flow *with* the stream of electrons—pass easily; but the hollows, which are the parts that try to flow the opposite way, are stopped. Thus the device acts as a rectifier of the received oscillations, keeping the crests but cutting out the hollows, and for that reason the inventor very appropriately called it a valve—a thing that allows passage only one way.

The Fleming thermionic valve soon came into use as a sensitive detector of wireless signals. Two years or so later its capabilities were much extended by the American electrician Lee de Forest, who introduced a third conductor in the form of a grid through which the stream of electrons passed on their way from the filament to the plate. With this addition, the device, now called a triode valve, could be applied as a powerful relay or amplifier, receiving any electrical oscillations and passing them on, greatly magnified. It is arranged that the incoming oscillations shall cause small variations in the potential of the grid; these produce large and sensibly proportional changes in the electron stream which passes to the plate. The triode valve is the essential instrument of modern wireless; it serves not only to rectify and magnify the received signals, but also, at the sending end, to create the oscillations which are radiated into space. Thus, from the great station at Rugby, a group of mammoth triode valves converts hundreds of horse-power into high-frequency electrical oscillations which carry signals to America.

Even this is not the end of the wonderful story, for the triode valve also acts as what is called a modulator, impressing upon the high-frequency waves which constitute wireless radiation the fluctuations of amplitude which enable them to serve as carriers of speech or of music, so that they may thereby convey the relatively slow vibrations of quite another sort which make up sound. Further, in telephoning over wires, the triode valve forms an admirably effective relay, acting, at a succession of points along the line, to restore the energy of the transmitted sound without injury to its quality. Moreover, by using suitable 'filtered' bands of carrier currents, a number of entirely independent conversations can take place simultaneously over the same wire, while it serves also as channel for a multiple group of telegraphic messages. All these wonders are made possible by the triode valve. Its technical applications appear to have no bounds. It is also an instrument of research; in the hands of physiologists and others it measures the slightest and most fugitive of electrical effects.

I have cited enough examples to illustrate the broad truth of Tredgold's dictum that the scope and utility of civil engineering are increased by every discovery in natural philosophy. But so sweeping a statement can scarcely fail to have some exceptions, and exceptions are in fact suggested by the present curious state of physical science. At the moment the very basis of physics is in a state of flux. Its exponents are struggling to assimilate two momentous new ideas—the principle of relativity and the quantum theory. The relation of these ideas to the accustomed body of older physics is obscure. They present dilemmas which are not yet solved. Their exact form and place in the logical scheme of scientific thought has still to be determined. One may say that, while the superstructure remains intact, the philosophical foundation on which it stands is strangely disturbed. Physicists are, as it were, confronted with a difficult but not impossible task; they have to transfer bodily their elaborate and beautifully coherent building, as a going concern, from one foundation to another, and the new foundation is not quite ready. They are hard at work laying it, laying it indeed so deep that the passer-by cannot see what is going on. When the operation is completed it will be a great achievement. But I do not think it will make much difference to the engineer, for his concern is with the superstructure itself. That will doubtless settle down quite comfortably when the necessary adjustments are made. It will function as well as before, and continue to admit of extensions which the engineers will in due time turn to practical account.

The century we now review is but a petty unit in the multitude of centuries that make up the recorded and unrecorded history of man. By comparison it is a mere fragment of time, yet how big when judged by the changes it has wrought! If we test progress by the conquest of inanimate Nature, then the century now closing finds no parallel in the past. It may be likened to the efflorescence of a plant which for long has been quietly growing to maturity and suddenly bursts into flower. We have witnessed as it were the

change from bud to blossom. What is to follow? What is left for the future engineer to do? When you celebrate the second centenary of this Institution, of what will your lecturer have to tell? Can the recent astounding pace of discovery and invention be maintained? Or does a time approach when engineers will sit down like so many Alexanders to lament a too-completely conquered world of mechanical things, just as a time comes to geographers when there are no more regions to explore? Transport, especially by air, may be made less perilous and more convenient. Communication may be extended to include vision; that is half done already, and I confess to no enthusiasm for the other half. Power will certainly be more generally distributed.

Can we expect, however, that the engineers of the coming century will bring about developments in the application of natural resources comparable to those of the past hundred years? I am, as I said, no prophet, but I doubt it. To me it seems more likely that there will be something of a lull in the revolutionary fervour of the engineer. Social changes—drastic social changes—may be looked for, but not, I think, so directly consequent on his activities as in the century now ending. Mechanical devices will, of course, be increasingly used, but probably they will become standardised and taken for granted, like the watches we carry. We cannot be surprised if we find interest in them slacken. Improvements will be made, but they will attract little notice, for the things they affect will already be commonplaces of life. It may very well happen that the mental energy of mankind, now flowing so strongly in this channel of ours, will seek and find outlets in other directions. While as engineers we may regret such an issue, we cannot but admit that it may prove beneficial to the human race, since beyond question there is grave need for progress of quite a different kind.

For the fact remains that all our efforts to apply the sources of power in Nature to the use and convenience of man, successful as they are in creating for him new capacities, new comforts, new habits, leave him at bottom much what he was before. I used, as a young teacher, to think that the splendid march of discovery and invention, with its penetration of the secrets of Nature, its consciousness of power, its absorbing mental interest, its unlimited possibilities of benefit, was in fact accomplishing some betterment of the character of man. I thought that the assiduous study of engineering could not fail to soften his primitive instincts; that it must develop a sense of law and order and righteousness. But the War came, and I realised the moral failure of applied mechanics. It was a shock to find that a nation's eminence in this department of intellectual effort did nothing to prevent a reversion to savagery, conscienceless, unbridled, made only the more brutal by its vastly enhanced ability to hurt. I saw that the wealth of products and ideas with which the engineer had enriched mankind might be prostituted to ignoble use. It served to equip the nations with engines of destruction incomparably more potent and ruthless than any known before. We had put into the hand of civilisation a weapon far deadlier than the weapons of barbarism, and there was nothing to stay her hand.

Civilisation, in fact, turned the weapon upon herself. The arts of the engineer had indeed been effectively learnt, but they had not changed man's soul. In our diligent cultivation of these arts we engineers have perhaps forgotten that progress in them has far outstripped the ethical progress of the race. We have given the child a sharp-edged tool before he has the sense to handle it wisely. We have given him the power to do irreparable mischief when he scarcely knows the difference between right and wrong. Does it not follow that the duty of leadership is to educate his judgment and his conscience? Collective moral sense, collective political responsibility, the divine maxim to do to others as we would that they should do to us—these are lessons in respect of which all the nations, even the most progressive, have still much to learn.

There are people who talk glibly of the next great war. I wonder if they know how near, in the last war, the world came to destruction through misapplying the endowment which it owes to the engineer. Do they realise that with added experience and further malignant ingenuity, the weapons of a future war will be more than ever deadly, more than ever indiscriminate, and the peril to civilisation will be indefinitely increased?

Surely it is for the engineer as much as any man to pray for a spiritual awakening, to strive after such a growth of sanity as will prevent the gross misuse of his good gifts. For it is the engineer who, in the course of his labours to promote the comfort and convenience of man, has put into man's unchecked and careless hand a monstrous potentiality of ruin.

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hardening brands of cement has been of considerable assistance in this connexion, owing to the reduction in the length of time necessary before a new work can be put into service. The introduction in large numbers of heavy express locomotives has necessitated bringing up the track on fast lines to a very high standard, and much attention is being paid to experiments in the United States on a track consisting of a continuous raft of reinforced concrete on which the rails are directly bedded.

Papers on railway design and maintenance as affected by the application of electricity; on modern road and bridge construction; and on the engineering aspects of the problem of road traffic, focus attention on some of the problems with which recent development in transportation has provided the engineer.

In view of the interest and importance of the various papers, it is unfortunate that the time allowed for discussion was so inadequate.

An interesting series of visits to the National Physical Laboratory, the University of Cambridge, and various engineering works, was arranged as part of the programme, and was attended by a large number of members and delegates.

Obituary.

PROF. C. G. J. PETERSEN.

THE Danes have long been prominent in marine fisheries investigations, and the names of Carl Georg Johan Petersen, Johs. Schmidt, Th. Mortensen, and Commander Drechsel are familiar in this respect. The latter passed away last year, and now the busy life of Dr. C. G. J. Petersen is ended. A native of Denmark, his earlier years of study were at Aarkus, on the east coast of Jutland, and by and by, after graduation, following his natural bent, he entered as a junior helper in the Zoological Museum, Copenhagen, in 1881, acted as assistant curator, 1883–89, meanwhile aiding in the reorganisation of the Danish fisheries investigations. So far back as 1882–83 he had been on board the fishery inspection-vessel *Hauch* with Prof. Japetus Steenstrup and Commander C. F. Drechsel, and afterwards with Prof. Chr. Lütken; his researches, along with those of Cleve, Posselt, Meinert, Levinsen, and Traustedt, being published in 1893 in a 4to vol. with an atlas in Fol. under the title "Det videnskabelige Udbytte af Kanonbaaden Hauch's Togter." In continuation of the work on the fisheries carried on by H. Kroyer, Chr. Lütken, and G. Winther, he was by and by (1888) officially appointed by the Government under the Department of Agriculture. Seeing that his investigations could not be fully carried out on board the inspection-vessel, he, by the aid of Commander Drechsel and Prof. Lütken, got an old transport vessel transformed into a laboratory, which thus had the advantage of easy transference to the scattered fjords and islets of the Danish shores. A small open motor boat and a dinghy were also attached to the station.

Thus settled in a congenial post, Petersen entered into the fisheries work with enthusiasm, producing year by year for nigh forty years a series of important researches on the food-fishes and fisheries of Denmark, occasionally illustrating his memeirs by excellent plates, charts, and tables. The thorough manner in which he dealt with the subject in hand was characteristic. In no memoir was this better shown than in his investigation of the plaice of the Lim Fjord, and his advice for the transplanting of the young to Thisted, Bredning, and Vilsund. Much interest was taken in Great Britain, indeed, at the carrying out of the scheme. The re-stocking of the Lim Fjord fisheries in 1908 had the result of bringing 200,000 Kr. annually in excess of the average figures for the years previous to that date. Of late years two million of young plaice have annually been transplanted to these waters at a cost of 20,000 Kr.

Not only were the food-fishes of Danish waters carefully investigated, but also the distribution of their eggs and young, the nature of the food of both young and adult, and the character of the sea bottom were minutely investigated. Thus a quantitative study of the inhabitants of the sea bottom, with lists and plates showing their distribution, formed one or more of Petersen's various papers, one of his earliest, indeed, dealing with the Mollusca and Echinoderms of the areas frequented by the food-fishes. In his study of the animal communities of the level sea bottom—sand, mud, clay—he distinguished seven as follows: I. the *Macroma baltica* community, including *Mya*, *Cardium*, and *Arenicola*. II. The *Venus* communities, with *Venus*, *Tellina*, *Mactra*, *Abra*, *Psammobia*, *Cyprina*, with *Ethucardium* and *Spatangus purpureus*. III. The *Brissopsis* community, including *Brissopsis*, *Amphiura*, *Calocaris*, *Nucula*, and *Eumenia*. IV. Communities from deeper water than *Brissopsis*, such as *Pecten vitreus* and *Abra longicollis*. V. included *Macoma calcarea* and *Astarte borealis*. VI. The communities of the Lusitanian region, including *Tapes decussatus*. VII. Bottom fauna of the Atlantic. These he illustrated by coloured charts—each community having a special tint. His investigations of the pelagic fauna and flora of the several areas were equally methodical, the oceanic and neritic diatoms and *Peridineæ* receiving careful attention. He held that the organic matter of the sea bottom was due to plant growth and was not derived from the plankton. Both the pelagic and demersal eggs of fishes were studied, and the development of such as the gobies to the adult stage followed—with accompanying figures.

Not only did Petersen work out the life histories of the marine fishes of the Danish waters, the possibility of their increase, the means of protecting them from their enemies, but he also studied the life history of the eel, a fish so important to his countrymen, inspecting the numerous traps which are set singly or in rows, and carrying out experiments with artificial light during its migration. Further, he prepared two reports on the oysters and

oyster fisheries of the Lim Fjord, giving a historical summary, an account of the banks, the food, age, spawning, and methods of capture. These oyster fisheries yielded in the decade 1900–1909 an average annual revenue of 70,000 Kr. to the State. Since the introduction of the new rental tariff they have furnished 140,000 Kr. in rental alone, and by the new methods of working this will be still further increased. Amongst other schemes he considered the question of utilising the common starfishes as manure. Nothing, indeed, relating to the Danish fisheries escaped him, and his training and abilities as a practical naturalist enabled him to improve various nets, such as otter-seines, as well as invent an apparatus, 'grab' as it was called, or bottom sampler, to lift samples of the sea bottom with its inhabitants for investigation. In connexion with the organic matter on the sea bottom, he found *Zostera* richer in pentosan compounds than plankton organisms, and that bivalves were capable of digesting it. In 1914 he urged the establishment of a permanent biological station on land on which young men could be trained for the work of the fisheries—with the prospect of regular employment.

Taken all in all, it is seldom that so able and so experienced a naturalist has given his life-long services to his country, or left so noteworthy a record behind him. Petersen often attended the meetings of the British Association, where he was equally welcome as popular. He was no less esteemed abroad than at home, as testified by his honorary degrees of LL.D. from the University of St. Andrews and D.Sc. from the University of Leeds, whilst for seven years he was at the head of the International Council for the Exploration of the Sea. He was inclined to recommend the policy of increasing the size of the fishes—especially flat fishes—rather than increasing their numbers by artificial hatching as in Norway and America.

W. C. M'INTOSH.

PROF. A. H. LEAHY.

ARTHUR HERBERT LEAHY, who died at Littlehampton, Sussex, on May 16, just before he had completed his seventy-first year, will be mourned by many generations of Sheffield students. For thirty years he was one of the best-known members, first of Firth College, then of University College, and finally of the University of Sheffield.

Leahy was born at Corfu in 1857, and was the eldest son of Colonel Arthur Leahy, R.E., of Flesk, Killarney. He was educated at Uppingham School, Trinity College, Dublin, and Pembroke College, Cambridge, and was placed ninth wrangler in 1881. In 1886 he was made a fellow and mathematical lecturer at Pembroke, and in 1892 became professor of mathematics at Firth College, Sheffield.

While at Pembroke, Leahy contributed to the study of spherical and tesseral harmonics and helped to introduce into England some of the continental work in this branch of applied mathematics. At all times he was keenly interested in what may be called the mathematical side of theoretical physics, but his teaching and administrative duties took up his time, and his mathematical interests were satisfied by following developments from afar. An aspect of the breadth of his tastes appears from his work on old Celtic literature and his classical learning. Leahy's interest in astronomy led Pembroke College to give to the University of Sheffield a valuable telescope and transit instrument, housed now in the Observatory in Weston Park adjoining the University. Many were the nights spent there by him, and many the visitors whom he was delighted to welcome there.

Leahy's main achievements were in the building up of what is now the University of Sheffield, in setting the foundations of the Mathematical Department, and in teaching many of those who are now carrying on the torch. The University remembers him with grateful appreciation of his services.

THE issue of the *Physikalische Zeitschrift* for Feb. 15 contains an obituary notice of Prof. Ferdinand Kurlbaum, by Dr. F. Henning, a former colleague at the Reichsanstalt. F. Kurlbaum was born at Burg, near Magdeburg, on Oct. 4, 1857. On the death of his mother, his father, a district judge, placed him in charge of an aunt until he was six, when his father married again.

As he grew up Kurlbaum hated school, and was twenty-three years of age before he passed the university entrance examination and became a student at Heidelberg, and later at Berlin. In 1887 he got his doctor's degree with a research on the wave-lengths of certain lines in the solar spectrum, done under the guidance of Kayser, who was then one of Helmholtz's assistants. On Kayser's promotion to Hanover, Kurlbaum became his assistant and remained with him until 1891, when he was appointed assistant at the Reichsanstalt in Lummer's department. In 1901 he became head of the Electrical Machinery Department, and in 1904 left the Reichsanstalt to become professor at the Charlottenburg Technical School, with Rubens as a colleague. Military occupations had a great attraction for him, and during the War he did a large amount of testing mirrors and guns. He died on July 29, 1927. His work on black body radiation and on the radiation thermometer is well known.

WE regret to announce the following deaths:

Mr. Charles S. Boyer, of Philadelphia, known for his studies of Diatomaceæ, aged seventy-one years.

Dr. John S. Dexter, since 1923 professor of zoology in the University of Porto Rico, on April 19, aged forty-two years.

Prof. Léon Guignard, professor of general botany in the Faculty of Pharmacy of Paris, and president in 1919 of the Paris Academy of Sciences, aged seventy-five years.

Prof. Harris H. Wilder, professor of zoology in Smith College, Northampton, Massachusetts, known for his work on the anatomy of amphibia and also for his anthropological studies, on Feb. 27, aged sixty-three years.

News and Views.

IN this issue we are publishing as a supplement an abridgment of the remarkable James Forrest Lecture on "A Century of Inventions" delivered by Sir Alfred Ewing on Monday, June 4, before the Institution of Civil Engineers. This is the thirty-fourth lecture of the series, and the subject suggested by the council for the lecture was a remark of Tredgold's to the effect that "the scope and utility of civil engineering will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical science." This sentence was contained in the same document wherein Tredgold defined civil engineering as the art of directing the great sources of power in Nature for the use and convenience of man. Tredgold himself died a few months after he penned these lines, worn out by incessant study, but his phrases, so often quoted, will remain as long as civil engineering is practised. Sir Alfred Ewing's lecture was listened to with rapt attention by a large gathering of distinguished engineers and men of science, some of whom had themselves witnessed the vast extension of scientific discovery and engineering so eloquently referred to by Sir Alfred. Of absorbing interest throughout, the lecture ended upon a somewhat unusual note and many readers will probably find in its closing paragraphs its most pregnant passages. In proposing a vote of thanks, Sir Richard Glazebrook referred to the work of Sir Alfred Ewing at the Universities of Tokyo, Dundee, and Cambridge, as Director of Naval Education and also as Principal of the University of Edinburgh—and recalled the pioneering work he has carried out in magnetism and other subjects. Sir Alfred, it may be added, was born in Dundee on Mar. 27, 1855, and in the early 'seventies was first a student under Fleeming Jenkin and afterwards a member of his permanent staff, where he obtained experience in cable engineering.

IN connexion with the celebration of the centenary of its incorporation, the Institution of Civil Engineers has issued a brief history of the Institution of some sixty pages. In the course of the short chapters are given some of the most interesting facts regarding the foundation of the Institution, its constitution, its growth in membership, its various homes, its prizes, and endowments, and its several activities. Founded in a Fleet Street coffee-house, the Institution had its first permanent home in Buckingham Street, Adelphi; in 1834 a house was taken in Cannon Row, Westminster, from whence the Institution removed four years later to Great George Street, where it has had three homes. The present buildings, completed in 1913, represent a capital investment of more than £350,000. Photographs are reproduced of the fine vestibule, staircase, great hall, theatre, and library. The library contains more than 54,000 volumes, among which are forty editions of Vitruvius in various languages, and 896 volumes of tracts which to some future historian of engineering "may well prove to be a mine of curious information." The *Minutes of Proceedings* published up to the present run to 224 volumes, and on these and the *Abstracts*, etc., more than £400,000 has been expended. A list of presidents and secretaries of the Institution is given, while the interest of the record is increased by a series of marginal illustrations of great engineering works, from the bridges of Rennie and Telford down to the present time.

A BANQUET was given to Mr. A. V. Roe by his aeronautical friends on June 8 to commemorate the twentieth anniversary of his entry into aeronautics. Mr. Roe was a trained engineer and tried athlete, and in this way was specially equipped for the building and testing of his early experimental triplane. His admirers need not bother about the current controversy over his 'hops' in 1908, entirely credible in themselves, but scarcely ranking with flights officially controlled by competent observers. Roe's reputation is independent of such accidents of fortune, and is firmly based on the manner in which he evolved, from his early triplane, a series of designs culminating in the standard biplane, well known as peculiarly free from 'vices.' Looking through the old records, one is struck by the way in which the first freakish-looking triplane is transformed into an entirely modern design. It was a step-by-step process, but now appears almost an organic growth, save for the sudden change from triplane to biplane, since approved by the progress of aerodynamical science.

IT is almost impossible now to project one's mind back into these early days of aeronautics, when a fog of ignorance concealed the most fundamental facts and requirements. The physical principles of flight had then been revealed only to Lanchester's prophetic eye. The circulation theory of lift was scoffed at in the highest places, for one could see that no air 'circulated' round the wing, and the trailing vortices were invisible to the eye of the pitot-tube. The principles of stability were still wrapped up in Bryan's mathematical statement. Structural stresses were based on the roughest information as to pressure distribution. But one can follow from page to page the steady evolution from a thing of stick and string and cloth, into an engineering design. It is Mr. Roe's distinction that he was one of the earliest British starters, and that he stayed through the race in which so many fell by the way. If an established position as a successful designer and constructor is not a relevant reward, he may add the esteem of his contemporaries in the old flying days of unforgettable memories.

CAPT. G. H. WILKINS and Lieut. C. B. Eielson, who recently flew across the Arctic Ocean from Alaska to Spitsbergen, arrived in London last week and were entertained at luncheon by the British Government on June 7. Capt. Wilkins gave some indication of his plans for Antarctic explorations. His aim is not to reach the South Pole, but to explore the unknown region lying south of the Pacific between the Ross Sea and Graham Land. This flight will be about 3000 miles over entirely unknown parts of the ice-sheet of Antarctica. One object which Capt. Wilkins has in

mind is the selection of sites for meteorological observatories, but there is little likelihood that any descents will be possible in the course of the flight. He proposes to leave the Ross Sea in January, taking off from a whaling ship on the open water which is often found off the Ross Barrier at that season. He hopes to be brought home by a whaler from the Graham Land area. The machine will be a Lockheed Vega seaplane. The *Times*, which gives an outline of Capt. Wilkins' plans, also announces that Commander R. E. Byrd will make his base on the Ross Barrier next southern summer, and explore by aeroplane to the south and east, hoping to reveal the course of the great mountain ranges which are known to border the Ross Sea.

IN addition to the expeditions of Capt. G. H. Wilkins and Com. R. E. Byrd, a third expedition to the Antarctic is announced for next season. According to the *Times*, Com. D. G. Jeffrey, R.N. (retired), will lead an American-financed expedition in September to Graham Land, where a base will be established on the west coast, in the area explored by Dr. J. Charcot. From there it is proposed to explore eastward to Coats Land with the view of filling in the missing western coast-line of the Weddell Sea and determining the course of the Antarctic Andes of Graham Land. A vessel of the deep-sea minesweeper type will be used, and two aeroplanes will be taken, the larger with a cruising radius of 6000 miles. The South Pole is not the objective of the expedition, but there may be a flight in that direction. Com. Jeffrey hopes to include among his staff certain men who served with him on Sir E. H. Shackleton's expedition in the *Endurance* in 1914–17. Only six months' stay in the Antarctic is anticipated, which is rather a short time for the completion of the programme.

ON May 31, the aeroplane *Southern Cross* started from Oakland, California, to cross the Pacific Ocean in three laps, ending in Australia. On June 9 the aeroplane landed at Brisbane, having accomplished safely a journey of 7340 miles. The *Southern Cross* carried a crew of four: Capt. Charles Kingsford-Smith and Mr. Charles Ulm, pilots, both of whom are Australians, and Lieut. Harry W. Lyon, navigator, and Mr. James Warner, wireless operator, both of whom are Americans. The first lap of the journey, California to Hawaii, a distance of 2400 miles, was covered in a little more than twenty-four hours. The second lap, Hawaii to Suva, Fiji, nearly 3200 miles, took about thirty-four hours; this flight is the longest over water that has yet been made. The last stage of the journey, Suva to Brisbane, was about 1500 miles, and took about twenty hours; during this time the weather was often unfavourable. It is a great achievement to have flown and navigated an aeroplane over the Pacific Ocean for the first time, and all the members of the crew are to be congratulated on the successful conclusion to their months of careful preparation.

WIRELESS messages from the airship *Italia* were received by the base-ship, *Città di Milano*, at King's Bay, Spitsbergen, on June 9, after two weeks' silence. The crew of eighteen were all safe on the ice in approximately lat. 80° 30′ N., long. 28° E., a position about fifteen miles from the nearest land in the island of North-East Land of the Spitsbergen group. The airship is reported to have been completely wrecked. Three men were sledging westward to find help, and the others were drifting with the ice. The drift will carry the Italians to North-East Land, but may take them to the inhospitable east coast which is faced with an ice-cliff. They have provisions for a month, and should be able to shoot some seals. The steamer *Braganza*, in trying to reach the shipwrecked men, was stopped by heavy ice near Cape North, about a hundred miles to the west. The difficulty of navigating along the north coast of Spitsbergen this month may delay rescue, but Norwegian airmen will no doubt locate the wreck and bring food to the men, even if they cannot carry them to safety. There are several good dog teams in Spitsbergen, and these are being used to take help. They should succeed, unless the drifting ice in Hinlohen Strait proves impassable. A Russian ice-breaker, which has been asked for by the Norwegian government, could probably get through the ice to North-East Land in four or five days.

WE understand that it has now been intimated that Great Britain will not be represented officially at the International Congress of Americanists which is to be held at New York in September next. As these matters are conducted on behalf of His Majesty's Government through the Foreign Office, it is to be presumed that that Department has now decided that the Congress is not of sufficient importance to warrant the attendance of an official representative. If this should be correct, it is, to say the least, unfortunate. At the last congress in Sweden, when Great Britain was officially present in the special circumstances of a member of the British Royal House being Royal Consort, all the principal governments in the world, including even China, were officially represented. Americanist studies, it is true, are not numerously represented in Great Britain, but British students of American archæology, few as they are, are universally recognised as being in the first rank. It would be interesting to know if the action of the Foreign Office in refusing an invitation to the only congress devoted to Americanist studies, and otherwise recognised by the whole world as of first-rate importance, was taken under advice, and, if so, what body was consulted.

AT the close of the International Congress of Geography at Cambridge, the delegates and others will pay a visit to the Borough of Newbury Museum on July 27. Members will stay in the town overnight and will be received at the Museum on the following morning. The visit takes place at a moment of importance in the history of the Museum. It has been decided to enlarge the premises as a memorial to the late Mr. Walter Money, the historian of Newbury, whose death at the age of ninety years took place last year. The Museum, in addition to the preservation of objects of local interest, aims at being educational on broad lines, and much use has been made by students of the archæological collections which, under the curatorship

of Mr. H. J. E. Peake, have been arranged on the 'space for time' method. With the enlargement of the Museum, these collections will be extended to 3000 B.C. instead of 2400 B.C. as at present, with a prelude dealing with the Palæolithic age. For the enlargement a sum of £1200 is required immediately, for which an appeal has been made by the Mayor and Museums Committee. Subscriptions may be sent to the Mayor, Municipal Buildings, Newbury.

IN his Friday evening discourse, delivered on June 8 at the Royal Institution, on "The Waves of an Electron," Prof. G. P. Thomson stated that it now seems that the original view of the primitive elements of electricity and matter called electrons, which regarded them as small spheres, is inadequate to explain all the facts, and that an electron has associated with it a group of waves. This idea, originally due to L. de Broglie, has been tested experimentally by Davisson and Germer in the United States, and by Reid and Prof. G. P. Thomson himself in Great Britain. When electrons are scattered by atoms, it is found that if the atoms have a regular arrangement, as in a crystal, the scattered electrons are concentrated in definite directions and form a pattern, sometimes of considerable complexity. This is what would be expected if the electrons are guided and controlled by waves. In the case o iscattering in metals the crystal structure of which is known, the pattern to be expected can be calculated and compared with the experiments. Prof. Thomson showed that there is complete agreement for all the metals which he has tested. In order to allow the electrons to get through the metals, very thin films of the latter are necessary, those used being less than a millionth of an inch thick. At this thickness metals are quite transparent to ordinary light. While the experiments prove the existence of the waves, their exact relation to the mass and electric charge of the electron remains mysterious.

THE Slaughter o Animals (Scotland) Bill, which is to be read in the House of Commons for the third time on June 22, provides for the training and licensing of slaughtermen in Scotland and for the use of humane-killers in that country on all animals except pigs, and those killed by the Jewish method or on farms. It is expected that the Meat Traders' Federation, which is opposed to any change in the existing methods of slaughtering, will seek to obtain the exclusion of sheep from the operation of the bill, on the plea that loss of time would be occasioned by the use of the instrument when these animals are being slaughtered at high speed. It has been calculated that time is worth about three-farthings per man per minute under the normal conditions of working in Edinburgh. The humane-killer is simpler to handle than, for example, a Lewis gun, which can be positioned, mounted, and loaded by recruits in 9 seconds, so the time lost per sheep should be considerably less than a minute of one man's time. An average dressed carcase of mutton weighs about 60 lb., and about 18 lb. of home-killed mutton was consumed per head of the population in 1922, so that the loss of time due to humane killing would be worth about a farthing per annum per head of the population.

IN 1926 the Ministry of Agriculture issued an Order prohibiting the use in Great Britain of arsenical dips for the second of the two statutory 'dippings' for sheep scab where a dip of that character had been used for the first dipping. This Order was made because of complaints that serious losses had been sustained by farmers where, as is essential for sheep scab, the second dipping had been carried out within 14 days of the first dipping. Since that Order was made the Ministry has received representations from farmers in Wales and other parts of Great Britain urging that they should be allowed their former discretion in the choice of an approved dip, so that they might use an arsenical dip for both dippings where desired, and the National Farmers' Union of England and Wales, in support of these representations, has informed the Ministry that a guarantee against loss has been obtained from the manufacturers of the bulk of the arsenical dip used in Great Britain. The Ministry is therefore satisfied that it can now properly remove its prohibition on the use of an arsenical dip for both dippings. There are some 306 approved sheep dips, of which 222 are non-arsenical; an owner has therefore a wide range of choice, and there is no compulsion upon him to use an arsenical dip if he does not wish to do so.

FELSTED School is to be congratulated on the success and enthusiasm of its scientific society. Surely few such societies can boast a half-century of useful work, for in 1877, when the Felsted School Scientific Society was founded, nature study and science courses were still in embryo, and of England's present total of 428 museums only 84 were in existence. The thirtieth *Report* of the Society indicates continued liveliness. A generous donor has presented an observatory, a 4½-inch equatorial telescope, a 3½-inch transit instrument, and an altazimuth, and an astronomical section has been created. Two new dark rooms for photography have been formed, and that good work is being done is shown by the excellent natural history pictures which illustrate the report, and by the descriptions of the use of bird-watching 'hides.' The majority of the papers read before the sections were by the boys themselves, and that is as it should be.

THE Zoological Society of Scotland had the misfortune to open its zoological park in Edinburgh just before the War, and as a consequence its survival value was put to a severe test. The *Annual Report* for the year ending March 31, 1928, shows that the test has been safely passed and that the Society is now assured of complete success. The surplus of revenue over expenditure for the year was £3445, as against £735 last year, and this sum has been used in paying off the debt upon a Reptile House and Tropical Bird House, while a sum of more than £10,000 has been raised for the development of the Park and the bringing in of the new ground to the crest of Corstorphine Hill. The Scottish Zoological Park is outstanding on account of the natural beauty of its site, and the extensions foreshadowed in the report promise to add greatly to its amenity, since a track for a service of small motor conveyances is being laid to the top of the hill, which overlooks the Firth of Forth, and fine masses and

ledges of weathered rock afford ideal places for the construction of natural enclosures. The Carnegie Aquarium, erected at a cost of more than £20,000, and designed on the most modern lines, was opened in July, and has proved to be a great attraction. Amongst the most interesting of the births in the Park was a Californian sea-lion and a king penguin, the fourth of its kind to have been successfully reared. During the year 346,452 individuals visited the Park. The report contains a number of photographs, which show the attractiveness of the enclosures and their inmates.

PRESIDENT THOMAS S. BAKER, of the Carnegie Institute of Technology, who recently visited Europe in connexion with the forthcoming second International Conference on Bituminous Coal to be held at Pittsburgh on Nov. 19–24 (concerning which a preliminary announcement appeared in NATURE on Mar. 3), has already received tentative acceptances from some seventy engineers and other prominent scientific men from twelve countries, to attend or present papers to the conference. The list contains such well-known names as Dr. F. Bergius, Prof. W. A. Bone, Dr. G. Egloff, Prof. F. Hofmann, Dr. A. D. Little, Prof. A. Mailhe, Sir Alfred Mond, Prof. S. W. Parr, and Prof. H. S. Taylor. Scientific workers of all countries who may wish to take part in the congress are requested to notify the secretary, Prof. S. B. Ely, Carnegie Institute of Technology, Schenley Park, Pittsburgh, U.S.A., as soon as possible, and foreign delegates desiring to avail themselves of the opportunity to visit industrial plants in the United States of America are invited to make known their wishes. As has already been announced, the programme will include the discussion of low temperature distillation, high temperature distillation, coal tar products, power, smokeless fuel, complete gasification of coal, hydrogenation, pulverised fuel and its new applications, fixation of nitrogen, coal beneficiation, and cognate matters. The purpose of the congress is similar to that of the first congress held in 1926, namely, to present the results of recent studies of coal that have to do with improved methods of utilisation and combustion.

THE *Annual Report and Proceedings of the South-Western Naturalists' Union*—a record up to Dec. 31 last—shows a membership of 70 members, 16 societies, and one institution. Considering the large area covered, this seems small, as very good work has already been done by individual members of the Union since its foundation on Nov. 25, 1922, and the annual conferences offer exceptional opportunities for the meeting together of all concerned. The president for both 1927 and 1928 is Dr. G. P. Bidder; the vice-presidents for 1928 are Prof. C. Lloyd Morgan and Dr. E. J. Allen. Dr. Bidder's presidential address at the fifth annual conference held at Exeter last year on "Some Sponges of the South-West Coast" is contained in the present report. In this interesting survey he describes the common sponges of Britain and suggests a classification based on that given at the Leeds meeting last year of the British Association. His presidential address for this year, delivered at the sixth annual conference, held at Bristol on May 25–28, dealt with "The Relationship to each other of the Various Groups of Animals." The *Proceedings* also contain short sectional reports, a lecture by Mr. C. W. Bracken on "Insect Casuals and Migrants," and concludes with three short papers on Lundy Island. This Union is as yet in its infancy. It was founded in order to bring local naturalists together, that real team work might be done in all branches. A scheme for organising the work was planned, and sections established with recorders and referees chosen from the leading authorities on the various subjects. There is an annual conference, lectures are given and excursions arranged. A glance at the names of the officers for both past and present years, and also of the lecturers, should be a guarantee of efficiency, and it is to be hoped that the Union will enlarge its membership and produce still more good work in the future.

THE second conversazione this year of the Royal Society will be held in the rooms of the Society on Wednesday, June 20, at 8.30 P.M.

THE following have been nominated by the Council of the Institution of Electrical Engineers for the vacancies which will occur in various offices on Sept. 30 next: *President*, Lieut.-Col. K. Edgcumbe; *Vice-Presidents*, Mr. P. V. Hunter and Dr. A. H. Railing; *Honorary Treasurer*, Lieut.-Col. F. A. Cortez Leigh.

THE Right Hon. Sir Alfred Mond, president of the British Science Guild, will take the chair at the annual general meeting of the Guild, to be held in the hall of the Royal Society of Arts, John Street, Adelphi, W.C.2, on Thursday, June 21, at 5 P.M. The annual report of the Guild for the year 1927–28 will be presented at this meeting, which will be open to the public.

PROF. A. W. PORTER, who has been associated with the Physics Department at University College, London, since 1892, is retiring from the chair of physics at the end of this term. Prof. Porter is one of the founder members of University College Mathematical and Physical Society, of which he has several times been president, and the past and present members of the Society are entertaining him at dinner in the College on Monday, June 25, at 7.30 P.M.

MANY readers of NATURE are familiar with the pioneer work carried out by the late Mr. W. H. Dines in investigations of the upper air and other aspects of meteorological science. As a memorial to Mr. Dines, the Royal Meteorological Society has taken steps to establish a fund to be employed to assist and encourage the advancement of meteorological knowledge, especially along the lines which he did so much to create and foster. Contributions to this Dines Memorial Fund are invited by the Society and should be sent to the assistant secretary, 49 Cromwell Road, South Kensington, S.W.7. We hope that the appeal will meet with a generous response, so that the fund raised may provide a worthy memorial of a great meteorologist.

AT the annual meeting of the British Association to be held in Glasgow on Sept. 5-12, Sir William Bragg, who succeeds Sir Arthur Keith as president, will deliver an address on the subject of "Craftsmanship and Science" at the inaugural general meeting in St. Andrew's Hall. Dame Helen Gwynne-Vaughan, professor of botany at Birkbeck College, London, has accepted the office of president of Section K (Botany) of the Association, and will address the section on the subject of "Sex and Nutrition in the Fungi." Prof. R. H. Yapp was originally elected president of the section, but resigned when he found he was unable to attend the meeting.

THE spring issue of *The Fight against Disease*, the quarterly journal of the Research Defence Society, contains a portrait of its late treasurer, Sir David Ferrier, and an address delivered by Lady Briscoe on "Animal Experimentation and Knowledge," which gives a useful summary of the value of experiments upon animals in advancing our knowledge, prevention, and cure of disease. The annual general meeting of the Society will be held at 11 Chandos Street, W.1, on June 19, at 3 P.M., when Sir Bernard Spilsbury will deliver the Stephen Paget memorial lecture.

THE annual summer meeting of the London Students' Section of the Institution of Electrical Engineers will be held in Holland and western Germany. The party will leave London on Saturday evening, July 28, for Rotterdam, where two days will be spent. Visits have been arranged to works at Rotterdam, Eindhoven, and Utrecht, and a pleasure trip to The Hague. In Germany visits have been arranged to works of engineering interest at Essen, Dusseldorf, and Cologne. The party will return from Cologne on the evening of Aug. 6.

THE council of the Royal Society of Edinburgh has awarded the Keith Prize for the period 1925–27 to be divided equally between Prof. T. J. Jehu and Mr. R. M. Craig for the joint series of papers which have recently appeared in the publications of the Society on the geology of the Outer Hebrides, and the Neill Prize (1925–27) to Prof. Arthur Robinson, professor of anatomy in the University of Edinburgh, for his contributions to comparative anatomy and embryology. The Bruce Prize for the period 1926–28 has been awarded by the joint committee consisting of representatives from the Royal Physical Society, the Royal Scottish Geographical Society, and the Royal Society of Edinburgh, to Prof. Dr. H. U. Sverdrup, of the Geophysical Institute, Bergen, for his contributions to the knowledge of the meteorology, magnetism, and tides of the Arctic, as an outcome of his travels with the Norwegian Expedition in the *Maud* from 1918 to 1925.

THE Council of the Royal Statistical Society is this year again awarding the Frances Wood Memorial Prize, value £30, for the best investigation, on statistical lines, of any problem affecting the economic or social conditions of the wage-earning classes. Competitors must generally be undergraduates, or graduates of not more than three years' standing, of a university of Great Britain or Ireland, and less than thirty years of age on Oct. 31 next. Theses submitted or intended to be submitted as university exercises, and also published papers, are admissible. Essays must be sent to the honorary secretaries of the Royal Statistical Society, 9 Adelphi Terrace, W.C.2, not later than Oct. 31 next.

THE Booth Steamship Co., Ltd., has arranged a summer cruise to the South American continent of unusual interest. The Booth liner *Hildebrand*, starting from Liverpool, touches the Portuguese Riviera and Madeira, and then crosses the Atlantic to the mouth of the Amazon, up which the liner goes about 1000 miles. The cruise lasts six weeks, during which 11,800 miles are covered. It is stated that the trip costs little more than an equal period of time in a good European hotel.

A GENERAL discussion on "Homogeneous Catalysis" will be held by the Faraday Society in the physical chemistry laboratory of the University of Cambridge, on Friday and Saturday, Sept. 28 and 29, under the chairmanship of Prof. C. H. Desch. The subject will be discussed under the following principal headings: (1) Uncatalysed homogeneous reactions and negative catalysis; (2) intermediate addition-compounds in homogeneous catalysis; (3) neutral salt and activity effects in homogeneous catalysis; (4) ionisation as a factor in homogeneous catalysis. A number of foreign guests have been invited by the Society to take part in this discussion. Members and visitors will be accommodated at Pembroke College during the period of the visit. Particulars can be obtained from the secretary of the Faraday Society, 13 South Square, Gray's Inn, W.C.2.

THE Report of the Bristol Museum and Art Gallery Committee for 1926–27 mentions that about 800 examples of living wild plants were exhibited during the year, and continues: "It is a matter for regret that so greatly has wild plant life been destroyed by building and other agencies in the neighbourhood of the City in the post-War years, that the area of collecting has had to be increased over a wider two-mile belt around the City." The report bears witness to much good work in all branches of museum activity except perhaps research: this may be because the labours of the staff are bent towards preparing for a move into the extension now being built.

A NEW part (No. 811) of "Sotheran's Price Current of Literature" has just been issued, and is as interesting and valuable as previous issues. The catalogue is always a mine of bibliographic wealth and should be of great help to collectors of rare editions and to librarians. The present part contains particulars of upwards of 3000 works of science classified under the headings of general and collected works, mathematics, astronomy, physics, meteorology and physical geography, geology, mineralogy and crystallography, chemistry, and rare and valuable books. Copies can be obtained from H. Sotheran and Co., 140 Strand, W.C.2.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A demonstrator of chemistry at St. Bartholomew's Medical College—The Dean, St. Bartholomew's Hospital Medical College, E.C.1 (June 19). An assistant in the Intelligence Section of the Mineral Resources Department of the Imperial Institute—The Secretary, Imperial Institute, South Kensington, S.W.7 (June 20). An assistant lecturer in mathematics at King's College, London—The Secretary, King's College, Strand, W.C.2 (June 22). An assistant pathological chemist at St. Mary's Hospital, Paddington—The Secretary, St. Mary's Hospital, Paddington, W.2 (June 25). An agricultural economist and a lecturer in agricultural engineering at the Edinburgh and East of Scotland College of Agriculture—Mr. Thomas Blackburn, 13 George Square, Edinburgh (June 25). A woman assistant lecturer in botany in the Department of Education of the University of Birmingham—The Secretary, The University, Birmingham (June 26). A lecturer in electrical and mechanical engineering at the Forest of Dean Mining School, Cinderford—The Secretary, County Education Office, Shire Hall, Gloucester (June 27). A lecturer and demonstrator in the pharmacy department of the Birmingham Central Technical College—The Principal, Central Technical College, Suffolk Street, Birmingham (June 30). An assistant lecturer in the Mathematics Department of the Belfast Municipal College of Technology—The Principal, Municipal College of Technology, Belfast (June 30). A demonstrator of biology at Guy's Hospital Medical School—The Dean, Guy's Hospital Medical School, London Bridge, S.E.1 (July 3.) An assistant lecturer in agricultural chemistry at the University of Leeds—The Registrar, The University, Leeds (July 7). A psychiatrist and medical director, a psychologist and an assistant psychologist under The Child Guidance Council—The Secretary, Child Guidance Council, 24 Buckingham Palace Road, S.W.1. An advisory bacteriologist at the Midland Agricultural and Dairy College—T. Milburn, Sutton Bonington, Loughborough. An assistant mistress at the County School for Girls, Beckenham, with qualifications in either botany or chemistry—The Head Mistress, County School for Girls, Beckenham. A science teacher at the Technical School, Lurgan—The Principal, Technical School, Lurgan, Co. Armagh.

Our Astronomical Column.

NOVA PICTORIS.—Dr. H. Spencer Jones, H.M. Astronomer at the Cape, gave some interesting information about this object at the meeting of the Royal Astronomical Society on June 8. It appears as an oval nebulosity the major axis of which, lying approximately east and west, is about 1½″ in length; within this there are four nuclei. The relative positions of the nuclei may be indicated by drawing an equilateral triangle with its base upwards; the nuclei are, (1) at the centre of gravity (this is the brightest), (2) at the lower angular point (this is the faintest), and (3) and (4) slightly below the two upper angular points. The three brighter ones could generally be seen, the faintest one only when definition was very good. The sketch that was shown indicated that these nuclei appeared somewhat nebulous.

Dr. Spencer Jones agrees with the Greenwich astronomers in thinking that the large nebulous rings (some 3′ in diameter) surrounding the star are not objective, but are optical phenomena due to the star's light having a different mean wave-length from the average star. Hence no weight can be given to values of the star's parallax deduced from them.

It is fortunate that owing to its position near the pole of the ecliptic, it is possible to observe the star at some time of the night throughout the year. Its behaviour has been in many respects unique among the novæ, and its further development is likely to give valuable information.

PLANETARY PHOTOGRAPHY.—Prof. W. H. Wright chose this as his subject for the George Darwin lecture which he delivered at the meeting of the Royal Astronomical Society on June 8. Numerous photographs were shown of Venus, Mars, Jupiter, and Saturn in light of various wave-lengths from infra-red to ultra-violet. The photographs of Mars were the only ones that showed far more surface detail in the long than in the short wave-lengths. The well-known outlines of the so-called seas appeared with very strong contrast in the infra-red photographs, but were practically invisible in the ultra-violet ones, showing that the Martian atmosphere, like our own, exerts considerable absorptive action on the shorter waves, so that the photographs in these show atmospheric detail, but nothing on the surface. On the other hand, the photographs of Venus in short wavelengths show fairly distinct markings, which were found to vary from day to day, thus giving hope that they may teach something about the planet's rotation; while the infra-red photographs were completely featureless. It may be that these do not penetrate to the actual surface, but only reach a lower cloud layer.

The Jupiter photographs, while not identical in the different colours, do not differ so widely as those of Mars. Very great interest was excited by some remarkable cinematograph films of Jupiter. These were exposed at intervals of minutes, but run through the lantern so quickly that the planet was seen in rapid rotation, its entire surface being rendered visible. The films included the transit of a satellite and its shadow across the disc. The satellite could be traced for part of its course and then became invisible. The film, like those taken during the eclipse of last June, shows the possibility of astronomical applications of the cinema, not merely for popular exhibitions, but for serious scientific work.

DISCOVERY OF MINOR PLANETS.—*Astr. Nach.*, No. 5559, contains the annual article from the Berlin Rechen Institut on the discovery of minor planets during the year. There were 112 planets found in the twelve months ended June 30, 1927; only 103 were really new, the others being identified with planets that had been missing for some years. Unfortunately 58 of the new planets were only observed once; thus nothing could be deduced about their orbits. Sixteen planets were observed sufficiently to deduce trustworthy orbits; to these were assigned the numbers 1058 to 1072, also the number 933; it was found that the planet previously numbered 933 was really 715, Transvaalia. The highest inclination of the new planets is 17° (planet 1070), the highest angle of eccentricity is also 17° (planet 1065). Five planets lately discovered have been named Bodea, Zachia, Piazzia, Gaussia, Olbersia, commemorating the names of astronomers concerned in the search for the first minor planets.

Research Items.

GYPSY MARRIAGE.—Mr. T. W. Thompson, in a continuation of his study of gypsy marriage in England, in pt. 4 of vol. 6, Ser. 3, of the *Journal of the Gypsy Lore Society*, deals principally with the question of permanence and divorce. A number of temporary unions are recorded. These lasted for varying periods from a few days or weeks to six months, a year, or even two years. In effect, these seem to have been trial marriages; though the Heron family seems to have been peculiar in this respect and deliberately to have taken their wives on trial, which as a premeditated act can be paralleled in a few cases only in other families. It is suggested, however, that this postponement of the marriage rite may have been a survival of the practice among German gypsies whereby marriages were not ratified by the Hauptmann until they had been in force for two years, during which period the bridegroom had to serve his father-in-law. There is no evidence that service in return for a bride ever existed in England. Marital fidelity after a settled marriage seems to have been more or less the rule, at any rate among the women. Some, however, had a regular succession of lovers or husbands. Among the men the patrilineal Herons claimed to have the right to occasional intimacy with gypsy women, though allowing their wives no liberties. Unfaithful wives were punished by stripping naked, when they were sometimes tied up and whipped or chased round a field; mutilation, such as nose slitting or cutting off an ear, was sometimes practised. Among English gypsies divorce was purely informal; but the Scottish gypsies parted with a good deal of ceremony. A century ago the woman received a token made of cast iron with a mark on it resembling the character T, and she was never permitted to marry again. If she did she was liable to the extreme penalty; she was tied to a stake with an iron chain and beaten to death.

QUATERNARY HUMAN SKELETONS FROM THE VALLÉE DU ROC, CHARENTE.—In the *Bull. et Mém. de la Soc. d'Anthropologie de Paris*, T. 8, Sér. 7, fasc. 1-3, Dr. Henri Martin describes three skeletons from a rock shelter in the Vallée du Roc. The remains were found buried under blocks of fallen stone, by the weight of which they had been much damaged. They belonged to three individuals, possibly the members of one family, a man of about fifty years of age, a woman of about forty, and a boy, probably of about eighteen, in view of the fact that the first wisdom tooth had not yet fully erupted. The remains had evidently been buried and the fall of rock was posthumous. The point of greatest interest in the skeletal remains lay in certain resemblances to Chancelade man as described by Testut. This was manifested in the cephalic index of the man, 72·8, as compared with Chancelade, 72·02, as well as in the scaphocephalic character of the skull of both male and female. Yet notwithstanding the keel-like ridge, both skulls were comparatively low. The supraciliary ridges were well marked. The cephalic index of the woman was 76. The skulls bear no resemblance to neolithic skulls, but are comparable rather with those of Brunn, Cro-magnon (female), and Laugerie Basse, but, as stated, particularly of Chancelade. The cranial capacity is approximately 1350 cm. (female) and 1525 cm. (male). The teeth are large and well formed, the third molar being smaller than the second, which is contrary to the state found in Neanderthal man. The wearing of the teeth shows a lateral bite. There are signs of caries in the man. The remains were found immediately above a Solutrean layer among signs of numerous hearths, and it is suggested that they belong to late Solutrean or the beginning of the Magdalenian period.

CAPROKOL.—We have received from the British Drug Houses, Ltd., London, N.1, a small booklet on Caprokol therapy. Caprokol (or hexyl resorcinol) is used both as a urinary antiseptic by internal administration and also as a general antiseptic by external application, including the cleaning of mucous surfaces. Its use as a general antiseptic has recently been referred to in our columns. Caprokol was introduced as a urinary antiseptic about three years ago, and considerable clinical evidence has now accumulated as to its value in various infections of the urinary tract. In doses of 1·2 gm. daily it clears up cystitis, pyelitis, or urethritis caused by staphylococci, streptococci, gonococci, or *B. coli*. In cases of infection with the latter organism it is advisable to give local treatment also in the early stages. To ensure complete and permanent sterility of the urine, prolonged treatment is sometimes necessary: an immediate effect, however, of the administration of the drug is the cessation of pain and relief from the frequency of micturition which so often accompanies urinary tract infections. The drug's antiseptic action is enhanced by its power of lowering the surface tension of the urine: fluids or alkalis which raise the surface tension should not be given at the same time as Caprokol. The evidence suggests that this compound has a definite use in practical therapeutics.

ATTITUDE OF EMPLOYEES TO INDUSTRIAL PSYCHOLOGY.—In the *Journal of the National Institute of Industrial Psychology* (vol. 4, No. 2) there is an interesting discussion on the attitude of employees to investigations of a psychological nature. It is obvious that no investigation can succeed without the co-operation and goodwill of the workers concerned, and it is equally obvious that workers are quite likely to view with suspicion strangers who come and observe them at work, who suggest alterations in long-established habits, and seem to take up a new attitude to problems. Mr. A. Stephenson points out that the present attitude of the workers towards investigations depends very largely on their attitude to the investigator and on local traditions and temperament, unless political convictions are so strong as to exclude all other considerations. In some industries where there is fear of dismissal it is sometimes very difficult to get rid of the impression that any worker who is being observed must necessarily be inefficient. Older workers are sometimes intolerant of innovations, and tend to consider that twenty years' experience must be worth more than any instruction. Where changes in the firm's policy are imminent and of a kind distrusted by the worker, then an investigator may be regarded as a spy: Mr. Stephenson said that such difficulties can usually be resolved by holding a conference and explaining clearly the objects of industrial psychology. On the whole though, workers prove to be interested in, or at least tolerant of, such investigations, and when one considers their novelty one is surprised at the willing help afforded in so many cases.

MARMOT PLAGUE IN UNITED STATES.—There has been a remarkable increase in recent years in the numbers and extent of the range of the eastern woodchuck (*Marmota monax*), a native of the States east of the Great Plains and north of northern Arkansas, Alabama, and North Carolina. Where these rodents confine their activities to their accustomed haunts on rocky hillsides, thickets, or forest land, no harm results, but their extension of range has led

them to transgress on cultivated land, and corn and forage crops, young fruit trees, and poultry have suffered. It is even recorded that disastrous flooding of crops and erosion of soil has followed upon their burrowing in levee and ditch banks. The U.S. Department of Agriculture (*Leaflet 21*) states that the surest practicable method of controlling the pest is gassing the woodchucks in their burrows, and recommends the use of carbon disulphide, calcium cyanide, or exhaust gases from a motor car. No individual effort, however, can afford any but a temporary success, and co-operation over a large area is essential for effective control. The leaflet states that the factors contributing to this recent general increase are not fully known, but curiously enough it says nothing about protecting and encouraging the wild creatures, birds and beasts, which are the natural controllers of such ground rodents.

THE INSECTS OF SAMOA.—Two further fascicles of "Insects of Samoa," a work in course of publication by the British Museum (Natural History), have recently come to hand. Part 4, Fasc. 2, deals with a number of families of Coleoptera, and Part 5, Fasc. 1, with aculeate Hymenoptera. The several accounts are written by specialists well known as authorities in the groups concerned, and should prove specially valuable in connexion with distribution, modification due to isolation and other problems of island life. Certain of the species described or listed are peculiar to the Samoan group: others, such as the beetles *Gnathocerus* and *Tribolium*, are cosmopolitan, while some other insects appear to be limited to certain of the Pacific Islands or extend into the continental tropics. The longicorn beetles are of exceptional interest, since each of the Samoan islands seems to possess endemic species, and four genera are unknown outside the archipelago.

SPERMATOGENESIS IN SPIDERS.—Dr. E. Warren contributes to the *Annals of the Natal Museum* (vol. 6, Part 1, March 1928) an important paper on the comparative histology of the testis of South African spiders, in which special attention has been directed to the nuclear divisions. The nuclei of the young genital cords of the embryo are capable of dividing by amitosis, and in the testis the germinal nuclei at the margin can divide without mitosis, and the spermatogonia can also divide amitotically to form primary spermatocytes, though in some spiders occasional mitoses were present. In some spiders the primary spermatocytes divide without mitosis to form secondary spermatocytes and spermatids, and chromatin structures indistinguishable from spermatozoa are formed in cells which have originated either without mitosis at all or without the full complement of mitotic divisions characteristic of typical spermatogenesis. In many species there are two kinds of sperms originating in different lobules of the testis. The presence of typical spermatogenesis in many spiders indicates that the various atypical methods which have been observed are to be regarded as simplifications of the typical process rather than as something fundamentally new or as a survival of primitive methods. The occurrence of amitosis is too general to be explained as an abnormality resulting from the temporary absence of the correct stimulus for the normal development of the spermatozoa. "The truly remarkable diversity which is seen in the chromatin behaviour of the genital cells of allied spiders is not in accord with the view that heredity depends on a system of material genes lodged in specific chromosomes and bodily passed on as a complete system from one generation to another." In most spiders the spermatozoa in the vesiculæ seminales become enclosed in capsules, and in some species the chromatin of the encapsuled spermatozoon may divide into pieces or may even be transformed into a resting nucleus.

A NEW FAMILY OF TURBELLARIÆ.—N. Nasonov describes in the *Bulletin de l'Académie des Sciences*, Leningrad (1927, No. 9-11, pp. 865-874), a new family Multipeniatidæ of the Turbellaria Allœocœla. The animals were discovered in the mouth of the River Maiche, which flows into Ussuri Bay, Sea of Japan. The representatives of the new family, two species of the same genus (*Multipeniata batalansæ* and *M. kho*), differ greatly from members of other families of Allœocœla, especially in the remarkable structure of the male genital apparatus, since they possess several copulatory organs in different stages of development. A fully developed copulatory organ is a closed system isolated from testes and from glands; when it fulfils its function, it is replaced by the next one when this reaches its full development, and so on.

NON-MARINE MOLLUSCA OF BURU.—The non-marine molluscan fauna of the island of Buru has never been thoroughly investigated, and only scattered notes exist. Mr. Toxopeus has, however, visited a limited portion of the island for something less than a year, and the result of his collection of mollusca is now reported on by Dr. T. van Benthem Jutting (*Treubia*, vol. 7, suppl.). Omitting varieties and unidentified forms, the number of species amounts to 50, only 6 being described as new, while 18 are reported for the first time. There are two excellent plates and a number of rather rough, but effective, text illustrations, including distribution maps of the genera *Isidora*, *Physastra* and *Ameria*. A list of species formerly reported from the island but not found by Mr. Toxopeus is given, with references to the places of their description.

IRON ORES OF SOUTH AFRICA.—While on the staff of the Geological Survey of South Africa, Dr. P. A. Wagner contributed liberally to geological literature of the type that is of far more than local interest, and since his resignation he has prepared for publication still another memoir of outstanding importance, dealing on this occasion with "The Iron Deposits of the Union of South Africa" (*G. S. S. Africa, Mem.* 26, 1928). The types of ores considered include magmatic segregations; contact metasomatic deposits; lode and vein deposits; banded ironstones of the characteristic pre-Cambrian type; bedded ores of various ages; replacement and metamorphosed deposits, including those of the Lake Superior type; and laterites and other surface ironstones. Each chapter contains a wealth of observational data and critical comment—stratigraphical, petrological, chemical, and economic. South Africa possesses the most extensive titaniferous ores in the world, but apart from these her known reserves are exceeded only by those of India, the United States, Brazil, and France. As there are also associated resources on an ample scale of coking coal, limestone, dolomite, manganese, and fluor spar, the production of iron and steel should in the future prove to be a factor of prime importance in the economic development of the Union.

GEOLOGICAL HISTORY OF TASMANIA.—A stimulating account of this critical region of Gondwanaland, by A. N. Lewis, has recently appeared in the *Proc. Roy. Soc. Tasmania* for 1926 (pp. 1-24; 1927), with special reference to the relation of the existing topography to the Triassic dolerite intrusions and the major block-faulting. Mr. Lewis considers that after

the intrusions the old land surface was reduced to a peneplain, and that the present surface features have been moulded on variously uplifted blocks of country, the faulting and elevation responsible for these being of Tertiary age, probably late Miocene or early Pliocene, about which time there were at least two phases of volcanic activity. A discussion of the paper by P. B. Nye and others, with a reply from Mr. Lewis, appears in the same *Proceedings* for 1927 (pp. 67-77; 1928). Mr. Nye contends that the present physiography dates from the time of the dolerite intrusions, while Mr. Lewis retorts that if this had been so Tasmania would long ago have been reduced to a most mature peneplain. He thinks it inconceivable that 200 million years of denudation could still have left conspicuous dolerite-capped hills if the latter had been finally elevated at the time of intrusion. Apart from this controversy, the paper and discussion are valuable as a contribution to our growing knowledge of the great dolerite intrusions of the Mesozoic era.

FIELD CURRENTS FROM POINTS.—A paper in the May number of the *Physical Review*, by Prof. Millikan and Messrs. Eyring and Mackeown, on the extraction of electrons from cold, negatively charged points by strong electric fields, is of particular interest in view of recent theoretical investigations of the problem on the basis of the new mechanics. The data which are presented show conclusively that a detectable current is first obtained for a definite strength of the field at the surface of the metal, irrespective of the applied potential and the disposition of the electrodes. The critical field is about the same for a tungsten point as for a tungsten wire, but it is greater for platinum than for tungsten. The importance of the field as variable rather than the potential was shown very clearly with a steel point and plane discharging system. The electric fields used are enormously high, thirty-five million volts per centimetre being attained in one instance.

INTERNATIONAL WEIGHTS AND MEASURES.—The *Proceedings of the International Bureau of Weights and Measures* for the year 1927 show that the question of the gas thermometer scale is to be considered, and that Prof. Keesom and Mr. Tuyn, of Leyden, have been asked to draw up a report on the subject. The various copies of the standard metre have been examined as to their expansion with increase of temperature, but there is a slight difference between the results obtained by the two methods used which has not yet been explained. The standards made at the same time have the same expansion, and the new quartz standards agree very closely with each other. The fine lines which mark the length of the standard are shown in the *Proceedings*, magnified 500 diameters, and it is noticeable how much finer the lines on the newer standards are than on the old. Several of the quartz standard kilograms having decreased in weight by 0·1 milligram in three years after being heated, observations have been made on a platinum kilogram submitted to a current of air at 100° C. for thirteen months, but no change in its weight could be detected. The proposal to make the British yard and the United States yard identical was withdrawn.

LONGITUDINAL STABILITY IN AEROPLANES.—An interesting new presentation of aeroplane stability analysis, in practical form, is contained in a publication of the Aeronautical Research Committee by S. B. Gates, on "A Survey of Longitudinal Stability below the Stall, with an Abstract for Designers' Use" (*R. and M.*, No. 1118. London: H.M. Stationery Office, 1928. 1*s*. 3*d*.). The paper develops in terms of new units, in which the resistance derivatives are expressed as non-dimensional quantities, a more compact analysis of longitudinal stability below stalling than has hitherto been attempted, and throws it into a form to bring it immediately within the scope of designers. The description is in terms of the two quantities, in practice at the disposal of the designer, position of centre of gravity and size of tail. With these co-ordinates the region of longitudinal stability is defined on a series of plane diagrams, and in typical cases curves have been filled in from which the damping and period of the phugoid motion may be estimated.

THE STRUCTURE OF A DETERMINANT.—In his lecture on the Rouse Ball Foundation at Cambridge in 1927, Major P. A. MacMahon gave an account of some recent developments in the theory and structure of determinants. A worker in this field is fortunate in having, in the four volumes of Muir's "History of the Theory of Determinants," a classified summary of the progress of the subject from 1693 until 1900. No important discovery has escaped the notice of Muir, who has spared no pains in mastering the great variety of notations employed at different times. During the last few years, two important advances have been made in the theory of the structure of a determinant. In the first place, various connexions have been established with symmetric functions appertaining to such algebras as that of hyperdeterminants. Again, a certain algebraical expression, brought into prominence by Muir and named by him a 'permanent,' has been found to be a corner-stone in the algebraic theory. Both advances, which proceed hand-in-hand, are linked in a remarkable way with MacMahon's own work on the partitions of numbers. As yet the connexion with symmetric functions, arising from the new outlook, is but in its infancy. The study of the symmetric function of the umbral algebras, of which determinants are particular cases, is only just broached. Major MacMahon's very stimulating lecture is printed *in extenso* in *Jour. London Math. Soc.*, vol. 2.

THE STRUCTURE OF LONG CHAIN COMPOUNDS.—The *Proceedings of the Royal Society of Edinburgh*, vol. 48, Part I., contains an account of a further X-ray investigation by E. Henderson of a number of normal saturated dicarboxylic acids. Between the odd and even members of this series there is a definite alternation in physical properties, and this difference is also apparent in the crystal structures. The work has been extended to mono- and di-alkyl malonic acids with interesting results. The structure attributed to dioctadecyl malonic acid indicates that in acids of this type the two long hydrocarbon chains lie approximately parallel to one another, thus:

$CH_3 . CH_2 \ldots\ldots CH_2 \quad COOH$

$\diagdown \quad \diagup$

C

$\diagup \quad \diagdown$

$CH_3 . CH_2 \ldots\ldots CH_2 \quad COOH$

It has previously been observed that long chain compounds terminating in an incompletely saturated group form bimolecular layers in the crystal, the molecules of one layer being oppositely orientated to those in the other. Results now obtained with fatty acid amides confirm the view that the formation of these bimolecular layers is due to the presence of the incompletely saturated group in the molecule. In the malonic acids these bimolecular layers are not observed, and it appears, therefore, that the two carboxyl groups mutually satisfy their residual affinity.

Ancient Greek Physical Types.

AT a meeting of the Royal Anthropological Institute on Tuesday, May 22, the president, Prof. J. L. Myres, read a paper on ancient Greek physical types. He said that though the number of ancient skeletons from Greek sites is still small, evidence already published, especially by Duckworth and Hawes, is sufficient to show that at the beginning of the Bronze Age the population of Crete and the Cycladic Islands was already a mixed one. Both the chief ingredients, 'Mediterranean' and 'Armenoid,' can be traced in separate occupation of certain islands, and where there is mixture of breeds, the proportions of these ingredients vary, both locally and from period to period. Single skulls of neolithic period, from Lycia, Crete, and Leucas, are alike broad-headed. It is, however, only in the early part of the Bronze Age that evidence becomes more copious. In Crete, the proportion of Armenoids begins at about 10 per cent; falls somewhat in the Middle Minoan Age, as though this continental type were being absorbed in the insular; then rises to 46 per cent in the Late Minoan Age, indicating fresh intruders from adjacent mainlands. It is not at present possible, however, to distinguish arrivals from Greece and from Asia Minor.

So early as the 'third city' on the site of Troy (about 2000–1900 B.C.), there is direct evidence of the presence of a northern type, confirming inferences from the distribution of tumulus-burials south of the Lower Danube at a period when tumulus-burying people were spreading from east of the Dnieper into Central Europe. Probably these people were blond, like their descendants farther north; but direct evidence for colour only becomes available at all quite late in the Bronze Age. Blondness, however, is not confined to pure 'northern' strains, but is shared by many mixed breeds in Central and Eastern Europe, which are more or less broad-headed; and there was probably a larger element of relatively fair, and especially of ruddy or auburn-haired people in classical Greece than could be inferred from the prevalent head-forms.

To supplement the scanty records of human remains, ancient representations of bald men are of value; and also the representations of satyrs, giants, centaurs, and low-class individuals, as evidence for the persistence of a 'backwood' type with snub-nose, wrinkled forehead, heavy brow-ridges, and low forehead. This is quite distinct from the markedly Armenoid appearance of Thersites in the "Iliad." That it was a real type and widespread, is shown by the portraits of Socrates, and Egyptian representations of Asiatic captives in the thirteenth century. Other valuable features are the distinct types of beard, Mediterranean and Armenoid, in Greek portraiture and vase-paintings; and the varying proportions of the whole body, indicating co-existence of a slight-built and a thick-set type.

Literary evidence for colour of hair and eyes is supplemented, though scantily, by archæological. The blond and ruddy complexions already mentioned are not to be ascribed solely to the 'coming of the Dorians' in the twelfth century, for they are recognisable rarely so far back as the fourteenth, and characterised the greater heroes of the Trojan War period, in the thirteenth and twelfth. In general, it is inferred that the 'Greek type,' like the Greek people generally, was in process of determination whenever the Ægean was temporarily secluded from invasions; then local conditions, which are peculiar and austere, operated to eliminate the less acclimatisable breeds. The well-marked varieties which are now to be observed in the more remote districts, and especially in some of the islands, show that this process has been going on since the great period of open intercourse in later classical times. The results of this are displayed in Græco-Egyptian mummy-portraits, and in Byzantine mosaics and frescoes.

Durham Castle.

THE conclusions reported by Prof. Arthur Holmes in his paper on "The Foundations of Durham Castle and the Geology of the Wear Gorge," published in the *Durham University Journal* for March 1928, should do something to reassure those who have feared for the architectural glories of that ancient palace and fortress building, and make it clear that its repair, though likely to be both difficult and costly, is not impracticable.

Prof. Holmes has refuted the current local hypothesis that percolating waters, short-circuiting across the neck of the river bend, have removed material from under the cracked and broken walls. He accepts the historian's assurance that coal working has never been permitted where subsidence consequent thereon could have affected the castle buildings. He and his colleague, Dr. Hopkins, have made a large-scale geological map and have shown that the deeply incised meander which almost surrounds both Durham Cathedral and Durham Castle is post-Glacial in age and is cut through unweathered Coal Measure sandstones and shales. The 'Cathedral sandstone' on which the Cathedral is firmly founded is recognised as the 'Low Main Post' of the local miners.

Towards the castle the strong rock-beds dip down, and the castle buildings stand partly upon the rubbly top of the Cathedral sandstone, but mainly upon drift-sands and boulder clay which forms part of the filling of the deep pre-Glacial valley long famous as the 'Teme Wash.' The main course of that great drift-filled trough passes some few hundreds of yards to the eastward of Durham Castle; but, under the town and market place, a sand-filled tributary valley comes in and joins it from the west. The drift beneath the castle walls rests against a spur of Cathedral sandstone between the two channels. The Castle was in fact "founded on what is little better than loose rubbish," but the rock, some twenty or more feet below ground level, is strong enough to afford a stable and trustworthy foundation. As and when funds permit, it is proposed to continue the underpinning of the damaged walls and to construct beneath the neighbouring shaken parts of the buildings a reinforced concrete raft which will bear directly on the solid rock.

Appearances may well be deceptive, but to a visitor from another coalfield the character of the cracking and the distribution of the damage done recall occurrences in buildings beneath which old colliery workings are in process of slow collapse. Prof. Holmes points out that at the Durham Castle courtyard boring, the place of the valuable Hutton coal seam is only some 40 to 60 feet below Wear River level, and if one dare suspect the completeness of the historical record in a coalfield where the art and practice of coal working was so early begun, one would suggest that before a great expenditure is incurred upon the work of reconstruction, the presence or absence of ancient coal workings, and the condition of the measures above them, ought to be tested further by modern methods of exploratory boring.

W. G. F.

Association of Teachers in Technical Institutions.

CONFERENCE AT BRADFORD.

THE recent conference of the Association of Teachers in Technical Institutions gave ample evidence that the period of peace as regards such matters as salary and superannuation is being used for the discussion of the larger questions to which teachers should have opportunity of addressing themselves. The presidential address of Mr. W. W. Sirman (Handsworth Technical College) contained no reference to salaries other than a comment that industry is still the highest bidder for the services of what he called the 'ideal teacher,' namely, "one possessing experience in research, experience in industry, and ability to teach," and no reference to superannuation other than a reminder that the minimum number of hours required to qualify for superannuation leaves but little time for keeping abreast of industrial changes and improvements. His address was mainly concerned with points arising out of the recent reports of the Emmott Committee on technical education and of the Board of Education's Consultative Committee (cf. NATURE, Jan. 14, 1928, and Feb. 5, 1927). He made a special plea for the development of day technical classes, and underlined important sections of the Emmott Report dealing with grouped courses, equipment, and the personnel of governing bodies of colleges.

The Emmott Committee's report was also the subject before an open meeting, when the discussion was opened by Mr. A. E. Evans and Mr. Wickham Murray, who used the history and principal features of the report as a background for the Association's educational policy. Mr. T. Boyce (Director of Education, Bradford) emphasised the necessity of linking technical education—which he said is not yet thoroughly envisaged as an intrinsic part of our system—to other forms of education, and he asked that the Hadow Report, in spite of certain criticisms levelled at it by Mr. Evans, should be accepted as a great move forward to those very ideals for which the A.T.T.I. has so long worked. Finally, a resolution urging the establishment of a central committee to co-ordinate the local inquiries suggested by the President of the Board of Education in his reply to the Emmott Committee, received the approval of the meeting.

This attention to the wider developments and implications of technical education was also reflected in other resolutions passed by the Conference. While, at conferences held under the shadow of salary and similar negotiations, much time has been taken by resolutions affecting purely domestic policy, the Bradford resolutions were concerned with several vital points at which educational endeavour may influence the life of the community. Three resolutions dealing with the social significance of biological science, particularly so far as its application can provide a foundation upon which to build a sense of racial responsibility, were passed unanimously.

An important feature of the Conference was a visit to the Research Station of the British Research Association for the Woollen and Worsted Industries at Torridon, Leeds. Addressing the Conference dinner, this Association's Director of Research, Dr. S. G. Barker, made reference to an important development in the linking of education and industry so far as research is concerned. Hitherto the science graduate who left the university to enter industry had some difficulty in obtaining the Ph.D. degree, since regulations necessitated further university residence. But such an interruption of his industrial life was not always possible, and strong representations had therefore been made from the industrial research side for permission for Ph.D. work to be carried out completely in industry. It was therefore gratifying to note that two universities have already granted such permission.

An exhibition of books and apparatus was held in the College of Arts and Crafts, but all the Conference meetings were held in Bradford Technical College, which is deservedly known for the scope and standard of its work. Diploma courses are available in textiles, chemistry, dyeing, engineering, physics, and biology, and are specially suitable to students wishing to attempt the honours degree examinations of the University of London. An important link between education and industry also exists in the award of the College associateship to diploma students who have had one year's industrial practice and submit an approved thesis embodying the results of original work.

University and Educational Intelligence.

CAMBRIDGE.—Dr. T. C. Fitzpatrick, president of Queens' College, has been elected as vice-chancellor for the year 1928–29.

In connexion with the International Geographical Congress in July, honorary degrees of Sc.D. are to be awarded to General Vacchelli, Surveyor-General of Italy, the president of the Congress, to Prof. E. de Martonne, of the Sorbonne, and to Sir Charles Close, president of the Royal Geographical Society.

The John Winbolt Prize in engineering has been awarded to A. Callender, Pembroke College, for a dissertation on "A Method of Determination of Impact Allowances for Railway Bridges."

Prof. Baker, St. John's College, Mr. R. H. Fowler, Trinity College, and Mr. F. P. White, St. John's College, have been appointed delegates from the University to the International Congress of Mathematicians at Bologna in September next.

Applications for the John Lucas Walker studentship in pathology, value £300 annually and tenable for three years, should be sent, accompanied by copies of papers containing published work, testimonials, and references, before June 30, to Prof. H. R. Dean, Pathological Laboratory, Medical School, Cambridge.

LONDON.—The following doctorates have been conferred: *D.Sc. in Physics* on Mr. E. G. Richardson (University College), for a thesis entitled "Measurements of Sound Waves and other Periodic Aerial Motions"; Miss Kathleen Lonsdale (University and Bedford Colleges), for a thesis entitled "An X-ray Study of some simple Derivatives of Ethane"; *D.Sc. in Geography* on Mr. J. N. Carruthers, for a thesis entitled "The Flow of Water through the Straits of Dover," and other papers; *D.Sc. in Geology* on Mr. W. G. St. John Shannon, for a thesis entitled "The Petrography and Correlation of the Sedimentary Rocks of the Torquay Promontory," and other papers.

MR. R. A. WARDLE, lecturer in economic zoology in the University of Manchester, has been appointed to the chair of zoology in the University of Manitoba, Canada.

DR. ETHEL M. POULTON has been elected by the corporation of Yale University to the Seessel fellowship for advanced research in biology. Dr. Poulton is at present lecturer in botany in the Education Department of the University of Birmingham.

Calendar of Customs and Festivals.

June 17.

St. Moling Luachra, Bishop of Teach Moling, now St. Mullins, Co. Carlow (late seventh century, *d. circ.* 696), a descendant of the Leinster royal line. The interest of the legends and cult of the saint lies in their very evident connexion with earlier pagan belief. The saint settled at Rosbrock—'Badger Wood,' an ancient name for Tegh Moling—a place also associated with Finn MacCumhaill. St. Moling is said to have built here the first mill in all Ireland, and in a time of scarcity to have initiated the use of rye for food among the inhabitants. He spent many years in irrigation work with his own hands, and acted daily as a ferryman over the River Barrow.

St. Mullins, situated on the banks of the Barrow near the confluence of one of its tributaries, later became a place of considerable strategical importance. It was the site of a round tower and was a point of defence of the English Pale. The story of the saint's activities as ferryman, his association with milling, the cultivation of rye, and irrigation work, the name 'Badger Wood,' probably a sacred grove, and the existence of a dun or tumulus near by, point to this locality having been a stage on an early line of communication which became an important centre of pagan belief and culture.

The famous artificer Goban Saer is said to have constructed an oratory of oak for the saint, and several stories are connected with the building work of St. Moling. He is also associated in legend with both trees and stones. He lived for seven years in the hollow trunk of a tree, and one of the miracles which took place at his intercession was the transport of a huge oak felled by his workman to the banks of the Barrow to enable it to be cut up. The nature of the story points to this having been a sacred tree. He also shared in the allocation of the wood of the great yew of Lethglen felled by St. Molaise. When his great irrigation channel was completed, after many years of work, all those present waded through it against the current, and the saint undertook to intercede for all who did likewise in after days. This continued to be the practice of all the many pilgrims of both sexes who resorted there in after times, thereby obtaining remission of their sins and relief in illness. It continued to be the practice to walk barefoot through the traditional channel when it had become overgrown with thorns. On one occasion St. Moling cast the dead body of a young man into this channel, whereupon he came to life and swam about, though unable to swim before.

Pilgrims to St. Mullins venerated the saint by saying two prayers each of the nine times they circled on their knees in the largest of the buildings around a great stone on which the saint was said to have celebrated mass, placing a pebble on the stone for each round. They then deposited a leaf in the window of the inner shrine under which the altar had once stood and kissed the stone beneath before they resumed their shoes. The churchyard was much used for interments, and it was the custom to follow the practice, of pagan origin, of bearing the corpse around the churchyard before interment. Both legends and practice point to a survival of a pagan cult.

St. Moling was the patron saint of Leinster, and in particular of the royal Kavanagh clan, who were always buried in his churchyard. He is said to have negotiated the abrogation in favour of Leinster of the Borumha tribute to the High King of Ireland, which was afterwards reimposed in the eleventh century by Brian, known, in consequence, as Boru.

June 23.

St. John's Eve—Midsummer Eve.—The summer solstice was the most important of the festivals of the year among the Aryan peoples. The most significant survival of its observance is the wide-spread custom of the midsummer bonfire or need fire. In Celtic Britain the importance of the fire festivals of May 1 and Hallow-e'en point to a different calendrical system; but, either by transference or by superposition, the midsummer observances in the British Isles duplicate the May fire festival.

Under the Christian Church, the popular observances at midsummer have been connected with St. John the Baptist, but there can be no question as to their derivation from earlier pagan custom. Certain rites of Adonis, for example, of which Frazer thinks a survival is to be found in customs connected with St. John which are found in Sardinia and Sicily, were observed in June. There was at Rome a midsummer saturnalia celebrated by slaves and plebeians. It was specially connected with the fire-born Servius Tullius, and was in part a water and flower festival. It is also significant that the Mohammedan Berbers of Algeria and Morocco still observe traditional midsummer customs analogous to those found elsewhere, although this date does not appear in the Moslem calendar.

The turn of the year, when the sun has attained its zenith, is for a primitive people a critical period. Frazer, indeed, has suggested that the midsummer observances may have been intended to strengthen the sun as his power begins to wane. The part played by water in many of them may be taken as an index of the anxiety of the people for the prosperity of the harvest now at hand. The apparent combination of spring and midsummer in the fact that in Sweden St. John's Eve is the day for the observance of the maypole festival, in association with the practice of jumping through fires, may be due to climatic conditions; but in some parts of Russia the death and resurrection of Kupalo, which takes place on this date, is also associated with both fire and water. A straw figure dressed in woman's clothes with necklace and floral crown, and a tree felled for the purpose named Marena (winter or death), are the central figures of the festival, the straw figure being carried by couples as they jump through the fires. On the next day the figure is stripped and thrown into a stream. Frazer quotes a number of similar customs from various localities in Russia which take place between the feast of St. John and the end of the month.

It is significant of the critical character of this period that it should be regarded as a time for divination. By a familiar process of inversion, the measures originally taken to avert a contingent evil or secure a benefit become a forecast of the event. This is especially to be seen in the widespread customs associated with St. John's Eve, which foretell the character of the future partner in marriage, for example, by means of a looking-glass, in which the form of the future husband will appear looking over the inquirer's shoulder, as in Scotland and in Greece, or by placing it under the pillow, as in the Balkans, when it will affect the maiden's dreams. In Russia, the Balkans, Greece, and many parts of Europe, the white of egg, or melted wax, thrown into water, are believed to be equally efficacious, by the symbolism of the forms they produce in solidifying. In England the 'dumb cake,' made, baked, and broken by two and placed under their pillows by a third, brought the desired vision to the three diviners. In Wales spinsters made a garland of nine different kinds of flowers. Walking backwards they tried to throw the garland on a tree. The number of times it fell to the ground foretold the years they would remain unmarried.

Societies and Academies.

LONDON.

Royal Society, June 7.—**O. W. Richardson**: The emission of secondary electrons and the excitation of soft X-rays. These two groups of phenomena are closely interrelated. In order to harmonise the agreement between the soft X-ray and secondary electron discontinuities with the low soft X-ray and high secondary electron generation efficiencies, it is necessary to postulate an abnormally high absorption of the soft X-rays in the medium in which they originate. The possibility of a similar misfit in connexion with thermionic emission and chemical action is considered. In each case the radiation appears to behave as if it were absorbed about a million times faster near its point of origin than it would if it were separated out into a beam and its absorption coefficient measured elsewhere.

R. H. Fowler and **L. Nordheim**: Electron emission in intense electric fields. The emission of electrons from a cold metal under a strong applied field is calculated exactly, using the new mechanics, Sommerfeld's theory of metals and the simplest form of boundary field, which is sufficiently representative for the problem in hand at all ordinary temperatures.

O. W. Richardson and **F. C. Chalklin**: The excitation of soft X-rays (2). Earlier measurements on the critical potentials of iron have been extended. There is now a substantial agreement between different observers as to the complex phenomena displayed by this element. Rollefson's series is probably real; similar series are suggested for cobalt and nickel and also combination series. The tungsten 'spectrum' has been re-examined by deposition of tungsten on a carbon target. In this way it has been possible to show that the former 'spectrum' was a mixture, the probable contaminant being nickel.

G. Timms: The nodal cubic surfaces and the surface from which they are derived by projection. Cayley's classical treatment of the twenty-three types of cubic surface proceeds by the separate consideration of the several cases; it has been proved, but in a highly abstract manner, that every surface should be obtainable as the projection of a non-singular surface in higher space: the subject of this paper is the actual generation of all the various types of cubic surface by the projection of non-singular surfaces, namely, the non-ruled surfaces of order n in space of n dimensions.

J. M. Robertson: An X-ray investigation of the structure of some naphthalene derivatives. The X-ray investigation of naphthalene tetrachloride and 1.2.3.4.5.8.-hexachlornaphthalene.1.2.3.4.tetrahydride shows that in both cases the lattice is body-centred, and the space group probably C_2^4, involving polarity in the crystals. The reflection molecule and the groups of halogen atoms lie on a virtually different type of lattice and interleave the nearly flat carbon rings, the long axis of the molecule being approximately the c-axis of the crystal.

C. V. Raman and **C. M. Sogani**: A critical absorption photometer for the study of the Compton effect. The great difference in transmission through a filter on the two sides of the K-absorption edge forms the basis of a very simple and convenient method of studying the characteristics of the Compton effect. The materials of the target for the X-ray tube and for the filter in the path of the scattered X-rays are so chosen that the unmodified scattered ray lies on the short-wave side of the limit, while the modified ray scattered through a sufficiently large angle is on the long wave-length side of the limit. The increased transparency for the scattered radiation at such angles is readily shown by a photographic plate behind the filter, a steel wedge placed side by side with the filter forming the standard of comparison.

C. G. Darwin: The wave equation of the electron. In two papers Dirac has recently reconstructed the quantum mechanics of the electron, accommodating in a natural manner the properties associated with the 'spinning electron.' He works throughout with the calculus of q-numbers. The present work starts from his equation, but develops the same properties by the use of ordinary differential equations. There are four simultaneous partial differential equations of the first order, which are invariant for Lorentz transformations. A comparison with previous theories shows that Schrödinger's equation is a first, and the equations of the present author a second, approximation to the exact equations. In the case of hydrogen the solution leads exactly to Sommerfeld's original values for the levels.

S. Chapman: The molecular displacements in diffusing gas-mixtures. The displacement-distribution function found by Einstein for Brownian grains is applicable to a uniform gas mixture, but the constant D in his formula in general differs from the coefficient of diffusion for the mixture. The form of the function is found for a gas-mixture which is non-uniform in temperature and concentration, in the case where the concentration of one constituent is small.

J. R. Wilton: A series of Bessel functions connected with the lattice-points of an n-dimensional ellipsoid. It is known that the number of lattice-points in a many-dimensional ellipsoid is expressible by a series of Bessel functions. The paper is concerned with the degree of approximation given by a partial sum of this series, and with similar problems of a more general character.

E. H. Linfoot: On the law of large numbers. The paper discusses the following problem: Given an infinite sequence of trials, the probability of a success at the ith trial being p_i and the p_i being subject only to the most lenient possible condition, how can we estimate the probable deviation of the number m of successes actually obtained in the first n trials from the 'normal' number?

A. T. Price and **S. Chapman**: On line-integrals of the diurnal magnetic variations. Line-integrals of the field of the diurnal magnetic variation are calculated, taken round the boundary of an area of 400,000 square kilometres in northern Europe. The data used are the mean hourly inequalities of the two components of the horizontal magnetic force for the 20 international quiet days of the summer of 1924, derived from six observatories. The line-integrals do not vanish exactly, but their values are interpreted as due, not to earth-air currents, but to slight uncertainties in the data, owing to the observatories being too far apart round the boundary curve. If the non-zero line integrals were interpreted as indicating earth-air currents, the current-densities would be of the order 10^{-3} amp./km.^{2}, which is about one-tenth the order of the mean current densities inferred from line-integrals of the whole magnetic field; but the observed order of magnitude of the vertical electric currents in the atmosphere is 10^{-6} amp./km.^{2}.

W. G. Bickley: The influence of vortices upon the resistance experienced by solids moving through a liquid. Two cases of two-dimensional streaming past a cylinder, with vortices present, are worked out in detail. Where there are two symmetrically disposed vortices, the resultant is a force in the line of motion. With one vortex and circulation, the force is inclined

to the direction of motion. The lift-drag curves show a resemblance to those found experimentally for the Flettner rotor.

H. S. Edwards: The effect of temperature on the viscosity of neon. The new method previously described for the accurate determination of the variation of the viscosity of air with temperature is modified to deal with a gas of which only a limited quantity is available. Neon was purified by a simple method of fractional distillation over charcoal surrounded by liquid air and measurements taken over the range $-78.4°$ to $444.5°$ C.

W. G. Bickley: The distribution of stress round a circular hole in a plate. The paper considers the distribution of generalised plane stress in a uniform, infinite, elastic plate due to an arbitrary distribution of traction round the boundary of a circular hole. The stresses are expressible in terms of two pairs of conjugate functions, and these in turn are expressible as definite integrals involving the boundary tractions. A physical interpretation of these integrals in terms of 'stress sources' is obtained. The results are in fair accord with experimental determinations.

J. D. Cockcroft: On phenomena occurring in the condensation of atomic streams on surfaces. The conditions under which atomic streams of cadmium and silver condense on different surfaces have been investigated. As shown originally by Wood, condensation into a homogeneous deposit does not occur unless the surface temperature is below a certain critical value; this value is a function of stream density, which varies by a factor of 10^4 as the surface temperature varies over a range from $-80°$ to $-150°$ C. When no precautions are taken to outgas the surface, the surface adsorption forces are identical for different metallic surfaces and glass. When the effect of gas is eliminated, the surface forces are increased. The experiments confirm Frenkel's theory of formation of surface films.

C. D. Ellis and **G. H. Aston**: The dependence of the photographic action of β-rays on their velocity. Measurements have been made of the relative photographic activity of β-rays in the range of speeds $H\rho$ 2000–$H\rho$ 8000 by direct comparison of photographs of the continuous spectrum of radium *B* and *C* with Gurney's electrical measurements. The results show, for example, that electrons of speed $H\rho$ 5000 have only one-half the photographic effect of electrons of speed $H\rho$ 2000.

P. Kapitza: The study of the specific resistance of bismuth crystals, its change in strong magnetic fields, and some allied problems. Part 1. Growth of crystal rods with definite orientation of crystal planes, and specific resistance of the crystals. In order to obtain crystal rods with perfect cleavage plane orientated in any desired direction relative to the axis of the rod, no strain must be set up during crystallisation. During the growth of the crystals, cracks and imperfections are developed in the lattice, which account for the variation of specific resistance observed in previous researches; in the case of a perfect crystal the specific resistance along the trigonal axis is $1.38 \times 10^{-4} \pm 1$ per cent, and perpendicular to the axis $1.07 \times 10^{-4} \pm 1$ per cent at 16°. The cracks are produced during cooling at a temperature very close to that at which bismuth solidifies. A perfect bismuth crystal has no well-defined cleavage plane at room temperature, and is very flexible. There seem to be two crystalline bismuth modifications; one at present unknown but probably cubic, and transferred to the ordinary rhombohedral modification at a temperature slightly below melting-point, accompanied by a change of shape, which accounts for the occurrence of the crack.

Part 2. Methods for observation of change of resistance in strong fields. The study of the change of resistance of a conductor in a magnetic field which exists for 1/100 second is made possible by the fact that larger current densities are permissible in the conductor, during this short interval, without heating the conductor. The measurements can be made with an oscillograph. A special switch is used, the make-and-break of which can be adjusted relatively to the current wave through the coil producing the magnetic field, with an accuracy of about 0·0002 sec.

Part 3. Change of resistance of bismuth and time-lag in magnetic fields. A method is described of eliminating time-lag in measuring the change of resistance in a magnetic field. Experimental results at 290°, 196°, and 91° abs. are given for change of resistance when the current is perpendicular to field, for different orientations of crystal axis relative to the field. Impurities and imperfections in the crystal lattice greatly influence the change of resistance, especially with low temperatures and strong fields. In weak fields the change of resistance of a perfect crystal follows a square law, and in strong fields a linear law; the linear law is practically independent of orientation of the crystal relative to field. In the case of current parallel to lines of force of field, a 'saturation effect' was found; the change of resistance is very small and strongly affected by imperfection of crystal lattice.

Geological Society, May 23.—**P. G. H. Boswell** (lecture): Geological features of the New Mersey Tunnel. The tunnel will be the greatest subaqueous tunnel in existence. The subaqueous portion of the tunnel (44 feet in diameter) and the two Birkenhead approach-tunnels lie in the Middle Bunter Sandstone ('Pebble-Beds'), which dips eastwards at about 3° to 5°. A fault-system, apparently of small aggregate throw, was met with at about 1828 to 1870 feet from the Liverpool shaft. The hade was eastwards, whereas in the case of the sub-river fault in the Mersey Railway Tunnel it was westwards. On the Liverpool side, the presence of the 'Castle Street Fault,' which throws down the Upper (Soft) Bunter Sandstone on the east, was confirmed. At the Old Haymarket entrance another north-north-west and south-south-east fault throws eastwards, and brings Lower Keuper Sandstone into contact with Upper Bunter. It has been possible to construct exceptionally accurate profiles of the system of buried channels. They appear to be of subglacial origin, and do not deepen seawards; they are filled with gravel and sand, overlaid by boulder-clay. In place of the single channel found in the Mersey Railway excavations, two (or more) feeding-channels occur farther north. Interesting, and at present unexplained, features have been observed in the levels of underground water. As would be expected, the fresh water table rides on the back of the salt water table in the neighbourhood of the Mersey estuary.

PARIS.

Academy of Sciences, May 14.—**A. Mesnager**: A rectangular specimen, submitted to normal pressures on its bases.—**Pierre Termier** and **Eugène Maury**: New geological observations in eastern Corsica; the tectonic unities.—**Ch. Gravier** and **J. L. Dantan**: Some results obtained in the course of night fishing (with a light) in the Bay of Algiers.—**P. Helbronner**: The altimetry of Corsica. Outline of some results of measurements of heights above sea level of some points in Corsica.—**E. Mathias**: A curious photograph of lightning obtained in the region of the Lake of the Four Cantons. This photograph supports the theory

of lightning put forward by the author in 1924.—**W. A. Tartakowsky**: An expression for the number of representations of a number by a positive quadratic form with more than three variables.—**Paul Alexandroff**: The homeomorphy of closed ensembles.—**Bertrand Gambier**: Ruled algebraic surfaces: singularities and classification.—**A. Th. Masloff**: The deformation of surfaces with conservation of a conical conjugated system.—**Rodolphe Raclis**: Theorems of existence for the integral equation of Fredholm of the first species, the nucleus of which possesses lines of discontinuity.—**Alex. Froda**: A new classification of the discontinuities of a uniform function of real variables.—**Corps**: The experiments of M. Esclangon and their application to the study of the movements of the ether in the neighbourhood of material masses.—**C. Gaudefroy**: Observations on the fringes obtained in convergent light.—**J. Gilles**: The structure of the spectrum of the second order of sulphur.—**Paul Mondain Monval** and **Paul Schneider**: The refractive index and specific mass of liquid sulphur and of viscous sulphur. Curves are given showing the variations of refractive indices, densities and specific refraction as a function of the temperature. These afford evidence of an internal transformation at 160° C.—**J. Trividic**: The absorption of iodine by carbon from solutions in mixed organic solvents. In all the experiments the Freundlich equation covered the observed facts.—**R. Locquin** and **V. Cerchez**: Ethyl amino-malonate. This has been prepared with a 90 per cent yield by reducing ethyl isonitrosomalonate $(CO_2Et)_2.C-N(OH)$ with aluminium amalgam and water. One atom of hydrogen in this ester is still replaceable by sodium, which reacts with alkyl halides in the usual way.—**Charles Jacob**: The metamorphism of limestones and the structure of the North Pyrenees slope.—**Marcel Roubault**: The tectonic of the neighbourhood of Arbas (Haute-Garonne).—**A. Pereira Forjaz**: Spectrochemistry of the Portuguese mineral waters: the water of Gerez. Germanium, cæsium, silver, and lead have been detected in this water.—**Roger Guy Werner**: Study of the family Gyrophoraceæ.—**A. Sartory, R. Sartory**, and **J. Meyer**: Contribution to the study of the morphological and biological characters of *Mucor spinosus* (*Zygorhynchus spinosus*) cultivated on media resembling the habitat from which it has been isolated.—**Pierre Dangeard**: The conditions of release of free iodine in Laminaria. Details of experiments on *Laminaria flexicaulis*. With the exception of young specimens less than 10 cm. long, all the *Laminaria* in their natural state give off iodine vapour. The rate of evolution of the iodine is increased if the plant is cut or treated with acid or alcohol.—**Gard**: Rotting of the cultivated walnut, *Juglans regia*, and calcium carbonate. The distribution and intensity of diseased walnuts due to *Armillariella mellea* varies greatly from one region to another. After eliminating numerous possible factors, a distinct connexion was proved between the proportion of chalk in the soil and the disease, absence of disease corresponding with high proportions of chalk. The principal cause of the disease is considered to be the progressive decalcification of the soil by the intensive use of chemical manures.—**Georges Nichita**: Follicular atresia in *Girardinus Guppyi*.—**J. J. Rouzaud** and **L. C. Soula**: The influence of pinching the subhepatic veins on glycæmia and cholesterinæmia.—**A. Policard**: The proportion of calcium of the various regions of the ossification cartilage of the long bones.—**Edouard Chatton** and **André Lwoff**: The structure, evolution, and affinities of the ciliated Opalinopsidæ of the Cephalopods.—**Labbé, Nepveux**, and **Hiernaux**: The influence of insulin on the disturbance of nitrogen metabolism in diabetes.

Official Publications Received.

BRITISH.

Cambridge Natural History Society. Fauna List No. 1: Dermaptera and Orthoptera of Cambridgeshire. By E. B. Worthington. Pp. 8. (Cambridge.)

Board of Education. Educational Pamphlets, No. 58: Report on the Teaching of Electrical Machine Design. Pp. 11. (London: H.M. Stationery Office.) 3*d*. net.

Journal of the Royal Statistical Society. Vol. 91, Part 2, 1928. Pp. xii+153-302. (London.) 7*s*. 6*d*.

Ministry of Health. Voluntary Hospitals Commission: Final Report. Pp. 10. (London: H.M. Stationery Office.) 3*d*. net.

Journal of the Chemical Society: containing Papers communicated to the Society. May. Pp. xii+v+1061-1401. (London: Gurney and Jackson.)

A Brief History of the Institution of Civil Engineers, established 2nd January 1818, incorporated by Royal Charter 3rd June 1928. Pp. 62. (London.)

Memoirs of the Indian Meteorological Department. Vol. 25, Part 1: Sky-Illumination at Sunrise and Sunset. By Dr. K. R. Ramanathan. Pp. 18+2 plates. (Calcutta: Government of India Central Publication Branch.) 10 annas; 1*s*.

Annual Report of the Calcutta School of Tropical Medicine, Institute of Hygiene and the Carmichael Hospital for Tropical Diseases, 1927. Pp. 107. (Calcutta: Bengal Government Press.)

Report of the Astronomer-Royal to the Board of Visitors of the Royal Observatory, Greenwich, read at the Annual Visitation of the Royal Observatory, 1928 June 2. Pp. 18. (Greenwich.)

Publications of the South African Institute for Medical Research. No. 21: Studies on Cell Growth. Part 1: Serum Cultures of Young and Adult Mammalian Tissues and their Relation to Growth Processes *in vivo*. By Dr. M. J. A. des Ligneris. Pp. 257-384+34 plates. (Johannesburg.)

Quarterly Journal of the Royal Meteorological Society. Vol. 54, No. 226, April. Pp. 79-160. (London: Edward Stanford, Ltd.) 7*s*. 6*d*.

Air Ministry. Aeronautical Research Committee: Reports and Memoranda. No. 1114 (Ae. 287): Charts for the Calculation of Airscrew Thrust and Torque Coefficients. By Dr. J. D. Coates. (T. 2508.) Pp. 7+12 plates. 6*d*. net. No. 1119 (Ae. 292): Model Experiments with Rear Slots and Flaps on Aerofoils R.A.F. 31 and R.A.F. 26. By H. B. Irving, A. S. Batson and A. L. Maidens. (T. 2527.) Pp. 8+6 plates. 6*d*. net. (London: H.M. Stationery Office.)

Report of the Director of the Royal Observatory, Hong Kong, for the Year 1927. Pp. 19. (Hong Kong.)

Journal of the Institute of Actuaries. Vol. 3, No. 2. Pp. ii+75-158. (London: C. and E. Layton.) 8*s*.

FOREIGN.

Smithsonian Miscellaneous Collections. Vol. 80, No. 11: The Legs and Leg-bearing Segments of some Primitive Arthropod Groups, with Notes on Leg-Segmentation in the Arachnida. By H. E. Ewing. (Publication 2962.) Pp. 41+12 plates. (Washington, D.C.: Smithsonian Institution.)

Carnegie Endowment for International Peace: Division of Intercourse and Education. Annual Report of the Director for the Year 1927. Pp. 64+4 plates. (New York City.)

General Catalogue of Stellar Parallaxes. Compiled by Frank Schlesinger, with the assistance of Margaretta Palmer and Alice Pond. Edition of 1924, including all Determinations available in January of that Year. Pp. vii+57. (New Haven, Conn.: Yale University Observatory.)

Agricultural Experiment Station, Michigan State College of Agriculture and Applied Science. Circular Bulletin No. 101: Cockroaches, Silver-fish and Book-lice. By E. I. McDaniel. Pp. 12. Special Bulletin No. 169: Profit and Loss in Pruning Mature Apple Trees. By Roy E. Marshall. Pp. 39. Special Bulletin No. 172: Farm Real Estate Assessment Practices in Michigan. By R. Wayne Newton and W. O. Hedrick. Pp. 80. Technical Bulletin No. 89: Ultimate Effect of Hardening Tomato Plants. By John W. Crist. Pp. 22. (East Lansing, Mich.)

Bulletin météorologique de l'Observatoire météorologique de Beograd. 1: Observations diurnes à Beograd et résumés annuels 1920–1924. Publié sous la direction de P. Vujević. Pp. 39. (Beograd.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 80. Minute American Zonitidae. By H. Burrington Baker. Pp. 44+8 plates. (Philadelphia, Pa.)

Proceedings of the United States National Museum. Vol. 73, Art. 18: Fossil Nutlets of the Genus Lithospermum. By Edward W. Berry. (No. 2734.) Pp. 3+1 plate. (Washington, D.C.: Government Printing Office.)

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 16, Nos. 23 and 24. 23: Report of the President of the Academy for the Year 1927, by C. E. Grunsky; 24: Report of the Director of the Museum for the Year 1927, by Barton Warren Evermann. Pp. 689-758. (San Francisco, Cal.)

Bulletin of the Imperial Earthquake Investigation Committee. Vol. 11, No. 2: List of the After-Shocks of the Great Kwanto Earthquake. By A. Imamura and K. Hasegawa. Pp. 65-93+3 plates. (Tokyo.)

Japanese Journal of Astronomy and Geophysics. Transactions and Abstracts. Vol. 5, No. 1. Pp. 79+6. Vol. 5, No. 2. Pp. 81-125. Vol. 5, No. 3. Pp. 127-174+7-19. (Tokyo: National Research Council of Japan.)

Spisy Lékařské Fakulty, Masarykovy University, Brno, Československá Republika, Svazek 5, Spis 41-51. (Publications de la Faculté de Médecine, Brno, Tchécoslovaquie, Tome 5, Fascicule 41-51.) Pp. iii+66+20+16+21+17+15+32+32+8+41+62. (Brno: A. Píša.) 40 Kč.

Biologické Spisy Vysoké Školy Zvěrolékařské, Brno, Československá Republika, Svazek 5, Spis 61-75. (Publications biologiques de l'École des Hautes Études vétérinaires, Brno, Tchécoslovaquie, Tome 5, Fascicule 61-75.) Pp. iv+14+10+9+10+44+21+56+15+14+39+32+21+12+21+8. (Brno: A. Píša.) 40 Kč.

Sborník Vysoké Školy Zemědělské v Brně, ČSR., Fakulta Lesnická. (Bulletin de l'École supérieure d'Agronomie, Brno, RČS., Faculté de Silviculture.) Sign. D8: Fauna lesní hrabanky (Fauna of the Forest Soil). Napsal Dr. Štěpán Soudek. (With an English Summary.) Pp. 24. (Brno: A. Piša.)

CATALOGUES.

Heat Treatment Bulletin, No. 40: High Speed Steel. By A. R. Page. Pp. 8. (London: Automatic and Electric Furnaces, Ltd.)

Americana from the Time of the Discovery: with a Selection of other Voyages and Travels particularly to India and the East. (Catalogue No. 20.) Pp. 152. (Newcastle-on-Tyne: William H. Robinson.)

Cambridge Instruments for Heating and Ventilating Plants. Pp. 6. (London: Cambridge Instrument Co., Ltd.)

Second-hand and Shop-soiled Instruments and Apparatus at Reduced Prices. Pp. 8. (London: Ogilvy and Co.)

Disposal of Shop-soiled Instruments and Apparatus at Reduced Prices. Pp. 12. (London: E. Leitz.)

Diary of Societies.

SATURDAY, JUNE 16.

ROYAL SOCIETY OF MEDICINE (Therapeutics Section) (at Pharmacological Laboratory, Oxford), at 3.—Annual General Meeting and Laboratory Meeting.

MINING INSTITUTE OF SCOTLAND (at Dunfermline).

MONDAY, JUNE 18.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.—Anniversary General Meeting.—Presidential Address, Presentation of Medals and Awards, etc.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—Presentation of Royal Gold Medal.

TUESDAY, JUNE 19.

RESEARCH DEFENCE SOCIETY (Annual General Meeting) (at 11 Chandos Street, W.1), at 3.—Sir Bernard Spilsbury: The Work and Responsibilities of a Pathologist (Stephen Paget Memorial Lecture).

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—John Hilton: Some Further Enquiries by Sample.

ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Rev. Neville Jones and Col. W. E. Hardy: Stone Implements of South Africa.

WEDNESDAY, JUNE 20.

ROYAL METEOROLOGICAL SOCIETY, at 5.—J. Edmund Clark, I. D. Margary, R. Marshall, and C. J. P. Cave: Report on the Phenological Observations in the British Isles, December 1926 to November 1927.—C. K. M. Douglas: On the Relation between Temperature Changes and Wind Structure in the Upper Atmosphere.—R. M. Poulter: Simple Formulæ for Computing Relative Humidity.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at the Café Royal, Regent Street), at 7.30 for 8.—Dinner to celebrate the Society's 21st Anniversary.

FOLK-LORE SOCIETY (at University College), at 8.—Madame Fia Fastré: Exhibition of Toys from Mexico, France and Japan.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (Summer Meeting at Stourbridge) (continued on June 21, 22, 23).

THURSDAY, JUNE 21.

ROYAL SOCIETY, at 4.30.—Sir Robert Robertson: Studies in the Infra-Red Region of the Spectrum. Part I. Description of Prism Apparatus. Part II. Calibration of Prism Spectrometer; General Procedure and Preparation of Pure Ammonia, Phosphine, and Arsine Gases. Part III. Infra-Red Spectra of Ammonia, Phosphine, and Arsine. Part IV. Consideration of Bands of Ammonia, Phosphine, and Arsine. With Exhibition of Apparatus.—C. V. Boys: Solid Dipleidoscope Prisms.—Prof. G. I. Taylor: The Forces on a Body placed in a Curved or Converging Stream of Fluid.—S. S. Cook: Erosion by Water-Hammer.—*To be read in title only*:—J. Hollingworth: The Polarisation of Radio Waves.—A. C. Menzies: The Spark-Spectrum of Copper.—W. H. Taylor and W. W. Jackson: The Structure of Cyanite.—F. H. Constable: A New Interference Method of Measuring the Surface Area of Film Catalysts. Part I. Theory. Part II. Nickel.—S. J. Davies and C. N. White: An Experimental Study of the Flow of Water in Pipes of Rectangular Section.—L. P. Davies: The Photoelectric Properties of some Metals in the Soft X-Ray Region.—C. F. Powell: Condensation Phenomena at Different Temperatures.—J. M. Walter and S. Barratt: The Existence of Volatile Intermetallic Compounds. The Band Spectra of the Alkali Metals and of their Alloys with each other.—G. Temple: The Theory of Rayleigh's Principle as applied to Continuous Systems.—E. S. Semmens: The Selective Photo-chemical Action of Polarised Light. Part II.—W. R. Brode and Dr. R. A. Morton: The Absorption Spectra of Solutions of Cobalt Chloride, Cobalt Bromide, and Cobalt Iodide in Concentrated Hydrochloric, Hydrobromic, and Hydriodic Acids.—Prof. T. M. Lowry and G. G. Owen: The Mechanism of Chemical Change. I. Promotion and Arrest of the Mutarotation of Tetra-Acetylglucose in Ethyl Acetate.—C. H. Gibson and C. N. Hinshelwood: The Homogeneous Reaction between Hydrogen and Oxygen.—R. Schlapp: The Stark Effect of the Fine Structure of Hydrogen.—H. Glauert: The Characteristics of a Karman Vortex Street in a Channel of Finite Breadth.—D. M. Newitt: Gaseous Combustion at High Pressures. X.—K. R. Rao and A. L. Narayan: On Series in the Spark Spectra of Germanium.—N. K. Adam: The Structure of Thin Films. Part XI.—E. Newbery: A Revision of the Theory of Transfer Resistance.—E. Newbery: Metal Overvoltage Measurements with the Cathode Ray Oscillograph.—Lord Rayleigh: Observations on the Band Spectrum of Mercury.—G. B. Bandopadhyaya: Photoelectric Effect of Soft X-Rays.—A. Caress and Dr. E. K. Rideal: On the Chemical Reactions of Carbon Monoxide and Hydrogen after Collision with Electrons.—F. P. Bowden and Dr. E. K. Rideal: The Electromotive Behaviour of Thin Films. Part I. Hydrogen. Part II. The Areas of Catalytically Active Surfaces.—W. Payman: The Detonation Wave in Gaseous Mixtures and the Pre-Detonation Period.—Prof. G. P. Thomson: Experiments on the Diffraction of Cathode Rays. II.—R. Ironside: The Diffraction of Cathode Rays by Thin Films of Copper, Silver, and Tin.—A. Reid: The Diffraction of Cathode Rays by Thin Celluloid Films.—Prof. W. E. Curtis and W. Jevons: The Zeeman Effect in the Band Spectrum of Helium.—B. F. J. Schonland: The Scattering of Cathode Rays.—Prof. H. M. Macdonald: Note on Total Reflexion of Electric Waves at the Interface between two Media.—Prof. G. I. Taylor: The Energy of a Body moving in an Infinite Fluid, with an Application to Airships.

CHEMICAL SOCIETY, at 5.30.—H. M. Dawson and W. Lowson: Acid and Salt Effects in Catalysed Reactions. Part XV. The Catalytic Activity of Hydrochloric Acid in the Hydrolysis of Ethyl Acetate.—A. A. Goldberg and R. P. Linstead: The Chemistry of the Three Carbon System. Part XVIII. Quantitative Investigations on the αβ-βγ Change in Unsaturated Acids; Observations on the Reduction of Sorbic Acid and a New Synthesis of Pyroterebic Acid.—G. M. Bennett and W. G. Philip: The Influence of Structure on the Solubilities of Ethers. Part I. Aliphatic Ethers.—G. M. Bennett and W. G. Philip: The Influence of Structure on the Solubilities of Ethers. Part II. Some Cyclic Ethers.—R. G. W. Norrish and J. G. A. Griffiths: The Photochemical Decomposition of Glyoxal Vapour.

BRITISH PSYCHOLOGICAL SOCIETY (Industrial Section) (at the Royal Anthropological Institute, 52 Upper Bedford Place), at 6.—Elton Mayo: The Practical Outcome of Psycho-Pathology.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 8.15.—Annual General Meeting.—Prof. E. Brumpt: The Differential Diagnosis of the Intestinal Amœbæ of Man.

NEWCOMEN SOCIETY (at Stourbridge) (continued on June 22 and 23).

FRIDAY, JUNE 22.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.

ROYAL SOCIETY OF MEDICINE (Epidemiology Section) (Annual General Meeting), at 8.—Dr. J. A. Glover: Some Observations on Nasopharyngeal Infections in Public Schools.

ASSOCIATION OF ECONOMIC BIOLOGISTS (at Long Ashton, nr. Bristol).

SATURDAY, JUNE 23.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Newcastle-upon-Tyne), at 2.30.

FRIDAY, JUNE 22, AND *SATURDAY*, JUNE 23.

ANATOMICAL SOCIETY OF GREAT BRITAIN AND IRELAND (Summer Meeting) (in the Department of Anatomy, University of Manchester).—J. M. Yoffey: Essentials of Hæmopoiesis as seen in Fishes.—D. Stewart and S. L. Wilson: Regional Anæsthesia and the Innervation of the Teeth.—G. Jefferson and H. M. Morris: Movements of the Spine with Reference to the Localisation (Incidence) of Spinal Injury.—A. J. E. Cave: (*a*) Case of Symmetrical Thinness of the Parietal Bones; (*b*) Two Cases of Congenitally Enlarged Parietal Foramina; (*c*) Nerve Markings on the First Rib.—G. Elliot Smith: The Optic Connexions in the Brain—the Need for a Revision of the Traditional Description.—G. L. Streeter: The Lewis-Gregory Film showing the Living Rabbit Egg and the Phenomena of Cleavage and Formation of the Segmentation Cavity.—J. Beattie: The Sympathetic Nervous Control of the Heart.—J. Beattie and R. B. Malcolm: The Cerebro-spinal Circulation in Man.—W. E. LeGros Clark: The Optic Thalamus of Tupaia.—T. Wingate Todd: A Study of the Normal Mobility of the Alimentary Tract.—R. D. Lockhart: (*a*) Variations Coincident with Congenital Absence of the Zygoma (Zygomatic Arch); (*b*) The Anterior Commissure of the Brain.—E. Fawcett: A Few Remarks on the Vertebræ.—H. A. Harris: (*a*) The Closure of the Cranial Sutures in Relation to the Evolution of the Cortex Cerebri; (*b*) A Preliminary Note on the Relation of Ossification in the Hind Limb and Skull to the Index of Cerebral Value of Anthony and Coupin.—Tudor Jones: Note on the Evidence concerning the Minute Structure of Striped Muscle.—C. J. Patten: The Syrinx, and Mechanism of Voice Production.—A Discussion on Anatomical Terminology will be opened by T. B. Johnston.

SATURDAY, JUNE 30.

GENETICAL SOCIETY (at the John Innes Horticultural Institution, Merton, S.W.19), at 1.—Annual Meeting.

PUBLIC LECTURES.

MONDAY, JUNE 18.

KING'S COLLEGE, at 5.30.—Prof. E. L. Stevenson: The Expansion of Geographical Knowledge in the Early Renaissance as illustrated by Contemporary Maps (III.): Early Spanish Discovery in the New World.—Prof. H. Wildon Carr: Some Problems in Metaphysics (II.): The Mind-Body Relation.

UNIVERSITY MUSEUM, OXFORD.—Dr. Harlow Shapley: A Search for the Centre of the Milky Way (Halley Lecture).

WEDNESDAY, JUNE 20.

KING'S COLLEGE, at 5.30.—Prof. E. L. Stevenson: The Expansion of Geographical Knowledge in the Early Renaissance as illustrated by Contemporary Maps (IV.): Early French and English Explorations in the New World.—Prof. H. Wildon Carr: Some Problems in Metaphysics (III.): The Idea of a World Soul.

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The Significance of Imperial Chemical Industries.

FOUR years ago a Labour Government, pledged to the ideal of international co-operation, in a fit of political expediency exercised the veto of the State to frustrate the attempt of the majority of the board of directors of the British Dyestuffs Corporation, Ltd., and the Interessen Gemeinschaft to reach a working agreement for the better production and distribution of their products. The succeeding Government, although not prepared openly to be a party to co-operation between powerful chemical groups in Great Britain and Germany, sold its holding in the British Dyestuffs Corporation (albeit at a great depreciation), and thus left the directors free to do as they pleased.

In the meantime, however, the various German chemical groups had amalgamated into the most formidable chemical combine in the world. The new combine has made possible the pooling of resources upon research problems of importance; there are no longer trade secrets to be withheld from any unit of the industry: the State and the universities have given the combine all assistance within their power to afford. Its financial resources are enormous. Obviously its competitive strength in relation to that of Great Britain has been considerably enhanced, and equally obviously it would be difficult for such a combine to make an agreement based upon complete mutuality with any specialised chemical group in Great Britain.

Evidently Sir Alfred Mond, now Baron Melchett of Landford, had these considerations in mind when he conceived the plan of a corresponding combination in Great Britain. If there is eventually to be an international chemical combine to include Great Britain, Germany, and the United States, the sooner the chemical industry of Great Britain attains to the dignity of a unit the more potent will be our influence in any greater combine. The energy with which Sir Alfred has initiated his project is illustrated by the report of Imperial Chemical Industries, Ltd., covering the year 1927, the first year of its existence. The merger now directly controls the British Dyestuffs Corporation, Ltd., Brunner Mond and Co., Ltd., Nobel Industries, Ltd., the United Alkali Co., Ltd., as well as thirty-five other lesser manufacturing and trading concerns, indirectly controls thirty other companies, and has interests in certain American undertakings. The original scope of the undertaking has thus been considerably widened, and the process of consolidation and expansion is steadily going on. Its

trading connexions extend to virtually every corner of the world map.

The authorised capital of the combine is £65,000,000, its assets nearly £70,000,000. The gross profit for the year was £4,567,225, excluding a capital profit of £1,000,000 arising from the realisation of certain investments of the member-businesses which has been placed to the reserve accounts. In the first year of its existence the merger is in a position to pay a dividend of 8 per cent on its ordinary capital, 7 per cent on its preference shares, and to bring its deferred capital into the dividend list, in spite of the fact that in 1927 Great Britain was only just emerging from the disastrous industrial struggle of 1926. The financial results obtained indicate that the member-businesses have made good use of the advantages offered by the pooling of resources, and in view of the absence of criticism in the country as a whole, it can be assumed that these advantages consist of greater efficiency in production and distribution of multitudinous products, and that the consumer has gained and not been exploited unfairly because of the decrease of competition. Fertilisers, for example, are being sold at four-fifths of the pre-War prices, a fact of tremendous importance to the farming community.

The production of the maximum amount of goods at the least price, at a profit calculated to inspire confidence in the investing public and consistent with proper conditions of life for the work-people of the merger, are, however, merely means to an end, judging from the public utterances of its chairman. He appreciates the wider implications of creative industry, that its proper function is to consider world problems as a whole, to serve mankind as a whole, and in order to do this all relevant factors must be taken into consideration and fully examined. He realises that there is likely to be short shrift for monopolies the activities of which are actuated by the same lack of principle as the average small business. For the modern monopoly is acquiring more and more the character of a public corporation, serving a public uncircumscribed by political boundaries, its activities directed more and more by creative minds fully aware of the responsibilities attaching to their task, with a higher ideal than mere profit-making; attracted to the great enterprise, in fact, by the tremendous scope it offers for scientific methodology, and the adventurous application on a grand scale of the discoveries of science.

Probably Mr. H. G. Wells regards the men whom Sir Alfred Mond has gathered round him as among the "more vigorous intelligences in the business directorates of to-day" who "are beginning to realise the uncompleted implications of their enterprise," and as such the most promising instruments in the "open conspiracy" for the "awaking of mankind from a nightmare of the struggle for existence and the inevitability of war," men who refuse to regard the environment as a static entity, whose struggle is directed towards a modification of their environment. Conspicuous on the façade of the austerely beautiful and noble building rapidly approaching completion on Millbank, which is to serve as the headquarters of Imperial Chemical Industries, Ltd., are some sculptured peacocks. These, says the architect, Sir Frank Baines, should not be regarded as symbolic of mere pride of achievement, but of the incorruptibility of the commercial ideals which it is hoped will actuate the infant enterprise.

It would savour too much of blind optimism to assert that this generation of English people realises fully the appalling reactions of science, applied in a spirit of brutal materialism, upon the life of nations, or that the attitude of mind towards science has completely changed. Science is still largely judged by the material benefits it confers on those who have the prescience to utilise its discoveries, or the material comfort it brings to the multitudes, not very much by the habit of thought it engenders. Its social implications are still unappreciated even by the large majority of scientific workers themselves. When science has relieved man of material cares—and at the present rate of progress of scientific discovery that is not an impossible achievement—it will still be confronted with the task of showing man how to live. "It is," as Prof. Whitehead has said, "among the merits of science that it equips the future for its duties." It can be truly said that it has equipped Imperial Chemical Industries for its future duties. This gigantic industry is based on science, and modern science with its progressive dynamic outlook forces its disciples along hitherto untrod paths in search of greater knowledge and towards greater power.

Nevertheless, we discern an unmistakable tendency in the new combine to leave the main direction of the enterprise to what may be called the financial as distinct from the scientific interest. Only a small minority of the members of the Board inspire us with the confidence that they have had the requisite training in, and possess the requisite knowledge of, science, to be able to appreciate the implications of a discovery. It

may be urged that this contingency is met by leaving the direction of certain of the subsidiary companies to leading scientific workers, and by the creation of the advisory research council, through which agency academic and industrial men of science will co-operate to keep the central board abreast of scientific progress. But is this enough? It has to be borne in mind that the Mond and Nobel companies, which acted as the nucleus for the combine, were founded and controlled by the great men of science after whom they are named. They did not receive their first stimulus from financiers; finance followed their brains, which is the habit of finance the world over. The operations of banks and financial trusts since the War have not inspired the masses of the peoples of Europe and the United States with a great deal of confidence in anything but their capacity to exact a steady toll on industry, whether industry is flourishing or depressed. Booms in trade have been over-financed, but at the first signs of depression, credits have been either withdrawn altogether or made available on such terms that industry and trade have still further declined. It would be interesting to know if Sir Alfred Mond and his colleagues consider that the possibilities of any situation which may arise in the chemical industry are satisfactorily met by the formation of the new Finance Company of Great Britain and America, on the board of which he and Sir Harry M'Gowan are to provide a liaison with Imperial Chemical Industries, Ltd.

From the growth of internationalism in industry and finance, Mr. Wells visualises "an effective world-control . . . of the production and main movements of staple commodities and the drift and expansion of population. . . . These things assured, the abilities and energies of a greatly increased proportion of human beings could be diverted to the happy activities of scientific research and creative work with an ever-increasing release and enlargement of human possibility." We are prepared to believe that Sir Alfred Mond is inspired by an idealism akin to this, that he realises that economic direction of world affairs must be based on the scientific study of all those factors fashioning the environment of man, that industry at its truest and best must be the prelude to man's highest expression. The men he has chosen to deal directly with these matters and to control certain factories and processes enjoy his confidence and inspire us with the same feeling. But there is no guarantee that the same relations will exist between his successors and them or their successors. He has not started a tradition through which the supreme direction of production will be vested in men with a scientific outlook and creative minds.

In addressing the delegates of the Imperial Agricultural Research Conference in October last, Sir Alfred referred to the difficulty experienced in wresting "from short-sighted treasuries the necessary funds for carrying out . . . experimental work, which in its ultimate effect must vastly increase wealth and happiness and economic prosperity, though to those of little imagination it appears to be a wasteful means of immediate expenditure." Is he certain that there is no danger of a similar short-sightedness afflicting members of a board on which the financial elements predominate? This is an age of bold experimentation. Can it be suggested that the substitution of some of the financial elements by scientific workers of proved aptitude for direction and control and one or two creative artists might be amazingly successful in carrying the merger forward in pursuit of an ideal for industry, an ideal which would act as a beacon for every other industry?

A. G. CHURCH.

The West African Negro.

The Peoples of Southern Nigeria: a Sketch of their History, Ethnology, and Languages, with an Abstract of the 1921 Census. By P. Amaury Talbot. Published for the Crown Agents for the Colonies. Vol. 1: *Historical Notes.* Pp. xii+365. Vol. 2: *Ethnology.* Pp. xx+423+67 plates. Vol. 3: *Ethnology.* Pp. x+425-976+66 plates. Vol. 4: *Linguistics and Statistics.* Pp. v+234. (London: Oxford University Press, 1926.) 4 vols., 70s. net.

THE Government of Nigeria is to be congratulated on its wise policy in relation to anthropology. Not only is the study of this subject encouraged in its officials, but also official anthropologists have been appointed both in the northern and southern provinces, and a census has been published for each. Instead of these latter being mere lists of names and numbers, they are in both instances (the other instance being Mr. Meek's "The Northern Tribes of Nigeria") mines of information which will be valuable alike to administrators and to all other workers and travellers in these vast and little-known districts.

The four volumes before us attest the great industry and the sympathetic observation of the author. Mr. Talbot's chief interest is in religious

matters, and the greater part of vols. 2 and 3, comprising together almost 1000 pages, is concerned with religion. This proportion is in no way excessive, for religion plays an immense part in the life of all primitive peoples, especially Africans. There can be no understanding of native life in any branch—government, law, social organisation, agriculture, or any of the arts and crafts—without some knowledge of the religious ideas of the people. The beliefs of the southern Nigerians are too numerous to classify here. Mr. Talbot, who describes gods, kings, and ancestors, has rather unfortunately retained the term 'juju,' a word used by so many authors with such different meanings, that in common parlance it conveys no more than something vaguely magical or supernatural; in these volumes it is used to signify a minor deity who may sometimes be extremely powerful, but whose worship is usually more localised than that of the major deities. *Per contra*, we may be thankful to Mr. Talbot for avoiding 'fetish,' another word which has done much to confuse our knowledge of West African religion.

While the older writers were horrified by the cruelty of West African worship, and could see no motive behind it but blood-lust, Mr. Talbot has much to say of the goodness of the gods and the 'juju,' who act as guardians of society, to whom the oppressed can appeal, and whom the guilty, however rich and powerful, will fear. He does not, however, deny the reality and the extent of these sacrifices, but points out that most of the victims were captives or criminals. In the same way the secret societies, though powers greatly to be feared, also act as police, punishing crime and executing criminals. In respect of the death penalty and human sacrifice, the influence of religious beliefs must be considered, for to the West African life after death is no shadowy possibility, but a reality of which he is convinced. Certainly, life in the spirit world is not so pleasant as life on earth, but reincarnation is part of the general plan, and among most tribes is believed to occur fairly speedily, the only exceptions being persons so evil that the survivors take special measures to prevent their rebirth.

When we consider that these African holocausts were believed to be necessary to the gods in order to ensure the fertility both of man and of the earth itself, and that the price paid by the victims was merely death and rebirth, the motive can no more be attributed purely to blood-lust than that of the Inquisitors who burnt bodies to save souls. Nor can these people be accused of being specially revengeful, for compensation for murder is accepted; among many tribes of the Ibo a woman is handed over, and sometimes after she has borne a child she is allowed to return to her own people. It is not stated that the child is counted as heir to the murdered man, but this is presumably so. But in spite of the real religious background, Mr. Talbot's statements that the Nigerians believe in the doctrine of Karma and the existence of a super-soul should surely be accepted with caution:

"The essential idea appears to be that of a spark of Divinity, or a monad, which exists in a very high spiritual state—with God, as it is put; an Ego, which sends down emanations through various planes and finally on to the earth. This stream of consciousness manifests itself in physical, ethereal, mental, and spiritual bodies by means of which it gains experience and gradually evolves from a condition which, though pure and full of possibilities, was only embryonic, into a developed perfection. There is a general credence among the wise or initiated in the evolution of a man from a stone up to divinity, and it is no doubt partly owing to this cause that the power of metamorphosis is believed in and that so much of the folklore consists of stories in which animals are endowed with almost human attributes. The acceptance of the idea of the immortality of the soul implies also a trust in morality" (vol. 2, p. 279).

It would have been more to the point had the author quoted details in the form of specific actions, ceremonies, and verbal formulæ, in support of these statements, instead of extracts from the writings of Oliver Lodge, MacDougall, and William James. Indeed, his own beliefs appear at times to impede his critical faculty, so anxious is he to give 'explanations' in terms of clairvoyance, spiritualism, metamorphosis, bilocation, and other so-called metapsychic phenomena, for the strange happenings such as communication with the dead, change into were-animals, persons seen at a distance, etc., devoutly believed by the natives to be true, and attested by them in law courts.

According to Mr. Talbot, the complexity of Nigerian culture is due to foreign influence, but on this subject he is very difficult to follow, for he quotes examples impartially from Egypt, Crete, the Hittites, Babylon, Greece and Rome, the Etruscans and Carthaginians, from Crô-Magnon and from Mexico, nor is it clear whether analogous conditions are noted or direct influence inferred. On the other hand, comparatively little attention is paid to contact with the east and north through the great Negro kingdoms of Songhai and Melle. Since Mr. Talbot leans strongly towards foreign

influences, it is a pity that he has not tabulated the intrusive elements in culture and indicated their possible routes.

Apart from these two features and the neglect to separate theory clearly from fact, which may be regarded as blemishes by critically minded readers, these four volumes contain a mass of interesting material, a large proportion obtained at first hand. There are some interesting notes on animal 'affinities' possessed by individuals or families; the correlation of such beliefs to more orthodox totemism, and the part played by re-incarnation in both sets of beliefs, has yet to be worked out in detail. Southern Nigeria would appear to be a fruitful field for research.

The heads of most of the great States are divine or semi-divine personages, hedged about with powerful taboos, while some suffer a ceremonial death—the supreme penalty of divinity—lest they grow feeble and the land suffer accordingly.

The illustrations are excellent, and of unusual interest, especially those of the images of the secret societies, and of monoliths; while the diagrammatic distribution maps, and the tables of customs at the conclusion of most of the chapters, are of great value. B. Z. S.

Theories of Quanta.

The Quantum and its Interpretation. By Prof. H. Stanley Allen. Pp. xiii + 274. (London: Methuen and Co., Ltd., 1928.) 12*s.* 6*d.* net.

IN this book Prof. Stanley Allen gives an account of the quantum as it appears to an experimental physicist with strong theoretical interests. It differs from most books on the subject, first in omitting most of the mathematical proofs, and secondly, in not being confined to those theories which have enjoyed, or are enjoying, the sunshine of orthodox approval. The book is divided into three parts, of which the first—called "Fundamental Facts and Principles"—contains an account of the main facts and ideas in the various departments of physics, including magnetism, where Planck's constant makes its appearance. Prof. Allen has been very successful in giving an account of this work, largely on historical lines, well suited for the numerous students of physics whose mathematics is not strong enough to enable them to follow long calculations without losing the thread.

The only serious criticism one has to make is that it is a little too condensed for a student reading alone. For use in conjunction with lectures or other teaching it is admirable and fills an important gap. Apart from semi-popular works, most existing books are either too mathematical, too detailed, or both, for the average honours student. Prof. Allen explains both the original Sommerfeld quantum notation and the new Landé-Sommerfeld system. So much has been written in the former notation that some reference to it is necessary, but it is to be hoped that the confusion inseparable from two notations will not be continued by the text-books a moment longer than can be helped, now that substantial agreement has been reached.

The second part of the book is of a more speculative nature, and consists largely in an account of some of the more special theories, such as Whittaker's magnetic wheel, and the theory of unit magnetic tubes due largely to Allen himself. The third part is mostly a development of the first, including mention of a wide range of theories. There is a good deal not usually found in text-books, such as, for example, an account of Lewis and Adam's work on the numerical relation between h, c, and e. There is also a brave and not unsuccessful attempt to give a general idea of the matrix theory in its various forms. Indeed, the author has shown throughout great skill in giving the main lines of mathematical arguments without going into details. There is a brief but clear treatment of wave mechanics.

It is naturally the second part of the book which most invites criticism. The theories there described, however successful in their particular spheres, seem unlikely to be able to give a complete explanation of all the varied phenomena which involve Planck's constant. Indeed, from his introductory remarks, the author seems to admit as much, but he claims, and probably rightly, that some of the ideas they contain are likely to find a place in the final theory. This is especially true of the statical theories originally devised to explain chemical combination. The wave theory indeed marks a definite move in this direction, and recent work suggests the hope that we may soon have an adequate theory of at least the simpler molecules. Progress in this direction has suffered from the divergent training of mathematicians and chemists. Comparatively few of the former have been brought into sufficiently close touch with the chemical evidence to appreciate its weight and variety, and the latter do not usually put their theories into a form which lends itself to exact quantitative results. It cannot be too strongly emphasised that the chemical and spectroscopic results are equally important aspects of the same problem. The experience of the last few years has shown that

very varied theories can account for most of the spectroscopic facts with surprising success, and in spite of the triumphs of the wave theory, there is no certainty that the list is exhausted.

Much the same holds on the chemical side. It seems that the data in either branch are of too similar a character to discriminate sharply between a wide range of theories. The wave theory has indeed been much strengthened by predicting the otherwise unexpected diffraction of free electrons, but it should be remembered that the same could have been said of the old orbit theory and the Stern-Gerlach experiment, which is now equally well explained on the wave view. It is a better test of the fundamental truth of a theory that it should cover the simple facts over a wide range than the details of a special branch. The number of separate facts in, for example, spectroscopy, is apt to seem larger than it really is, owing to the enormous wealth of slightly varying examples. One will not feel confident that physics has finished with its period of Central American government by yearly revolution, until the ruling theory draws support from both parties in the State.

Prof. Stanley Allen devotes a chapter to an account of several theories of radiation which have been devised to explain the photo-electric paradox. The theories of guided quanta, propounded in different forms by Sir J. J. Thomson and L. de Broglie, get over the difficulty of reconciling photo-electric and interference phenomena by supposing the quanta to be systems or particles constrained to move along a Poynting vector of the classical wave system. It seems fairly certain that the solution of all problems in which many quanta are concerned can be found by treating the radiation as classical waves, reacting with the atoms in the manner considered by Schrödinger, except that for the interchange of energy between matter and radiation, and conversely, the intensities of the waves must be 'interpreted,' to use Darwin's term, as meaning the probabilities of the presence of a quantum which receives or loses energy as a unit. This purely mathematical treatment does not give any picture of what a quantum is, and it was to satisfy the instinctive desire that most experimental physicists feel for such a picture that the above theories, and the others described by Prof. Stanley Allen, were devised.

The crux is to give a detailed explanation of absorption and emission of radiation. If the theory can also explain the value of the non-dimensional quantity hc/e^2, so much the better. All such models imply the quantum as a 'something,' which must apparently be of small size, moving in a definite path. The best evidence for this is probably the Geiger-Bothe result, which follows immediately if quanta are like the particles of ordinary dynamics, and seems to require very special assumptions on any other view. In addition, most other views would make the conservation of energy only statistically true, and while this would get over certain difficulties, it is not likely to be accepted while any loophole of escape remains.

None of the models considered is completely satisfactory in detail, and many would lead to serious difficulties in other parts of quantum theory. They contain, however, some very promising features, and Prof. Stanley Allen has rendered a valuable service in bringing them together so that their strong and weak points can be compared.

G. P. THOMSON.

The Quest for Life.

Why I Believe in Personal Immortality. By Sir Oliver Lodge. Pp. viii + 152 + 4 plates. (London, Toronto, Melbourne and Sydney: Cassell and Co., Ltd., 1928.) *5s.* net.

THE present volume provides in a brief and concise form an account of the basis of what Sir Oliver Lodge calls his belief in personal immortality. A few new incidents are included for which the author pleads a 'supernormal' interpretation, but taken broadly, there is nothing in these which would compel the acceptance of that interpretation by unbiased minds.

The main point on which the discussion turns is Sir Oliver's view of the brain as the 'organ' of the mind. He conceives the mind or the soul in its early stages as 'unidentified,' by which he means, it would appear, that in this form it possesses none of the attributes of humanity, not having been yet incarnate. The psyche or mind is then imagined as leaking into the body destined to receive it. After a period of incarceration in matter, during which time the material body is used by the mind, the death of the former intervenes, and the now identified soul goes back whence it came, but this time carrying with it all the powers, experiences, and memories accumulated during its earth life. Thus, according to this view, the body is animated by a permanent entity which, seemingly devoid of personality at the beginning, acquires a personality through the hazardous adventure of earthly existence. This remarkable point of view (which certainly seems to add to the problem of life rather than to diminish it) is made

the basis of the now well-known spiritistic theories whereby the animating entities, once they have obtained conscious personalities, are able to maintain contact with one another, normally through the ordinary channels of communication, and supernormally through telepathy and telergy.

When lesions of the brain occur and the character and desires of the patient are altered, it is not, according to Sir Oliver, because the character has 'really' altered, but because the mechanism through which the real character functions is out of gear and deranged. It would thus appear that in accordance with this theory 'souls' and 'minds' are so intimately attached to their bodies that their progress is directly conditioned by them; for, should the mechanism fail to function, then the soul, which depends upon it for those experiences and memories which it is to carry over to its immortality, cannot fulfil what will doubtless be called its destiny, but will remain either wholly or partly unidentified. Indeed, it would seem that it follows from this argument that it is the body and not the soul that is important, since it is only through the body that the soul can function on this, its first personal plane. How far such a doctrine can be said to be more philosophical than the many which have preceded it is open to question, but as a support for so-called psychic phenomena it has decided advantages.

There is nothing in the book concerning these phenomena more startling or evidential than the records of cases published elsewhere. Moreover, Sir Oliver's rather persistent attacks on orthodox scientific caution regarding these occurrences are not justified and are sometimes unfair. The opposition and general disapprobation which Sir Oliver tilts against are not directed against the phenomena, which are admitted by all who have studied the subject, but against the wild interpretation of them and the faulty experimental methods employed in their investigation. Serious inquiry is, in almost every case, hampered by those responsible for the management of mediums, and the position of the scientific man desiring personal experience is often that of a spectator at performances which are mere travesties of scientific inquiries.

Belief in human immortality is not, it would seem, based on the evidential value of alleged psychic phenomena. In the present work Sir Oliver has partially revealed the true basis of his belief. Repelled by the sordid drama of human existence, by its waste, its greed, and its cruelty, his generous nature seeks another world where man's higher attributes may have a better opportunity. The same view has recently been rather pathetically voiced by a writer for whom Sir Oliver contributed a foreword with the statement that he was sure the messages were genuinely received and would be perhaps a help to people in their search for truth about our future state. After describing the glories of the world behind the veil, the writer tells of the mountains, seas, houses, and gardens of that land, but he adds that there are no storms in that country, no dustbins and no sinks! *Fere libenter homines id quod volunt credunt.*

Relativity.

(1) *The Mathematical Theory of Relativity.* By Prof. Th. de Donder. Pp. x + 102. (Cambridge, Mass.: Massachusetts Institute of Technology, 1927.) 2.75 dollars.

(2) *The Einstein Delusion and other Essays.* By L. A. Redman. Pp. 217. (San Francisco: A. M. Robertson, 1926.) 2.50 dollars.

THE two books grouped together in this notice deal with relativity, but in quite different ways, and whilst the first forms a very important contribution to our knowledge of this subject, the second has only an ephemeral interest and can be disposed of quickly. It consists of a series of essays, the principal one dealing with relativity, the rest with various other topics, mainly mechanical. The tone is severely critical and dogmatic to a degree, not at all justified by the knowledge of the subject matter exhibited by the author. It is sufficient to state as an example that, in the essay on relativity, exhaustive reference is made to numerous popular writings on the subject, but scarcely any to the original publications of Einstein himself or his successors. Surely it is not too much to expect that a critic should show some familiarity with original sources, if he wishes his criticisms to be taken seriously.

The first book, by Prof. de Donder, already well known as the author of "La gravifique einsteinienne" and numerous other publications, is based upon a course of ten lectures delivered at the Massachusetts Institute of Technology during the year 1926. Owing to the restricted space at the disposal of the author, the treatment is very concise and makes considerable demands on the previous knowledge of the reader, but the book will make a strong appeal to all those who can follow the argument.

The first four lectures deal with the geometry and kinematics of relativity, and the next four with the development of the fundamental equations

and their application to the mass gravific field, the electromagnetic gravific field and their combination, the electromagnetic mass gravific field. A variational method is used throughout, which constitutes a relativistic generalisation of Hamilton's principle of least action, though in a modified form. The mode of presentation adopted in these chapters offers novel features and advantages from the didactic point of view. The ninth chapter gives applications to restricted relativity, including the determination of the mass formula of the electron, the mechanical force due to the electromagnetic field and the stress and momentum components and energy of that field.

In some respects the tenth chapter on relativistic quantisation is the most important in the book in view of the present state of the quantum theory. The author employs a generalised Hamilton-Jacobi characteristic equation together with a transformation of the characteristic function, analogous to that used by Schrödinger, to derive an invariant quadratic function of the derivatives of a wave function, and by applying his variational method to this invariant deduces a wave equation of a very general type consistent with relativity. By specialising this equation he is able to obtain the fundamental quantisation equation of the point electron, and for a Minkowski field this reduces to Schrödinger's equation. The method is extended to continuous systems, and leads to the interesting result that " Relativity is able, not only to furnish quantisation, but even to show that it is a consequence of the condition of *permanence* of statistical ensembles."

The book is clearly printed and commendably free from misprints, and should be read by every serious student of relativity.

Our Bookshelf.

The Determination of Minerals under the Microscope: with Special Reference to the Interpretation of Interference Phenomena. By Dr. John W. Evans. Pp. xii + 110. (London: Thomas Murby and Co.; New York: D. Van Nostrand Co., 1928.) 7*s.* 6*d.* net.

IN very clear and simple style this book describes the outline to be followed for the complete determination of the optical characters of minerals in thin sections, with some remarks on the application of the same methods to minerals in small grains. The title rightly emphasises the importance attached to the interpretation of interference phenomena, as Chapter vi. on the 'directions image' gives detailed instructions for the determination of optical characters from the interference figures by methods which are neglected altogether in some schools of petrology. The frontispiece gives a good reproduction of the polarisation colour scale seen when a quartz-wedge is viewed between Nicol prisms, both crossed and parallel, as recently published, by Drs. W. R. Jones and A. Brammall. Chapters vii. and viii., on dispersion and 'other determinations,' are less carefully written than the earlier chapters, and the diagrams illustrating the effects of dispersion on the interference figures are liable to be misleading, as it is not clear which of the two kinds of shading used is meant to represent blue colour and which red.

The book is intended primarily for students, and the author has taken great pains to give the student every assistance. It is even explained that ω is called 'omega,' and that "$V_\rho > V_\upsilon$ may be read V rho greater than V upsilon." One hopes that even in these days of non-compulsory Greek this kind of thing is unnecessary. Another attempt to assist the memory of the reader leads the author to speak of crystals as fast and slow instead of negative and positive. This seems an unnecessary departure from a convention which is universal, and is one of the few points of nomenclature in crystal optics on which there is international agreement. The adoption of an analogous device in France to that suggested by the author would lead them to write of positive and negative crystals as 'grands et petits.' These, however, are trivial points. The student equipped with an efficient microscope will find this an admirable laboratory hand-book, and both author and publishers are to be congratulated on its excellence.

Metaphysics and Modern Research. By I. C. Isbyam. With Introduction and Introductory Essay: The Quest of Spiritual Truth, by Louis Zangwill. Pp. xvi + 494. (London: The C. W. Daniel Co., Ltd., 1927.) 15*s.* net.

THIS book is to be welcomed as a definite attempt to estimate the implications of modern research on philosophy. The author claims that his position rests on Plato, Kant, Leibniz, Bergson, and we are certainly in agreement with him when he maintains that recent advance in physical science has weakened materialistic views to an extent not yet generally appreciated. An introductory essay by Louis Zangwill is of special help to the less experienced student in showing him the unexpected paths that have been traversed in the quest of spiritual truth. This treatment is partly historical and has special reference to the philosophers already mentioned.

The work itself really consists of three books—I. "The Ego and Physical Force"; II. "The Ego and Spiritual Truth"; III. "The Self-Seeker and his Search." The argument is sustained largely by duologue, and the position of "I" naturally has to be faced; for surely no philosophical system can ignore the problem of solipsism. An interesting development is the idea of orders of ego, in which Mr. Isbyam postulates ego-entities of the first order—physical force; of the second—the impulse to use it; of the third—the emotions which order these impulses; the fourth order—of

purpose; and the fifth—beauty, love, spirit, truth. There is much in Mr. Isbyam's treatment of happiness as discipline of soul, and we believe that to many his advice will be welcomed, to fix attention on those who, because they harbour the spiritual entities so well, can keep their minds adjusted to the never-ending flux of all existing things, with ardour ever new.

The volume is further enhanced for the non-specialist by the inclusion of two appendices on the principles of relativity and quanta.

H. D. A.

La fabrication chimique de l'or. Par Jollivet Castelot. Texte français (traductions anglaise, allemande, espagnole). Pp. 126. (Douai: Chez l'Auteur, 19 Rue Saint-Jean, 1928.) n.p.

M. JOLLIVET CASTELOT claims to have succeeded in preparing gold by the action of arsenic and antimony sulphides on silver at 500–1100° C. M. A. Ballandras, a chemical engineer, has verified this result, obtaining colour reactions varying from light yellowish-black to peach-pink, a dark-black powder with a green reflection, and glossy flakes capable of taking a high polish. M. L. Outon, a pharmacist, has repeated the experiment with amazing results. All these gentlemen are to be congratulated on their spagyric achievements if not on their perception of the ridiculous—the inventor in particular, since although not unaware of the economic advantages of the reaction, he has confined himself to the simple search for truth. The yield of gold appears a little low, but doubtless could be improved. Modifications consist, for example, in the addition of tellurium or tin. It is somewhat to be regretted that alchemical prowess should be dissipated in the preparation of so inexpensive a material as gold, particularly if its manufacture on the large scale is to be ignored; radium, for example, costs a great deal more, and a catalytic or any other means for its preparation which would eliminate the somewhat tedious cultivation from uranium would be much appreciated. Even the production of any metal, however base, from gold itself would at least have about it an engaging air of novelty. M. Castelot "emits the hypothesis that the arsenic acts as a catalyser and the sulphur as a ferment in the transmutation." Such a statement is indeed amazing; more amazing, perhaps, than M. Castelot would admit.

A. A. E.

The Composition of Water. By Prof. J. R. Partington. (Classics of Scientific Method.) Pp. viii + 106. (London: G. Bell and Sons, Ltd., 1928.) 1*s.* 6*d.*

THE editor of these "Classics of Scientific Method" suggests that "a reader who takes up a volume of the series, dealing with a branch of science of which he is ignorant, will be able, without further aid, to trace the steps by which the human mind has passed from chaotic ignorance to ordered knowledge." The first impression of the reviewer was that this purpose had been admirably fulfilled in Prof. Partington's monograph on "The Composition of Water"; but closer study shows that, in order to make full use of the available material, he has thought it necessary to discuss the phlogiston theory, and to tell the story of the 'water controversy,' in which the question at issue was one of priority between Cavendish, Lavoisier, and James Watt. This policy has reduced the value of the monograph as a guide to 'the man in the street,' who does not want to be dragged up every blind alley that has been entered, even by the most distinguished pioneers. On the other hand, the monograph is an ideal one for the serious student of historical chemistry, since the standard is as high as that of the Alembic Club reprints, but the material is presented in the more attractive form of a continuous illustrated narrative.

Selene: or Sex and the Moon. By Prof. H. Munro Fox. (Psyche Miniatures, General Series No. 15.) Pp. 84. (London: Kegan Paul and Co., Ltd., 1928.) 2*s.* 6*d.* net.

THIS interesting book is written for the general reader with no special knowledge of biology; it is intended to arouse interest as well as to impart information on the subject. Prof. Munro Fox deals with the historical and the mythical aspects of the problem before directing the attention of the reader to authentic cases of animals obeying a lunar rhythm in reproduction.

The accounts of the sea-urchin at Suez and of the Palolo worm of Fiji summarise well what is known to science to-day as regards these two animals; but the treatment of the behaviour of the Californian smelt includes only the work of the Thompsons in 1919 and not of Clark in 1925. Clark showed quite clearly that the Californian smelt is a tidal form, that is, makes two spawning runs each lunar month during the breeding season. The possible causes of the lunar rhythm are discussed, such as tide and moonlight.

Apart from the fact that the references to the Californian smelt are now discredited, the book is worth reading for its lucid and concise exposition of the problem.

Does the Earth Rotate? By William Edgell. Reprint. Pp. 69. (Radstock, Som.: The Author, Westfield House, 1927.) n.p.

THIS book is pure paradox; it takes us back to pre-Copernican days, and asserts that the earth is flat and stationary, with the heavenly bodies within a few thousands of miles of it. Incidentally the author quotes astronomical facts incorrectly, giving the earth's rotational speed as 18 miles a second, that being actually the orbital speed. The difficulties alleged about falling bodies with a moving earth were of course in the minds of thinking men centuries ago, but were completely removed by the discovery of the true laws of force and motion.

The only service the book can do is to direct the attention of teachers to some points that may be difficult to beginners, and lead them to explain these points more fully and clearly.

A. C. D. C.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Monomolecular Films.

IN a recent communication to the Société Française de Physique (*cf. Le Journal de Physique et le Radium*, March, vol. 9, p. 37S; 1928), Mr. H. Devaux describes a continuation of his beautiful work on monomolecular films, in this case for films on mercury. He states that "Dans les cas, très nombreux, où l'on obtient une lame très mince continue, liquide ou solide, on peut tenter la mesure de l'épaisseur minimum réalisable. Cette mesure m'a donné des résultats satisfaisants quand j'employais le benzine comme dissolvant, par exemple pour l'acide abiétique. Au contraire, pour les substances présentées en dissolution dans l'eau j'ai trouvé des lames toujours trop étendues, qui auraient fait attribuer à la substance un diamètre moléculaire très inférieur au diamètre théorique. En voici des exemples :

Lame de saccharose	0,20 à 0,40.10^{-7}	au lieu de	0,73.	diamètre théorique.
Glucose . .	0,14 à 0,21	,,	0,58,	,,
Glycérine . .	0,06 à 0,08	,,	0,50,	,,
Gomme arabique .	1,2 à 1,3	,,	?	

"Résultats analogues avec la dextrine, l'amidon, l'albumine (environ de 1,5.10^{-7}), le tanin, l'acide picrique.

"Il est évident que pour toutes ces substances l'emploi de l'eau avait provoqué l'altération du mercure, de sorte qu'une impureté expérimentale augmentait indûment la surface."

Since 1926 we have been investigating thin films of various substances on mercury, the original object being to obtain further information on the molecular dimensions of cellulose and its derivatives. The investigation was extended to cover other 'high molecular compounds,' and the results seem of sufficient interest to permit brief description of the method and of their relation to Mr. Devaux's conclusions. The method consisted in allowing drops of solutions of the substances of varying concentration to spread on a mercury surface cleaned by the sweeping procedure, the amount of substance being insufficient to cover completely the liquid surface. The film area was developed with talc powder and measured by a planimeter. On plotting the thickness of the film calculated by *assuming* the density of the massive material against concentration, a point is arrived at where this thickness value becomes independent of the concentration (or dilution). The limiting values for cellulose nitrates out of *acetone* were of the order 3 to 5 A. The value found for stearic acid out of ether at 25° was 22 to 24 A., for oleic acid 11·2, for elaidic acid 12·2 A., for *n*-capric acid 13·6 A.

These results indicated that the fatty acids gave values comparable with those obtained by Langmuir, Adam, and others, so that these substances were apparently ordering themselves to oriented monomolecular films, not quite in the closest packing possible, but approaching it. On the other hand, the very low values for the 'high molecular' bodies either mean a casual net-work structure, of great porosity, or a molecular dimension which cannot be the *length* of the molecule, but may be the thickness of a polymeric chain or sheet. The former conclusion is in disagreement with the reproducibility and the behaviour of the films to compression by an encircling oil film. The latter view seems in accord with certain theories at present developing on polymerisation, and with the atom-group orientation theory of colloid micelle formation suggested by one of us in a previous letter to this journal ("The Nature of the Emulsoid Colloid State." S. E. Sheppard, NATURE, Mar. 17, p. 73; 1921).

By the same method we have obtained values of the minimum thickness for proteins out of water of the order 6 to 7 A. This is in good accord with the values for protein films on water obtained by E. Gorter and F. Grendel (*Trans. Farad. Soc.*, **22**, p. 477; 1926).

In view of the similarity of our results in non-aqueous solution to those obtained in aqueous solution, we suggest that Mr. Devaux's results do not necessitate his conclusion, "pour toutes ces substances," etc.

The tendency for strongly bipolar molecules, such as the fatty acids, to end-on orientation, at either a water or mercury surface, need not be expected in more complex bodies, such as the carbohydrates and proteins, which possess a multipolar structure, relative to simple dipoles. This conclusion is not incompatible with Mr. Devaux's suggestions concerning the effect of ionisation, and is in good accord with his remarks in a previous communication (Communication to the Société Française de Physique, Séance du 17 Février, 1928, *Journal de Physique*, p. 34S; 1928) concerning the formation and function of monomolecular films at the surface of living cells. We expect to present this material in conjunction with some work by Mr. A. H. Nietz at the Symposium on Polymerisation of the American Chemical Society in September of this year.

S. E. SHEPPARD.
R. L. KEENAN.

Eastman Kodak Company,
Rochester, N.Y., May 23.

Active Nitrogen.

DR. H. SPONER, in an article published some time ago (*Zeit. f. Phys.*, vol. 34, p. 622; 1925), advanced the hypothesis that active nitrogen is simply an atom of nitrogen, basing her argument on the parallel properties of active nitrogen and active hydrogen. The hypothesis seems to have found favour with many physicists. Now it is known that active hydrogen shows Balmer lines strongly, and if active nitrogen is also atomic in structure, this may also show the lines of atomic nitrogen. In order to test this point we have photographed the spectrum of active nitrogen in the near infra-red, after an exposure of 42 hours on neocyanine plates. A new band system, extending from 7500 A. to 8900 A., has been discovered. The well-known group of lines of atomic nitrogen discovered by C. C. Kiess (*J.O.S.A.*, vol. 11) about the region 8200 A. is absent, though the exposure was long enough to photograph a weaker band in the vicinity.

This new band system photographed by us for the first time in the spectrum of active nitrogen, was first noticed by A. Pfund (*J.O.S.A.*, vol. 9, p. 193) and Coblenz, a few years ago in their investigations of the infra-red radiations of nitrogen by the galvanometric method, and recently Poetkar (*Phys. Rev.*, Dec. 1927) has photographed it by using ordinary nitrogen discharge tubes. We have also obtained these bands in the ordinary discharge tube of nitrogen. There is no doubt that they owe their origin to the N_2-molecule. There are some indications that this band system is present in the solar spectrum, and may provisionally be identified with the band noted by Meggers about 8230 A.; and is due to the absorption of solar light by atmospheric nitrogen. Prof. M. N.

Saha is of opinion that these bands may owe their origin to the transition of the valency electron of one of the atoms to the metastable state ($^4S_2$, $^2D_2$ . . .), and hence they occur in the infra-red. According to Hund and Mullikan, such transitions are not only allowed in the molecular spectra, but also occur very strongly. These bands are therefore presumably analogous to A, B, a bands of oxygen, which are obtained in absorption and must therefore correspond to the forbidden electron transitions of the oxygen atom. But this suggestion can be tested only by a laboratory experiment on the absorption bands of nitrogen. *Without going into details regarding the* nature of active nitrogen, we are inclined to the view that it is a diatomic rather than a monatomic molecule of nitrogen. An attempt is being made to photograph the spectrum of active nitrogen in the Schumann region in search of the resonance lines of nitrogen.

Our attention has been directed to a note of Prof. J. C. McLennan, and Messrs. R. Ruedy and J. M. Anderson, published in NATURE of April 7, on the *spectra excited by active nitrogen*. These authors could easily obtain the lines of zinc and mercury corresponding to 8·4 volts, but were unable to excite the lines of either krypton or xenon. From this fact they conclude that only those substances become luminescent which combine chemically with nitrogen, and hence the activity is to be ascribed to chemiluminescence. We wish to point out that the resonance lines of both krypton and xenon, discovered by G. Hertz (*Naturwiss.*, p. 648 ; 1926) all lie in the Schumann region :

		Resonance Potential.
Krypton	1235·8	9·99
	1164·9	10·66
Xenon	1469·5	8·40
	1295·7	9·53

Prof. McLennan and his collaborators evidently did not work in this region. The next higher group of lines lies in the infra-red, and requires a potential of about 11 volts for excitation. It is not, therefore, surprising if they failed to obtain any impression of these lines on their plates, because on the present-day theories of active nitrogen, it is loaded to an energy content of about 11·4 volts.

We also feel, though here we *tread* on *rather* delicate ground, that the exposure of 12 hours given by these authors was not enough to bring out lines of inert gases if any were present, for they do not seem to have noticed the new band spectrum of active nitrogen in the infra-red, which we have photographed. So that the conclusion of Prof. McLennan and others regarding the chemical origin of the phenomenon associated with active nitrogen does not appear to be quite justified.

P. K. KICHLU.
D. P. ACHARYA.

Department of Physics, Science College,
Patna, India, May 10.

Is Crystal Reflection of X-Rays entirely a Classical Phenomenon ?

ACCORDING to recent papers by Waller (*Phil. Mag.*, **4**, 1228) and Wentzel (*Zeit. f. Phys.*, **43**, 1, and **43**, 779), the regular reflection of X-rays can be treated as a purely classical phenomenon and the modified scattering of the Compton effect can be disregarded. If this is so, then the values of the atomic structure factor for a given atom (or F values) at various angles of reflection have the property that

$$-(1/Z)\sum_{n=1}^{n=\infty}(-1)^n F_n \not> \tfrac{1}{2} \quad . \quad . \quad . \quad (1)$$

where F_n is the F value for the nth order reflection from planes of which the grating space is D, and Z is the number of electrons in the atom. The proof is indicated as follows : Let an electron be at a distance a from the centre of an atom, this centre being in a crystal plane and a being perpendicular to the plane, then (see Compton, " X-Rays and Electrons," p. 121) the structure factor for this electron is $\cos(4\pi a \sin\theta/\lambda)$. If in addition the centre of the atom is vibrating, due to heat motion, and carries the electron with it, the structure factor becomes

$$\exp.(-b\sin^2\theta/\lambda^2)\cos(4\pi a\sin\theta/\lambda).$$

For reflection we have $n\lambda = 2D\sin\theta$, and hence

$$F_n = \exp.(-\alpha n^2)\cos\beta n \quad . \quad . \quad . \quad (2)$$

where $\alpha = b/4D^2$ and $\beta = 2\pi a/D$. Substituting in the left side of (1), the series may be written

$$S = \sum_{n=1}^{n=\infty}[\exp.\{-\alpha(2n-1)^2\}\cos\beta(2n-1) - \exp.\{-\alpha(2n)^2\}\cos\beta(2n)] \quad (3)$$

since Z in this case is unity. By Cauchy's theorem $S \not> I$ where

$$I = \int_0^\infty[\exp.\{-\alpha(2x-1)^2\}\cos\beta(2x-1) - \exp.\{-\alpha(2x)^2\}\cos\beta(2x)]dx. \quad (4)$$

Evidently

$$I = \tfrac{1}{2}\int_0^1 \exp.(-\alpha x^2)\cos\beta x\,dx. \quad . \quad . \quad (5)$$

By the mean value theorem

$$I = \tfrac{1}{2}\exp.(-\alpha u^2)\cos\beta u \quad . \quad . \quad (6)$$

where $0<u<1$. Now $\exp.(-\alpha u^2)<1$ for $\alpha>0$ and $\cos\beta u \not> 1$. Hence $I \not> 1/2$ and also $S \not> 1/2$, so that (1) is proved.

We have plotted the F values as found by Havighurst (*Phys. Rev.*, **28**, 875) for (Na + Cl) against $\sin\theta$ and drawn a smooth curve passing through the experimental F values and through an F value of 28 for $\sin\theta = 0$. For the large angles we have extrapolated to $F=0$ at $\sin\theta = 0{\cdot}81$. We have read off sets of F values for different values of D, that is, for different values of $\sin\theta_1$, the value of $\sin\theta$ for first order reflection and have calculated the values of the left side of (1), which we shall represent by A, for various values of $\sin\theta_1$. We obtain the following table :

$\sin\theta_1$.	A.
0·05	0·497
0·10	0·558
0·126	0·487
0·15	0·430

For $\sin\theta_1 = 0{\cdot}10$, A is definitely greater than 1/2 in opposition to the requirement of the classical theory as given in (1). This matter will be discussed more fully in a paper appearing elsewhere.

G. E. M. JAUNCEY.
W. D. CLAUS.

Washington University,
St. Louis, U.S.A.,
April 25.

The Palæolithic Implements of Sligo, Ireland.

THE communication of Profs. Jones and Boswell in NATURE of June 2 does not, in my opinion, supply good reason for departing from my announced intention to wait until the autumn of this year before replying to criticisms and detailing the geological evidence on which my claim is based. A paper will then be read before the Society of Antiquaries of London. Nevertheless, there are one or two state-

ments in their letter upon which I will briefly comment now.

At Rosses Point, Profs. Jones and Boswell have ascertained, by counting, that there still remain ten slabs of the cherty roof-blocks of large size. They compare this number with the twenty-six slabs of the re-deposited dolomitic floor-stone, and appear to attach importance to the latter's preponderance. Of course there is a preponderance. Furthermore, this preponderance will tend to become greater as time goes on and as more and more of the floor-stone becomes detached and re-deposited by the waves during storms. If Profs. Jones and Boswell were to study my photograph of the site, taken before any of the blocks had been disturbed, they could draw the following section :—

(*a*) Re-deposited dolomitic floor-stone.
(*b*) Collapsed roof-blocks of cherty limestone.
(*c*) Flakes, implements, and cores.
(*d*) Dolomitic floor-stone, *in situ*.
(*e*) Cherty limestone.

Such a section bears an interpretation alternative to that offered by them.

Profs. Jones and Boswell give their opinion that rapid coastal erosion is taking place in the Sligo area, and in support of this contention they instance, on Coney Island, a concrete emplacement now overhanging the cave at the north-west corner of the island, which, they state, once formed the base of a beacon since moved inland owing to encroachment by the sea. If they had sought their facts from the builders (as I have done) they would have ascertained :

1. The emplacement did not serve, and was not intended to serve, as the foundation for a beacon.
2. It was a platform made flat for the use of the men who pump sea-water for the containers of the beacons situated farther inland.
3. The cave was in existence immediately below the emplacement at the time of its building.
4. Poteen used to be made there !

All we can say with certainty is that the front of the cave has given way along a joint-plane subsequent to the building of the emplacement, and that there is no evidence of a recent date for the formation of the cave in question. There have been occasional falls of cliff along the Carboniferous Limestone coast-line of Gower, Wales. But Paviland Cave is palæolithic.

I may say that I have obtained additional archæological and geological evidence in support of my claim, but, with regard to the cultural age of the implements (as I took the opportunity to inform the Royal Irish Academy's delegation in April), it is not improbable that they will prove to be older than originally suggested. The impression I first gained was that the industry should be correlated with the massive Chellean culture stage as typified at Cromer, Norfolk. Though my opinion, in this respect, differs from that of my collaborator, Mr. Reid Moir, the fundamental importance of my claim—*i.e.* to have discovered traces of palæolithic man in Ireland and to have established an inter-glacial period for that country—remains unaffected.

J. P. T. Burchell.

June 6.

The Buoyancy of Whales.

I agree with Sir Sidney Harmer (Nature, May 12, p. 748) that as the whale descends its chest is compressed and the density of its body is consequently increased. It is owing to this very fact (that is, its increased density) that the whale has difficulty in regaining the surface after descending to a great depth, and that there is consequently a limit to the depth to which it can safely descend.

Compression of the chest, however, does not account for all the phenomena. If nothing else took place, the dead whale would float when raised to the surface, and this is not the case, at any rate, not so far as I know. In explaining the facts it seems necessary to postulate the absorption or escape of the lung air. Death being due to asphyxia, as I am about to show, the latter possibility (that is, the escape of the lung air) seems not unlikely.

The whales I spoke of were not allowed to sink to the bottom, but were suspended by the whale-line and were hauled up as soon as possible. In whaling language they 'died on the first harpoon' ; that is to say, were only harpooned once, and after 'sounding' or going vertically down to a great depth, died under water. They doubtless died from drowning or asphyxia, as the whalers say. There is no other way of accounting for their death. The pressure of the water has evidently no injurious effect on them, and the injury done them by the harpoon—at any rate by the hand one—is not serious enough to cause death.

Sometimes, however, the Greenland whale died under water " on the third or fourth harpoon," when it was already far spent and about to receive the *coup de grâce* with the lance. A case of this kind came under my notice in 1886. It is recorded in the *Zoologist* of 1887, p. 97. Briefly, the whale received a fourth gun harpoon, descended a few fathoms, died under water, and floated up dead. Strange to say, it came up tail first. Its death seemed to be due to syncope, and the pressure of the water at the trifling depth at which it died did not seem sufficient to squeeze the air out of it. Consequently it floated up.

Sir Sidney Harmer seems unwilling to believe that whales use their lungs for hydrostatic purposes. I have shown that in recently dead whales the tendency of the body to float or sink depends on the state of the chest and lungs. It seems reasonable to suppose that the same is true during life. To arrive at the truth it is necessary to watch the whale when it is motionless, not when it is swimming about.

I have mentioned that the Greenland whale sometimes lies motionless at the surface with a part of its head above water and with its back awash. Scoresby tells us that when it is extended in this manner it "can sink downwards in the space of five or six seconds or less beyond the reach of its human enemies," and Beale, speaking of the sperm whale, says, "occasionally when suddenly disturbed the whale has the power of sinking quickly and directly downwards in the horizontal position."

In conclusion, I think the air in the lungs of the whales in the intervals between the respirations must be in a state of compression, and that it is owing to this that each time the animal breathes an appearance is produced resembling a puff of steam escaping from a boiler.

R. W. Gray.

Exmouth, May 31.

Physics and Metaphysics.

The writer of the review of " A Short History of Physics " (Nature, May 26) suggests an interesting speculation (p. 824) as to whether the great physical scientists "have not usurped the place of the metaphysicians," since "some modern theories make almost impossible demands upon the imagination of those without more than a fair amount of mathematical knowledge."

On the other hand, Mr. Selby's illuminating summary of "The Quantum Postulate and the

Atomic Theory," p. 828 of the same issue, indicates an interpretation of physical phenomena essentially the same as the older physiological theory of experience. There is nothing metaphysical in the conclusion that the limiting subjective unit is a *minimum sensibile*, for the individuality associated with events is still our three-dimensional brain-consciousness. If there be metaphysical regions, that is, states of energy, beyond or within those we term physical, we should have to evolve finer sense perceptions in order to become aware of them; and what is now hypothetically metaphysical would have become physical. Present interpretations of physical theories, however, do not appear to suggest the possibility of such evolution.

That one state of matter permeates grosser states of lower atomic velocity is a fact quite unrelated to our present powers of sense perception. We can enhance these powers to some extent by means of radio instruments, and experience a vicarious sensation of being in two places at once; but we cannot see *simultaneously inside and around* our physical bodies or the earth, and, therefore, we are unable to know what, if any, is the subjective state of high-power radioactive substances. Absolute permeability, absolute velocity, absolute time or absolute consciousness is as incomprehensible to our present organs of perception as 'absolute size'—a contradiction in terms, for size can relate only to a three-dimensional form of physical matter in space, and particles must become blended with energy at infinity. A formless, synthetic, immaterial substance of absolute and, therefore, ubiquitous density would be a state of absolute subjectivity, 'absolutely' *meta*physical for us.

W. W. L.

May 25.

Activation of Hydrogen by Electric Discharge.

MY attention has just been directed to the correspondence under this heading in NATURE of Jan. 21 and Mar. 10. Dr. Lunt has kindly summarised the experimental evidence which leads to the rejection of explanations of the type proposed by Mr. Glockler, and in this connexion I have nothing to add.

It is important to note, however, that in a large number of experiments, described very briefly at the commencement of my paper and in greater detail in the thesis, no activation could be detected. It appears that evidence of activation may be obtained only when the detecting agent is sufficiently close to the discharge tube and at pressures below about 5 cm. of mercury. Paneth and his co-workers, in a paper published at the same time as mine, also report failure to obtain active hydrogen by many of the methods described in the literature of the subject. It seems probable, indeed, that the greater part of the previous work describing methods of preparation and properties of active hydrogen other than monatomic hydrogen obtained at extremely low pressures may prove to be without value. If this be so, my subsequent experiments, together with those of Dr. E. J. B. Willey, who reports the formation of active hydrogen in the 'condensed' discharge as used for the production of the nitrogen after-glow, constitute the principal evidence for the existence of this substance. Further details concerning the active hydrogen which Dr. Willey has obtained would, therefore, be of great interest.

In the March issue of the *Journal of the American Chemical Society*, Messrs. Smallwood and Urey also describe unsuccessful attempts to prepare active hydrogen by the usual methods. In their paper it is stated that my results are open to criticism on the ground that I did not sufficiently guard against the possibility of sulphur dust being blown back into the discharge. This is incorrect, for adequate precautions were taken to prevent any accident of the nature described.

G. A. ELLIOTT.

Department of Chemistry,
University of Western Australia,
April 28.

Subsidiary Rectangles as Applied to the Formation of Magic Squares.

IN NATURE of Jan. 14 I gave an 'associated' rectangle 8×3, which is the smallest rectangle that will also provide the property, that the diagonals one way also sum to the same amount as the rows. I give below a similar rectangle in the smallest possible numbers (non-consecutive).

In NATURE of Feb. 4 I gave the smallest similar rectangle with consecutive numbers, 9×3 for order 27.

As the diagonal property is not necessary in order 27 with rectangles 9×3, and order 30, with rectangles 10×3, can only be constructed with non-consecutive numbers, order 33, with rectangles 11×3, is the smallest order in which the diagonal property is essential in the rectangles 11×3, with consecutive numbers, for the formation of associated pandiagonals.

I give the three additional rectangles, where in each case the diagonals from left to right sum to the same amount as the rows, and the rectangles are each associated.

8×3

12	20	18	11	3	27	19	2
4	13	23	6	22	5	15	24
26	9	1	25	17	10	8	16

112×42

10×3

20	25	6	2	19	11	15	4	31	27
23	22	14	29	8	24	3	18	10	9
5	1	28	17	21	13	30	26	7	12

160×48

11×3

21	29	26	20	9	1	11	10	12	16	32
28	4	3	7	19	17	15	27	31	30	6
2	18	22	24	23	33	25	14	8	5	13

187×51

J. C. BURNETT.

Barkston,
Nr. Grantham, Lincs,
May 15.

Rainbow Visible after Sunset.

IT may be of interest to record that about sunset on Monday, June 4, there was a fine rainbow here which persisted until the sun was well below the horizon. The last trace of it vanished at $20^h\ 11^m$ G.M.T., at which time the altitude of the true sun was approximately *minus* 1° 30′. Making a generous allowance for refraction, this would still put the upper limb of the apparent sun very appreciably below the horizon. This is perhaps the more remarkable in that there was a low bank of cloud along the western horizon. The great altitude of the top of the bow was very striking, and it did not, of course, reach down to ground level, but faded out at a considerable height, which there was not time to measure. My longitude and latitude were $4^m\ 28^s$ E., 51° 21′ N.

B. M. PEEK.

Gorse Cliff,
Herne, Kent,
June 12.

The Physiological Effects of Flying.[1]

By Group-Captain MARTIN FLACK,
Director of Medical Research, Royal Air Force Medical Service.

THE first observations upon the effects of flying seem to have been made in 1783, when some sheep and fowls were sent up in a balloon to a height of several hundred feet. Apparently, upon its descent, the observers were delighted to find that the aerial flight had induced no ill-effects. In December of this year, however, after an ascent to about 10,000 feet, a human observer is reported to have experienced considerable discomfort from the effects of cold as well as pain in the right ear.

The stimulating effects of low altitudes are recorded in a handbook on aeronautics published in 1786. "The spirits are raised by the purity of the air and rest in a cheerful composure." The author noted that all worries seemed to disappear as if by magic, so that ballooning came to be regarded as having a therapeutic value. This stimulating effect of altitudes up to 10,000 feet is still well known, many pilots stating that they experience a great desire to sing.

Between 1783 and 1903—the date of the first flight of the Wright brothers—the study of the effects of altitude was the chief point of physiological interest in aeronautics; but with the coming of the aeroplane many other problems have come into existence. Of first importance are those connected with the ability of man safely to fly a machine, of which he himself represents at present the controlling and co-ordinating mechanism. In addition, however, we have the question of the effects of flying from the point of view of the ordinary passenger.

As a general rule, passenger flying consists in what is known as 'straight flying,' no 'stunts' or aerial acrobatics being indulged in. The machine takes off, rises to a thousand feet or so, and proceeds direct to its destination. To many, the idea of aerial progress in a state of unstable equilibrium appears fraught with peril compared to usual forms of motion upon the earth's surface. Yet, with the increasing safety of machines, aviation must now be considered little if any more dangerous than motoring, especially in these days of speed and congested traffic. All machines for public transport are most carefully tested and inspected, and designers and constructors of aeroplanes are constantly seeking ways and means of making flying more and more safe.

An opinion as to the security of flying must not be formed from the number of accidents which occur in military flying. Such flying is totally different from civilian flying, involving considerably greater risks. The comparative safety of civilian flying is in part attributable to the careful medical selection of pilots. Pilots are not permitted to carry passengers or goods without the most searching medical examination, and are not passed for service until they have received a certificate of airworthiness in exactly the same manner as the aeroplane itself. The British company, Imperial Airways, Ltd., has recently carried more than 60,000 passengers and flown more than 3 million miles without serious accident. This point is emphasised, because the enjoyment of flying as passenger depends largely as to whether or not the passenger enjoys a feeling of security.

The other chief factor is the state of the atmosphere. If the weather is 'bumpy,' a passenger may become 'air-sick,' more especially when travelling in an enclosed cabin. As with sea-sickness, many people anticipate being 'air-sick,' and in this frame of mind the malady is prone to occur. Save in exceptionally bad weather, there is no reason why the average person should be 'air-sick,' the number of individuals liable to air-sickness being considerably less than those liable to sea-sickness. The best guide as to whether one is liable to air-sickness is previous experience in regard to swings, trains, and scenic railways. Only those who are liable to discomfort nausea on these are likely to suffer from air-sickness. There is no direct connexion between air-sickness and sea-sickness save perhaps that the person who becomes severely and intractably sea-sick is possibly likely to suffer from air-sickness. The subject who is just ordinarily sea-sick will not necessarily be 'air-sick.' The liability to air-sickness among the general population is considerably over-rated. Nor, it must be emphasised, is there any connexion between 'giddiness' when looking down from a height and a liability to 'air-sickness.'

At the heights of average aerial travel, that is, up to five or ten thousand feet, there are no effects from altitude upon the average passenger, nothing beyond a slight deepening of breathing being noticed, frequently attended, as already noted, by an exhilaration which often manifests itself in a desire to sing. Civilian passenger machines do not ascend high enough to induce anything akin to 'mountain sickness,' neither are the average altitudes reached sufficient to induce harm in people who are suffering from lung or heart ailments of such a degree as to enable them to pursue an average everyday life on the ground.

With regard to flying as pilot, various points must be taken into consideration, since it is upon him that the safety of the aeroplane rests.

Simple flying calls for certain co-ordinated limb movements which are initiated as the result of sensory impressions. Of such impressions those of vision are the most important, since without good visual judgment accurate flying is not possible. In fog and cloud flying, a pilot has to rely upon the information obtained from instruments by the use of his eyes. The same is true in a large measure of night flying, although here a certain amount of visual information is generally also available from external sources (horizon, stars, etc.). In all

[1] Substance of two lectures delivered at the Royal Institution on Mar. 22 and 29.

stages of flying experience, therefore, a pilot is dependent upon visual information, gathered either from objects outside or from instruments within the machine. In particular this is true during the stage of training, when all co-ordinated movements are initiated consciously. With growth of experience the pilot derives an increasing amount of information from the nerves of 'deep' sensation, namely, the 'feel' of the control column, rudder bar, and seat, and, as a result, comes in time more or less automatically to initiate the appropriate co-ordinated movements necessary for the accurate control of his machine.

Information is also derived from the 'feel' of the wind and varying air currents upon the face. Auditory sensations, however, do not play a great part in flying, although good hearing is necessary for the correct appreciation of the 'note' of the engine, as well as for the reception of wireless and so forth.

Besides the faculty of correct perception, a pilot must be capable of accurate co-ordinated performance with his limbs as the result of his perception. Delicately co-ordinated movements of arm and leg are necessary for the accurate control of an aeroplane. Some individuals are incapable of achieving this delicacy and are consequently heavy handed or heavy footed, or both. Other individuals are incapable of combining arm and leg movements with sufficient accuracy owing to an inability to perform successfully two relatively simple movements at the same time. The examination of the responses by means of a special apparatus—the Reid apparatus for testing flying aptitude—for the purpose is of great value in ascertaining a pilot's powers of performance.

Lack of aptitude for flying, therefore, may be due either to defective afferent impressions—chiefly from the eyes and the muscles, or to defective co-ordinated movements.

Further, to be a safe pilot, an individual must possess accuracy of judgment and coolness in emergency, also great powers of physical endurance to enable him to withstand high altitudes or long hours, as well as the effects of quick rotary movements in aerobatics and the effects of gravity after diving quickly or when rapidly turning at full speed at a sharp angle.

The effects of altitude call for especial consideration from the point of view of the pilot. In addition to the effects of diminution of oxygen supply, the effects of extreme cold and the actual diminution of the air pressure have to be considered.

The main effects of diminution of pressure in itself are due to the expansion of the air enclosed within the middle ear. This tends to expand as the pressure is reduced, but the pressure of such air is, generally speaking, automatically adjusted by swallowing. Therefore, only subjects suffering from catarrh of the Eustachian tubes leading from the throat to the middle ear are likely to suffer any inconvenience from this cause. The same is true when atmospheric pressure is again increased on coming down from average heights (1000-2000 feet). The movement of swallowing again automatically adjusts the pressure. When descending from greater heights, the increased pressure on the ear drum through the outer ear may be counterbalanced within the middle ear by gently blowing up the ear drums, while holding the nose, by the movements of forced expiration, a device well known to all pilots. Where Eustachian obstruction exists, however, a pilot may suffer considerable inconvenience during descents, especially if undertaken too rapidly. Diminution of pressure also causes any gas within the intestines to expand. Although in some cases this may affect breathing by hampering the action of the diaphragm, generally speaking, as the amount of this gas is not normally large and its expansion induces peristalsis of the bowels, it is soon voided from the body and inconvenience from this cause is rare. The idea that at great heights there is a danger of trouble arising in the body from the release of gases into the blood owing to the diminution of pressure, such as takes place in the diver or compressed air worker, is erroneous. In the case of airmen the diminution of pressure at present is not sufficiently great or rapid to bring about any liberation of gases held in solution in the blood plasma.

Since 1878 it has been known that the chief cause of 'mountain sickness' or 'altitude sickness' is lack of proper oxygenation (anoxæmia) of the body owing to the rarefaction of oxygen in the air breathed. Experiments conducted in rarefaction chambers, as well as at high altitudes, such as Pike's Peak and Monte Rosa and the Andes, have fully proved this point. In respect of life at high altitudes, however, a certain degree of bodily acclimatisation takes place after the first few days, which is not the case in respect of flying. In an aeroplane, the length of stay at high altitudes is not sufficient to induce any acclimatisation, beyond possibly a transitory concentration of the blood plasma. This will be appreciated when it is realised that a man who flies 240 hours yearly in reality only passes 10 days out of 365 reaching and returning from his maximum heights.

In high flying the cause of trouble is the demand by the body for a normal supply of oxygen under conditions where the head of pressure of the 'pressure feed' is failing. At 19,000 feet, although the percentage composition of the air is unaltered, the total atmospheric pressure is only half normal; that is, the pressure which drives the oxygen into the blood is only half the normal, and accordingly the body will receive only half the amount to which it is accustomed—actually less, since here no allowance is made for the pressure of water vapour. The gradual failing of the pressure feed of oxygen to the body with increasing height necessitates deeper and deeper breathing to get in the required amount of oxygen and a proportionately quicker rate of heart beat to keep up the circulation of the blood, which carries the oxygen to the seats of combustion. For this work alone, more and more oxygen is required in an atmosphere in which oxygen is progressively diminishing. This throws a certain strain upon the muscular mechanism of respiration and upon the circulation; a strain

which is increased owing to the relatively immobile position of the pilot. Unless, however, such strain is unduly severe or prolonged, it is readily tolerated by the body up to heights of 18,000 or 19,000 feet, provided that the respiratory and circulatory mechanisms are properly tuned up.

If the embarrassment of the respiration and circulation were the only effects of altitude, then until this became really excessive, the administration of oxygen to pilots, although an advantage as conserving the normal action of the lungs and heart, would not be altogether a necessity. A more subtle, and therefore often a less appreciated, danger exists which renders the administration of oxygen necessary, namely, a dulling of perception and judgment in addition to a gradually increasing general muscular weakness.

This dulling of perception and judgment begins lower, in most people after 12,000 to 15,000 feet. The pilot himself may not be, and usually is not, aware of it, and even possibly has an extra feeling of confidence. This may be exemplified by an observer who, during the War, returned from high flying reconnaissance, thoroughly pleased with himself, only to find later that he had taken 18 photographs on the same plate; and by a pilot, who, meeting enemy aircraft at 19,000 feet, in spite of the protests of his observer, cheerfully waved his hand to them but took no further action. Nearly all pilots notice the tendency to somnolence at high altitudes; many have difficulty in finding their way, being able to see the ground but not to read their maps. As a rule, scout pilots are less affected by altitude than high reconnaissance pilots, since they do not maintain high altitudes for the same length of time. At great heights it takes longer to see, to hear, and to act. The lessening of muscular power is more obvious; most pilots are aware of the difficulty of swinging a gun or even drawing the shutter of the camera at very high altitudes.

With aircraft going possibly to 30,000 feet or more, the danger to the pilot is greatly increased, and the use of oxygen is absolutely necessary. The effects of altitudes of 25,000-28,000 feet have been long known. Glaisher in 1862 noticed that at 26,000 feet, although he could see his instruments, he could not read them. Shortly afterwards he became paralysed in his hands, as did his assistant, who, however, managed to pull the valve rope with his teeth. In 1875 three Frenchmen, Croce, Spinelli, and Tissandier, made their famous ascent, only Tissandier surviving. Although warned of the necessity of using oxygen, they were all paralysed before they realised the necessity of taking it. Tissandier gave a graphic account of his experience, from which the following is quoted: "At 26,000 feet the condition of torpor which comes over one is extraordinary. Body and mind become feebler little by little, gradually and insensibly. There is no suffering. On the contrary, one feels an inward joy. There is no thought of the dangerous position; one rises and is glad to be rising." The balloon ascended to 28,820 feet, and then descended.

Recently, in November 1927, Capt. Gray, of the United States Army Aviation Service, after ascending to 42,470 feet, lost his life during the descent at about 29,000 feet owing to his oxygen running out, probably owing to a miscalculation in the time of climbing and descent.

Oxygen abolishes the troubles of altitude which are due to oxygen want. The man with oxygen perceives and acts far more quickly and accurately than does the man without oxygen. It is for this reason that during the War all long-distance bombers and high photographic aircraft, both enemy and British, were eventually equipped with oxygen apparatus. On such aircraft the use of oxygen is an absolute necessity if really efficient service is to be rendered.

When oxygen is carried it should be used throughout the flight, beginning before the aircraft leaves the ground. It should not be reserved until the individual feels he wants it, since the effects of want of oxygen which matter most are apt to be unnoticed by the individual.

The best method of taking oxygen is by means of a mask. This is more satisfactory than by a pipe, because it ensures a larger amount of the oxygen delivered reaching the lungs; moreover, there is not the same danger of the tube being blocked by frozen condensation, water, or saliva. Further, a mask also protects the face from frostbite. Instead of the usual mask some prefer a combination of mask and pipe, since it can be discarded more quickly should this be necessary.

The advantages derived from the use of oxygen at high altitudes may be summarised as follows:

1. It keeps a man alert and in a condition in which quickness of perception, accuracy of judgment and action are preserved to the full.
2. It gives a man more power to control aircraft, and gives the tactical advantages of height without its disadvantages.
3. It abolishes the disagreeable symptoms—headache, lassitude, etc.—which are so frequently experienced during and after flights at high altitudes.
4. It keeps the heart and respiration efficient for a much longer period and prevents their overstrain.
5. It helps to keep the body warm.

In addition to the effects of oxygen want, the effects of the cold of altitudes must also be borne in mind, since these in themselves tend to throw added strain upon the respiratory and circulatory mechanisms as well as inducing numbness and sensations of fatigue.

For success in flying, therefore, nervous stability, respiratory and circulatory efficiency are essential. It must be recognised that flying, especially military flying, imposes a very definite stress upon the body, especially when flights are made without the aid of oxygen for long periods at relatively high altitudes. When to this is added the stress of offensive and defensive warfare in the air, it is obvious that bodily strain or breakdown as the result of stress is likely to ensue if too prolonged.

The Correlation of Solar and Terrestrial Magnetic Phenomena.

By Prof. SYDNEY CHAPMAN, F.R.S.

SCHWABE'S discovery of the eleven-year sunspot cycle was soon followed by the recognition of a parallel cycle in the variations of the earth's magnetic field. Since then long series of solar and terrestrial observations have been accumulated. Magnetic observations, though still generally made in the manner introduced by Gauss, have been extended widely over the earth, while remarkable developments in the technique of solar observation have provided a wealth of detailed knowledge of solar phenomena. Yet although great advances have been made in establishing correlations between the two sets of data, some of the principal relationships remain obscure, and some important lines of investigation have yet received little attention.

The great complexity of both sets of phenomena accounts for this position of affairs. As regards the magnetic variations, observations over many years had to be collected from numbers of widely separated observatories, each contributing three distinct continuous records (for the three components of magnetic force) before it was possible to grasp the main features of the phenomena, and distinguish between what is characteristic of a general worldwide system, with its intensity waxing and waning more or less as a whole, and what is merely transient and local. As regards observation of the sun, though any terrestrial observatory has the whole solar disc at once in view, it has required the work of generations of observers to afford our present immense but incomplete knowledge of the remarkable happenings over that great surface.

In the detailed study of the relationships between the two groups of phenomena, statistical methods based on the use of the Wolf-Wolfer sunspot numbers have been very fruitful. These numbers characterise the state of the sun's surface on each day in one important respect, namely, the number and area of the dark and relatively cold regions of the surface. Daily areas of the bright patches called faculæ, though available in the volumes of Greenwich observations, have been less used: there is a considerable degree of correlation between them and the sunspot numbers. Such 'daily character' figures for the sun have been compared with magnetic data chosen to represent the character of a day from the magnetic point of view. At first the magnetic data used for this purpose were generally drawn from the records of a single observatory (such as the daily range in the magnetic declination), but the need for some index less dependent on local and accidental changes at a single station gradually became felt. About twenty years ago a scheme was put into operation by which many observatories contribute data on which international daily magnetic character figures are based. These are designed to represent the degree of world-wide magnetic activity or disturbance present on each Greenwich day; they are not founded on any definite physical estimate of the degree of disturbance, but on a general impression of the smoothness or irregularity of the continuous records at each observatory. Attempts have been made, and are continuing, to devise a practicable quantitative method of assigning such figures, but no plan has yet met with general approval.

While the present system certainly has defects, in that in different years, or even in different months of the same year, the same character figure may be used for days experiencing different amounts of disturbance, yet these magnetic figures have proved of great value in the study of solar and terrestrial relationships. The outstanding example of their usefulness is Chree's demonstration, based upon them, of the tendency for unusually quiet or unusually disturbed magnetic conditions to recur after the lapse of one or more solar rotation periods. This 27-day recurrence tendency had been recognised by Maunder (and by some earlier workers), who brought forward very strong evidence in support of it, drawn from the Greenwich records of magnetic storms; but conviction of its reality became general only when Chree's important work confirmed it in an indisputable way.

This recurrence tendency throws light on the failure to find much correlation between the *daily* magnetic character figures and the *daily* sunspot numbers, a failure which at first sight seems remarkable in view of the increase in frequency of magnetic disturbance in years of high sunspottedness. The recurrence tendency, as clearly interpreted by Maunder, shows that the solar agent that produces terrestrial magnetic disturbance must proceed from some limited region of the sun's surface, and travel outwards from the sun in a confined stream, affecting the earth only when it is swept over by the stream, which rotates with the sun (though of course lagging behind the radius through the point of emission). Magnetic disturbance is, therefore, an indication of the impingence upon the earth of some solar emission, which must be of a corpuscular nature; nothing happens when the sun is not emitting the corpuscles, but, equally, nothing happens upon the earth even when the streams are issuing from the sun, except when they chance to encounter the earth. Even if sunspots were the source of such streams, the daily sunspot numbers would not be expected to show a close correlation with the daily magnetic character figures, because a spot contributes to the sunspot number during the whole period of its passage across the visible disc of the sun, whereas the supposed streams issuing from it would appear capable of affecting the earth during at most two or three days.

It is certain, however, that the streams in question do not always issue from sunspots, because magnetic storms are sometimes observed when sunspots have been absent from the sun's disc for some days. Moreover, modern theories of

the sun's atmosphere render it likely that corpuscular emissions are due to a local and temporary rise in the radiation pressure, arising from an unusually bright region of the surface. Pike has shown that a dark region or spot behaves like a centre of attraction rather than of repulsion; chromospheric matter tends to flow towards it and not away from it. This accounts for the arched forms shown by many prominences; it would seem that the apparent attraction of the dark spots, and the deflecting influence of the magnetic fields associated with them, must often prevent the ejection of chromospheric matter right away from the sun. The frequency of such complete expulsion, as judged from the records of magnetic disturbance, is somewhat difficult to explain on the basis of our present knowledge of solar atmospheric conditions; but it would seem likely that bright regions associated either with no dark spots, or with several small dark spots rather than one or two large ones, would offer the most favourable conditions. This inference seems to be in agreement with a recent examination by Greaves and Newton of the solar conditions prevailing at the time of the greatest magnetic storms observed at Greenwich.

Whatever may prove to be the local conditions causing the emission of corpuscular streams from the sun, the emitting regions have the best chance of affecting the earth when they are fairly near the centre of the sun's disc. Consequently, the magnetic character figure for any day is likely to be associated with the presence of bright regions, perhaps of some special type, near the centre of the sun's disc, not necessarily on the same day but rather at a date preceding it, by an interval equal to the time taken for the solar agent to travel from the sun to the earth. The length of this interval is unknown, but there are some grounds, both theoretical and observational, for estimating it as from two to four days. As a means to a clearer understanding of the mode of action of the sun in producing magnetic disturbance, it is desirable to have a new set of solar daily character figures having special reference to the presentation of bright solar regions towards the earth. The Solar Physics Commission of the International Astronomical Union, and the International Research Council's Committee on Solar and Terrestrial Relationships, will discuss this proposal at Leyden in July, and it is to be hoped that some simple scheme will be devised for choosing solar daily character figures which will prove to be more closely correlated than the daily sunspot numbers are with the daily magnetic character figures.

There appears to be need also for a second set of magnetic character figures, or, as it is convenient to term them (to distinguish them from those already assigned under the international scheme), daily magnetic indices. The present character figures represent the degree of magnetic disturbance, but there are daily variations which go on independently, whether disturbance is present or not; the disturbance changes are simply superposed on the other daily changes, which are seen in their pure form on quiet days. For the sake of brevity it is convenient to refer to the two sets of changes, and the corresponding varying magnetic fields, by the symbols D (disturbance) and Sq (the solar diurnal variations seen in isolation on quiet days, though coexisting with disturbance on other days). The D and Sq fields both show a variation of average intensity in rough parallelism with the sunspot cycle, but in most respects they are strikingly different—in their distribution over the earth (and the change in this distribution throughout the year), and in their fortuitous variations of intensity from day to day. The fortuitous variations of intensity of D are represented by the magnetic character figures, but at present we have no index of the day-to-day variations of intensity of the Sq field. In the latter case the range of variation is much less than for magnetic disturbance, but the changes are both interesting and important; as yet very little attention has been given to them. They appear to be correlated only slightly with those of D.

In various papers I have indicated reasons for believing that the D and Sq fields are associated with different types of solar emissions, the variations of which determine the changes of intensity of D and Sq. As already stated, the D variations depend upon the impingence on the earth of corpuscular streams from the sun, while Sq appears to depend on the sun's ultra-violet radiation. In both cases the solar influence is exerted largely by the ionisation which it produces in the earth's outer atmosphere. If this hypothesis is correct, changes in the sun's ultra-violet radiation will affect the intensity of the Sq variations all over the earth. This appears to be the case with the eleven-year changes of average intensity of Sq, and is probably true also for the fortuitous variations, though this has not yet been definitely established. The difference between the nature of the solar influences which determine D and Sq renders natural the contrast between the character and changes of these two magnetic phenomena; it also indicates the desirability of a daily index of the intensity of Sq as well as of disturbance. One immediate application of such indices would be their comparison with the measurements of the sun's ultra-violet radiation which were commenced by Pettit at Mount Wilson in 1924; this work has shown that the radiation may vary considerably from day to day, and there is also an indication of a long period variation following the sunspot cycle. It is important to ascertain how closely the day-to-day variations of this radiation are in agreement with those of Sq.

Many other phenomena which, like Sq, are associated with the upper atmosphere, should also be compared with the variations of Sq as well as of D; among them may be mentioned the zone content, the intensity of the luminosity of the night sky in different spectral regions, and the transmissibility of radio waves of different frequencies. It will also be of interest to examine the correlation between the changes of Sq and D; it may well be that the sun's ultra-violet radiation will show a

close correlation with the sunspot numbers and the proposed new solar character figures for bright regions near the centre of the sun's disc, and that the comparative lack of association between *Sq* and *D*, and the greater range and abruptness of the changes in the latter, are due to the special feature that these depend on the conjunction of the earth with a limited solar stream.

For these reasons it seems likely that in time international co-operation will be desirable to assign to each day a magnetic index referring to the intensity of *Sq* on that day; but before such a proposal can profitably be discussed in detail, preliminary investigations of the *Sq* variations are necessary to ascertain how they affect different magnetic elements and different observatories. Mr. J. M. Stagg is at present co-operating with me in the first of such studies, confined to data from Greenwich and Eskdalemuir, on purely quiet days.

Obituary.

DR. JOHN HORNE, F.R.S.

IT is seldom that the death of a man more than eighty years of age can so truly be described as an irreparable loss to his science as can be said of John Horne, who has passed away with full mental powers and while completing a work on the geology of Scotland, which would no doubt have been a masterly digest of the voluminous and scattered literature, a luminous statement of the problems, and have been inspired by his contagious enthusiasm.

John Horne was born beside the Campsie Fells, near Glasgow, on Jan. 1, 1848. He was educated at the High School and University of Glasgow, but he did not graduate, as at the age of nineteen years, on the establishment of the Scottish Geological Survey in 1867, he was appointed one of the original members of the staff. His life was spent in its service, and after his retirement he often acted as its unofficial adviser.

Horne's two most important contributions to geology were his preparation of the memoir on the geological structure of the North-west Highlands of Scotland, which was written by himself and five colleagues, and the large volume, in collaboration with Peach and Teall, on the Silurian rocks of Scotland (vol. 1, 1899), which described in detail the structure of the Southern Uplands. In both cases Horne convinced Sir Archibald Geikie that Lapworth's interpretations were correct, and thus led to the abandonment of the previously accepted theory of the structure of north-western Scotland and to the scrapping of the Survey maps of large parts of the Southern Uplands.

Horne worked on all branches of Scottish geology. He was probably most interested in the pre-Palæozoic rocks and in glacial problems, and he was the author of the report of the British Association Committee supporting the direct marine origin of the high-level glacial clays at Clava. His greatest single achievement was his administration of the Geological Survey of Scotland from 1901 until 1911. He was a tactful genial chief who gained the enthusiastic support and affection of all his staff; he was an active reformer and secured the great improvement in the Scottish maps by the introduction of colour printing. His success in gaining the confidence of the Scottish coalowners secured for the Survey full and harmonious co-operation with the mining industry. In his association with others he was helped by his keen sense of humour; he had an inexhaustible fund of racy anecdotes, which he told brilliantly. His death will be widely felt as a personal loss, for he had great gifts of friendship. He was respected and beloved by all who knew him well.

The wide recognition of the importance of Dr. Horne's work is shown by his many distinctions. He was elected a fellow of the Royal Society in 1900; he was LL.D. of three Scottish universities; he was president of the Royal Society of Edinburgh (1915-19), president of the Geological Section of the British Association at the Glasgow meeting in 1901, chairman of the council of the Royal Scottish Geographical Society, and he received the Wollaston and Murchison Medals of the Geological Society.

While on the Survey, Horne formed his beautiful and fruitful friendship with B. N. Peach. They first worked together in southern Scotland, but as Horne was dissatisfied with the official treatment of some of their results, he persuaded Peach to join him in some unofficial work; to go as far from Edinburgh as was possible in Scotland, they selected the Orkneys and Shetlands. His literary co-operation with Peach began with short papers in 1880 on the glacial geology of the Orkneys and Shetlands and on the North-west Highlands in 1883; it was continued in important memoirs on the Orkneys and Shetlands and Caithness, the Canonbie coalfield, and the volcanic rocks of the Old Red Sandstone.

According to a popular fallacy, Horne was the patient persevering plodder, whose main usefulness was as the amanuensis of his brilliant associate. Horne brought to the work keen insight, a sound, steady judgment, and powers of searching criticism which he applied remorselessly to every problem on which he worked. He was the leader in their joint work. After their retirement from the Geological Survey, Peach and Horne began together a "Geology of Scotland," which was put aside time after time because Horne would not accept some of Peach's views and could not get a satisfactory statement of his opinion for publication. The book was taken up again after Peach's death two years ago, but the interval has not been sufficient for its completion. The manuscript, it may be hoped, is sufficiently far forward for publication, for it should prove of the greatest value to geology, and a worthy monument to its author.

Horne's name will endure beside those of Lapworth and Judd as the men who, by their accuracy of insight and originality of conception, have left their mark most deeply on Scottish geology.

J. W. GREGORY.

MR. W. E. PLUMMER.

BY the death, on May 22, of Mr. William Edward Plummer, Director of the Liverpool Observatory, at the age of seventy-nine, there passes an astronomer of a bygone generation who did his full share of work for the science. His work lay in various fields, and it was his fortune to be one of the earliest of those who practise the newer astronomy of the photographic plate and its measurement.

Greenwich Observatory has been the nursery of many who have proved to be competent astronomers and have held responsible positions in other British or Colonial observatories, and Plummer was one of these. In 1864, at the age of fifteen, he obtained employment as a computer in the Royal Observatory, and spent four years, doing the routine arithmetic known as reduction of observations, when he was recommended for a post then vacant in Mr. Bishop's observatory at Twickenham. This was a private observatory built by Mr. George Bishop, a successful business man, at his house in Regent's Park, London, made famous in the middle of last century by the labours of Dawes, Hind, and others, whose services he retained consecutively as observers, which on the death of the founder in 1861 was removed to Twickenham by his son George Bishop, junior. In 1853, Hind, who was then in charge and had been specially active in the discovery of minor planets, was appointed Superintendent of the *Nautical Almanac* Office, but he nevertheless continued to exercise a general superintendence of the observatory, the actual observers being in succession Pogson, Vogel, Marth, Talmage, and, after 1868, W. E. Plummer.

Though Hind was then acting in an advisory capacity, it seems evident that Plummer was responsible for the actual conduct of the observatory, and to him, therefore, must be given the credit for the results, though he always acknowledged his indebtedness to Hind for whatever skill he had as an observer. It was an avowed principle of the elder Mr. Bishop that the observatory "should do something," and during Plummer's tenure of office the subject selected was apparently cometary astronomy, and so early as 1870 a paper was contributed to the *Monthly Notices of the Royal Astronomical Society*, "On the Orbit of the Comet of 1683," that Plummer had recomputed from Flamsteed's observations at Hind's suggestion. This was followed by other papers of similar kind, and though the preparation and publication of engraved charts of the stars within 3° of the ecliptic, which had been a staple work of the observatory, was continued, the computation of elements of orbits of comets, ephemerides, and other cometary investigations, formed a large part of Plummer's work during the six years he was at Twickenham.

Mr. Bishop's observatory was closed at the end of 1876, but in 1874, Plummer had been chosen by the Rev. Charles Pritchard, Savilian professor of astronomy at Oxford, as his assistant in the University Observatory which was then being built, his appointment dating from September 1874, though he began to give help on the completion of the establishment earlier. His work at Oxford was naturally the carrying out of the researches initiated and organised by the professor; measures of photographs of the moon, wedge photometry that was used for the determination of the magnitudes of all naked-eye stars from N.P.D. 0° to 100°, which was published as the "Uranometria Nova Oxoniensis," and photographic stellar parallaxes, all of which were pieces of work of a novel kind requiring skill and resource in their prosecution. The last named may be the first research of the modern type which depends on the measurement of photographic plates. He represented the Oxford University Observatory at the meeting of the Permanent Committee of the Astrographic Chart in Paris in 1891, when decisive points for beginning the work were settled.

There is ample evidence of the esteem in which Plummer was held by Prof. Pritchard and how much his work was appreciated. The University of Oxford recognised the value of his services by bestowing on him the honorary degree of M.A. Two rather extensive investigations were made by him and published under his own name whilst at Oxford; in the *Monthly Notices* for February 1881 he discussed the motion of the Companion of Sirius, comparing its observed positions with those given by the orbit predicted from the variations in the position of the primary, and arrived at the conclusion, before suggested, that the small star observed may not be actually the perturbing body; the other was a determination of the solar motion from stellar proper motions, published in vol. 47 of the *Memoirs R.A.S.*, which modified previous results similarly obtained only slightly.

In 1892, the year before Pritchard died, Plummer was invited by the Mersey Docks and Harbour Board to be Director of its observatory at Bidston, Birkenhead, and here he remained until the end of his life. The duties of the post are mainly connected with the needs of the port, and include the determination of time, the testing and rating of chronometers for the mercantile marine, the keeping of meteorological records, and attention to a seismograph. But, besides the instruments that these tasks require, the observatory possesses an 8-inch equatorial, and for many years this was used for the observation of comets as they appeared, of occultations of stars, and for other purposes, but circumstances of the War and Plummer's advanced age prevented such observations recently. He contributed the annual report on cometary astronomy to the *Monthly Notices* up to the year 1912, and wrote papers on the same subject for the local astronomical society, in which he took much interest, being its president for several years. He held the honorary position of reader in astronomy in the University of Liverpool, and

his efforts in the cause of local scientific education received recognition by the award to him of the Kingsley Medal by the Chester Literary and Philosophical Society.

Plummer took an early interest in seismology, and was for many years a member of the Seismological Committee of the British Association. Before the beginning of his final illness, he co-operated actively in the foundation of the Tidal Institute, the work of which is already proving to be of importance.

Mr. Plummer leaves a family of two sons and a daughter: the elder son, Prof. H. C. Plummer, was Royal Astronomer of Ireland in the years 1912-21, and is now professor of mathematics in the Military College of Science, Woolwich.

DR. EDGAR WILLIAM WILLETT, who died at Hartfield, Sussex, on April 12, aged seventy-two years, was a son of the late Mr. Henry Willett of Brighton, and inherited his father's interest in geology. In 1881 he explored the mammal deposit in the Purbeck Beds at Swanage, and read a paper on a jaw of Triconodon to the Geological Society. In 1901 he investigated the occurrence of glossy flint implements in a gravel pit in Savernake Park, and read a paper on the subject to the Royal Anthropological Institute.

WE regret to announce the following deaths:

Mr. Cyrus C. Adams, of New York, geographer and formerly associate editor of the *Bulletin* of the American Geographical Society, aged seventy-eight years.

Dr. Bird T. Baldwin, head of the Iowa Child Welfare Research Station at the University of Iowa, and a past secretary and chairman of Section Q of the American Association for the Advancement of Science, on May 12, aged fifty-three years.

Prof. Gaetano Lanza, Cavaliere dell' Ordine dei Santi Maurizio e Lazzaro, emeritus professor of theoretical and applied mechanics at the Massachusetts Institute of Technology, on Mar. 21, aged seventy-nine years.

Prof. R. Lepetit, president of the Italian Society of Chemical Industry, known for his work on the synthesis of indigo and for the production of 'Italian green,' on Mar. 27, aged sixty-two years.

Prof. I. P. Roberts, formerly professor of agriculture, dean of the New York State College of Agriculture, on Mar. 17, aged ninety-four years.

Dr. Joseph Nelson Rose, associate curator of botany in the U.S. National Museum, an authority on the Cactaceæ and other Mexican and South American plants, on May 4, aged sixty-six years.

Prof. Arthur Schönflies, of the University of Frankfurt on Main, the well-known mathematician, author with Prof. Nernst of "Einführung in die mathematische Behandlung der Naturwissenschaften," which has run into ten editions, on May 27, at the age of seventy-five years.

News and Views.

THE physical inheritance of man having been placed in proper relation to its animal ancestry, Sir Arthur Keith turns to man's mental attributes, and at the University of Manchester on May 9 delivered what may be regarded as a supplement to his British Association address at Leeds. The spiritual characteristics of mankind have always proved the most obstinate to be enrolled under the banner of evolution, and Sir Arthur's frank statement of his conclusions has given rise to much newspaper controversy, some of which scarcely did justice to his views. The Manchester lecture appears under the title "Implications of Darwinism" in the *English Review* for June; but the title might as well have been "The Uniqueness of Man's Spiritual Attributes," for care is taken to show that the crude mental inheritance derived from his animal ancestry is overlaid in man by a more perfected control. It comes to this: that while man's brain, and with it man's mentality, are grounded upon those of his ancestral apes, the balance has been altered by the expansion and finer development of the brain matter, so that what are looked upon as higher centres predominate over the lower or crude animal centres.

SOME of the specific points made by Sir Arthur Keith may be instanced. He rejects duality in the brain: there is here no compound of substance and spirit, but a living organ and its essential manifestation—"mind, spirit, soul are the manifestations of a living brain just as flame is the manifest spirit of a burning candle." Human nature is in its basis animal. There is the same sort of drive induced by the primary instincts of hunger or sex, and the more primitive the race of mankind the more bestial is the response to the urge. But repression is the normal means of human progress, and the higher the stage of civilisation the more the elemental instincts are held in control by the development of the higher powers of reason. Yet a complete rationalising of mankind is impossible and undesirable, since a complete subordination of the primary instincts would mean race suicide. "Our aim should be not to eradicate the animal propensities within us, but to bend them so as to serve best the interests of both individual and country."

ALTHOUGH the British School of Archæology in Jerusalem was established in 1919 only, it has already done much valuable work in archæological exploration. The discovery of the Galilee skull is alone of sufficient importance to justify its existence. It has, however, done much more. As the headquarters of British students and in some sort a centre of British society in Palestine, it has both served science well and also enhanced British prestige among the people in a way that is difficult for those unacquainted with conditions in the Near East to appreciate. Under the Directorship of Prof. John Garstang, the School was also responsible for the functions of a department of antiquities, but the double duties were made distinct in 1926, when a separate organisation for the record and preservation of archæological remains was set up. In the following year the Government grant of £500, upon which the School had been largely dependent, was discontinued. Now, therefore, the School is entirely dependent upon

voluntary subscriptions, and there is considerable danger that its activities may come to an end unless a guarantee can be obtained that an adequate annual sum will be forthcoming. An appeal has been issued asking for a sum of £1150 per annum, but the particulars given in the statement show that this is sufficient for bare maintenance only, and that for anything like effectual performance of its functions, at least £2000 per annum is required. It would be less than creditable to Great Britain if the School of Archæology in a mandated territory, in which other nations maintain centres for organised research, had to be discontinued. Further, Palestine, it is scarcely necessary to point out, is a country not only intrinsically of the greatest archæological and historical importance, but it is one to the culture of which the English-speaking peoples owe much through the traditional position of the Bible in their life and literature. Subscriptions may be sent to the British School of Archæology in Jerusalem, c/o Palestine Exploration Fund, 2 Hinde Street, London, W.1.

FURTHER broadcast messages from General Nobile give an account of the wreck of the *Italia*. The airship appears to have lost buoyancy and descended rapidly, striking the ice. More than half the crew reached the ice in safety, although two were injured. The wreck, with the remaining seven of the crew, was carried onwards. These men are probably on the ice to the east of the main party, but their position is unknown. The greater part of the expedition's stores is with them. Whether the shipwrecked men reach land or remain on the drifting ice, their rescue is not improbable provided they manage to secure food from seals or polar bears. General Nobile, however, seems to lack firearms, and there is no one with the party who is versed in Eskimo methods of hunting. Captain Sir Hubert Wilkins, writing in the *Times*, points out that the expenditure of energy of the shipwrecked men will be small if open water prevents their travelling over the pack and that consequently a small amount of food should suffice. The large aeroplanes now on their way to Spitsbergen will be useful in locating the parties and dropping food and firearms, but a combination of the efforts of ship and dog teams indicates the most likely road to safety.

THE British Non-Ferrous Metals Research Association has just published its eighth Annual Report, from which it appears that its expenditure on experimental work during 1927 amounted to no less than £20,000. As an example of the practical results obtained, the research on lead cable sheathing has led to the discovery of ternary alloys which are greatly superior to the usual sheathing material, and the Post Office has now ordered a new submarine cable to be sheathed with one of them, and manufacturing production has been begun. These new alloys have been protected by patent. The work on alloys suitable for exposure to high temperatures has also made important progress, and is closely connected with an investigation of the causes of wastage of locomotive firebox stays, a subject of great importance to railway engineers. The systematic study of the effect of various impurities on copper, and application of spectroscopic methods to the laboratory analysis of metals and alloys, are among the other interesting subjects of research in hand. It has been the experience of this and other research associations that the direct communication of the results of laboratory research to manufacturers does not always lead to their full utilisation, and it has been found desirable to set up a new Development Section, the function of which is to assist members to apply in their works the scientific results obtained by the investigators. This Section, staffed by qualified men, has already proved a great success, and its work will be followed with interest by all who are concerned with the proper utilisation of the results of science by industry. It is certain that the gap exists, and this effort to bridge it deserves success.

AN earthquake of moderate intensity was recorded at Kew Observatory at 6 hr. 26 min. 18 sec. G.M.T., on June 15. The epicentre was about 7000 miles away, but the initial impulse was too small to give any indication of the bearing. The earthquake that disturbed the greater part of southern Mexico late in the evening of June 16 was registered at Kew Observatory on June 17 at 3 hr. 31 min. 49 sec. G.M.T. The records indicate that the epicentre must have been under the Pacific Ocean off the coast of Mexico (near lat. 15° N. long. 100° W.). The earthquake was evidently of a strength far greater than the first accounts seem to indicate. From the seismogram obtained at the Government station at Tucubaya it is inferred that the epicentre lay 262 miles south-east of Mexico City, and this agrees nearly with the statement that the damage was greatest in the town of Oaxaca, which lies about 230 miles south-east of that city. It is probable, however, that the focus extended a considerable distance to the north-west of Oaxaca, for in Mexico City many lightly constructed houses collapsed and water-pipes burst, while the shock continued of great strength for about four minutes. At the Oxford University Observatory, a great earthquake, with its epicentre 82½° distant and probably in Central America, was recorded at 3.20 A.M. on June 17.

THE Bill to regulate the date of Easter Day and days dependent thereon came before the House of Commons on June 15 and received a third reading. The Bill as it now stands provides that Easter Day shall be the first Sunday after the second Saturday in April in the calendar year next but one after the commencement of the Act and in all subsequent years. A further clause provides that the Bill shall come into operation on a date to be fixed by Order in Council, but not until a draft Order has been approved by both Houses of Parliament.

AT the invitation of the Rector and the Senate, Sir J. C. Bose delivered a series of two lectures before the University of Vienna on June 9–11. The first, on "The Plant as a Sensitive Structure," illustrated by experiments, demonstrated identical physiological mechanism in plants and in animals. The

second, on "The Action of Drugs and Alkaloids on Pulse-Beats of Plant and Animal," was given before members of the Faculty of Medicine, who were greatly interested in the effect of new Indian drugs on the animal heart, demonstrated by the resonant cardiograph, recently constructed at the Bose Institute. Much interest was also shown in the extreme delicacy of a battery of new instruments by which the activities in the interior of the plant may be shown. The infinitesimal contraction recorder measures the contraction of a single cell under stimulation; the pumping action of the active layer in propulsion of sap in plants was visibly demonstrated by an apparatus which magnified invisible cellular pulsations more than a million times. In recognition of the importance of his discoveries in advancing knowledge of plant physiology, Sir J. C. Bose has been elected a foreign member of the Academy of Sciences, Vienna.

PROF. RUGGLES GATES, professor of botany at King's College, London, sails for Canada on June 23 on an expedition down the Mackenzie River. A permit has been received from the Canadian Government to carry on botanical and anthropological investigations in the North-West Territories and Mackenzie River District. He is taking a cinema camera and 3000 feet of film, in addition to photographic apparatus and collecting materials, which will be admitted free of duty. The intention is to compare the flora of this region with the tundra of Russian Lapland, and to make an anthropological study of Eskimo and half-breeds in comparison with the Ojibway Indians of Northern Ontario. It is hoped to include in this study the blood groups, as well as skin, hair, and eye characters. The Royal Botanic Gardens, Kew, is supplying plant-drying apparatus, and the Governor of the Hudson's Bay Company has made a grant towards the expenses of the expedition. Mr. K. Mellanby, a young botanist from Cambridge, will accompany Prof. Ruggles Gates.

IN December last there was published in New York the first number of an illustrated monthly journal bearing the name *Evolution*. It has the active support of the leading biologists of the United States. Its editors announced in the first issue that *Evolution* "will carry the positive message of facts from every field of natural science and leave it to the reader to make his own mental readjustment." A survey of subsequent issues shows that this policy is being successfully carried out by zoologists and anthropologists of the highest standing, and for the modest sum of ten cents the American public can learn what scientific men have to teach concerning man's origin. The chief aim of *Evolution* is to deprive "fundamentalists of having a strategic advantage in their nearness to the public ear, men of science being separated from the masses by their vocabulary, dislike of publicity, and absorption in work." It is, perhaps, too much to hope that this new venture will gain the ear of Fundamentalists, but it will certainly provide its readers with sound science plainly stated, and hence we wish it every success.

IN connexion with the physical and chemical survey of the coal resources of Great Britain, the Department of Scientific and Industrial Research has recently appointed a committee to deal with the South Wales Coalfield. The committee includes representatives of the Monmouthshire and South Wales Coal Owners' Association, the South Wales Institute of Engineers, the Geological Survey of Great Britain, and the Department of Scientific and Industrial Research. Similar regional committees are already at work in Durham and Northumberland, Lancashire and Cheshire, South Yorkshire, Nottinghamshire and Derbyshire, North Staffordshire, and in Scotland. The object of the survey is to investigate the characteristics of the various coal seams with the view of their utilisation to the best advantage. Local laboratories are established in each area for the examination of samples and, when necessary, large scale investigations are carried out at H.M. Fuel Research Station or elsewhere. The work of each committee is to advise as to which seams should be investigated, to recommend what large scale work should be undertaken, and to bring to the Department's notice any problems of particular local interest which may require investigation.

FOR fifty-eight years the Pharmaceutical Society of Great Britain has published annually a *Year-Book of Pharmacy*. The interest taken in pharmaceutical and pharmacological research and the development of the pharmacological activities of the Society, indicated by the recent establishment of pharmacological laboratories, have rendered it desirable that recent work should be published or reviewed more promptly than can be the case with a yearly publication. The Society is therefore issuing a *Quarterly Journal of Pharmacy and Allied Sciences*, incorporating the *Year-Book of Pharmacy*, the first number of which we have recently received. The first 60 pages are occupied by original papers on pharmacology and pharmacy: the remaining 100 pages are devoted to abstracts on the chemistry of drugs, pharmacognosy, pharmacy, pharmacology and therapeutics, clinical tests and new remedies. Among the papers in the first part, the following may be noted: the pharmacological assay of digitalis by different methods, by J. W. Trevan, E. Boock, J. H. Burn, and J. H. Gaddum; a method of assay of the antirachitic vitamin D, by K. H. Coward; the growth-promoting properties of vitamin D, by A. L. Bacharach; strychnine hydrochloride: its composition and solubility, by J. E. Driver and S. P. Thompson: the solubility and rate of solution of arsenious oxide B.P., by G. E. Trease. In her paper Dr. Coward advocates the use of a 'unit' of vitamin D activity: it is suggested that the standard be a stable preparation of irradiated ergosterol, and that 0·0001 mgm. of this preparation be taken as the 'unit.' This quantity will suffice to give healing of rickets in rats maintained on a rachitic diet, when administered to the animals daily for 10 days. The *Journal* should be read by all pharmacists and pharmacologists: it should be especially useful to those interested in the methods of biological assay, which are assuming an increasing importance in pharmacology. We shall await further numbers with interest.

THE King has approved of the following title being taken by the Right Hon. Sir Alfred Mond, Bart.: Baron Melchett of Landford, in the County of Southampton.

THE Institution of Electrical Engineers will hold a conversazione at the Natural History Museum, Cromwell Road, S.W.7, on Thursday July 5, at 8.30 P.M.

PROF. J. C. McLennan, professor of physics in the University of Toronto, will deliver the Bakerian Lecture before the Royal Society on June 28; he will take as his subject "The Aurora and its Spectrum."

THE diploma of honorary membership of the University of Innsbruck has just been conferred on Mrs. Ogilvie Gordon in recognition of her valuable geological researches on the Dolomites of South Tyrol. Mrs. Ogilvie Gordon has also been nominated as an honorary correspondent by the Geological Survey of Austria.

THE appointments to scientific and technical departments made recently by the Secretary of State for the Colonies include a cotton investigator, Mr. T. C. Cairns, and a game ranger, Captain J. Minnery, to Tanganyika Territory; a live-stock officer, Mr. W. D. D. Jardine, to Kenya Colony; an assistant conservator of forests, Mr. D. McIntosh, and an assistant manager, oil palm plantation, Mr. I. G. C. Squire, to Sierra Leone.

THE Albert Medal of the Royal Society of Arts for the current year has been awarded by the Council, with the approval of the president, H.R.H. the Duke of Connaught, to Sir Ernest Rutherford, Cavendish professor of experimental physics in the University of Cambridge, "for his pioneer researches into the structure of matter." The Medal was founded in 1863 as a memorial to Prince Albert, for eighteen years president of the Society, and is awarded each year "for distinguished merit in promoting Arts, Manufactures, and Commerce."

KING Edward's Hospital Fund for London has arranged, by courtesy of a number of firms, a series of visits to factories in and around London which are the sources of many of the amenities of modern life and will be of interest to scientific workers. The programme includes the following works: Osram (General Electric Co., Ltd.) Lamp Works, Brook Green, Hammersmith (June 27); The Gramophone Co., Ltd. ("His Master's Voice"), Hayes, Middlesex (July 4); Kodak, Ltd., Wealdstone, Middlesex (July 11); Messrs. Bryant and May, Ltd., Fairfield Road, Bow (July 18); United Glass Bottle Manufacturers, Ltd., Anchor and Hope Lane, Charlton (July 25); Messrs. J. Lyons and Co., Ltd., Ice and Confectionery Factories, Greenford, Middlesex (July 30 and 31). Full particulars of the visits can be obtained from the secretary of the Fund, 7 Walbrook, E.C.4.

THE Liverpool meeting of the Institute of Metals, to be held on Sept. 4–7, is evidently proving attractive; already more than two hundred members—including many from overseas—have indicated their intention of taking part. The papers to be presented include a valuable series dealing with the die-casting of alloys, as well as the eighth report to the Corrosion Research Committee. A full discussion of corrosion problems will form a feature of the meeting, as is appropriate in a maritime centre such as Liverpool. On July 4 an election of members is taking place in connexion with the Liverpool meeting, full particulars of which can be obtained from Mr. G. Shaw Scott, Secretary, Institute of Metals, 14 Members' Mansions, Westminster, London, S.W.1.

THE Swiss Society of Natural Science is holding its annual conference this year at Lausanne on Aug. 30–Sept. 2. The provisional programme which has been issued announces papers by Prof. E. Bosshard, of Zurich, on chemical industry, its past and future; Prof. C. Schröter, of Zurich, on a journey through Java in 1927; Prof. M. Askonasy, of Genova, on the aims of research on tumours and the results already obtained; and Prof. A. Reymond, of Lausanne, on occult science in antiquity. The proceedings of the meeting will be organised in seventeen sections, covering all branches of science, pharmacy, engineering, the history of medicine and of science, etc. Communications for the sections should be notified to Prof. A. Maillefer, Musée de Botanique, Palais de Rumine, Lausanne, by June 30. Some beautiful and interesting excursions are promised. Full particulars of the meeting can be obtained from the president, Dr. J. Amann, 2 Avenue Rambert, Lausanne.

A recent *Daily Science News Bulletin* issued by Science Service, Washington, D.C., announces a gift by Mr. Jeremiah Milbank of 250,000 dollars for an international research upon infantile paralysis. Dr. William H. Park, of New York University, is chairman of the committee, and the universities of Chicago, Columbia, Harvard, New York, and Brussels, the Lister Institute of London, and the Metropolitan Life Insurance Company, will participate in the work.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A full-time assistant-master for science and mathematics at the London County Council Beaufoy Institute, Prince's Road, Vauxhall, S.E.11—Education Officer (T. 1a), The County Hall, Westminster Bridge, S.E.1 (June 26). An assistant lecturer in physiology and an assistant lecturer in biochemistry at the University of Birmingham—The Secretary, The University, Edmund Street, Birmingham (June 28). A full-time teacher in the mechanical engineering department of Lincoln Technical College—The Principal, The Technical College, Lincoln (June 28). Two lecturers at the Municipal Technical College, Swansea, with qualifications in two of the following three subjects: chemistry, botany, pharmacy—Director of Education, Education Office, Dynevor Place, Swansea (June 28). A full-time assistant lecturer in engineering at the Technical College, Cardiff—The Principal, The Technical College, Cardiff (June 30). Principal of the Wigan and District Mining and Technical College—Registrar, Wigan and District Mining and Technical College, Wigan (June 30). An assistant master at

the Rugby College of Technology and Arts, with good chemistry qualifications and subsidiary physics—The Organiser of Further Education in Rugby, 61 Clifton Road, Rugby (July 4). A lecturer in agricultural zoology at the University College of the South West of England, Exeter (for work jointly with the Seale Hayne Agricultural College, Newton Abbot)—The Registrar, University College, Exeter (July 4). An assistant lecturer in zoology at the University of Birmingham—The Secretary, The University, Edmund Street, Birmingham (July 5). A reader in materia medica and therapeutics at the University of Manchester—The Registrar, The University, Manchester (July 7). A technical officer at the Royal Aircraft Establishment, South Farnborough, for design and experimental work in connexion with electrical equipment for use on aircraft—Chief Superintendent (No. A 282), Royal Aircraft Establishment, South Farnborough, Hants (July 14). Candidates for not less than two vacancies for geologists on the Geological Survey of Great Britain—The Director, Geological Survey and Museum, 28 Jermyn Street, S.W.1 (July 14). A non-established draughtsman in the Ministry of Agriculture and Fisheries—The Secretary, Civil Service Commission, Burlington Gardens, W.1 (July 26). A senior lecturer in physics and applied mathematics at the Huguenot University College, Wellington, C.P., South Africa—The Registrar, Huguenot University College, Wellington, C.P., South Africa (Aug. 31). A professor of mathematics at the University College, Pietermaritzburg—The Registrar, Natal University College, Pietermaritzburg, Natal (Nov. 1). A zoological laboratory steward at University College, Hull—The Secretary, University College, Hull. A full-time science master at the Technical Institute, Tunbridge Wells—Dr. J. Lister, Technical Institute, Tunbridge Wells. Three junior assistants at the Directorate of Ballistics Research, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18. A capable research chemist or physicist in a research laboratory in London—Box No. 71, c/o NATURE Office, St. Martin's Street, W.C.2. A junior assistant at the Directorate of Metallurgical Research, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18.

Our Astronomical Column.

METEORS AND SKJELLERUP'S COMET.—Mr W. F. Denning writes: "The only nights favourable at Bristol for the observations of meteors, possibly connected with Skjellerup's comet, of last December, were June 10 and 11, which provided two excellent opportunities. The cometary orbit, however, approaches the earth's path to the nearest point on about June 7–8, so that this date had passed before the weather permitted suitable watching of the skies. Very few meteors were seen on June 10 and 11, and two only, out of about twelve observed, were directed from the region in which the cometary radiant was placed. There may have occurred a shower on preceding nights, but no information has come to hand with details of successful results, and I fear that none were obtained.

"Four fairly bright meteors were observed at Bristol, and as they may have been recorded elsewhere, I give their apparent paths :—

	G.M.T.	Mag.	From	To
June 10	11.5	1	313° + 69°	23° + 70°
„ „	12.5	Jupiter	325 + 56½	334 + 52
June 11	11.27	Jupiter	243 − 19	234 − 8
„ „	12.10	Jupiter	310 + 32½	308 + 31

The first two were observed by me; the others by an assistant. The radiants of the meteors were probably 251° − 25°, 310° + 62°, 251° − 25°, and 314° + 34°."

COLOUR PHOTOGRAPHY OF THE MOON.—Mr. F. J. Hargreaves, Director of the Photographic section of the B.A.A., was one of the first to obtain successful colour photographs of the moon; these were exhibited at a meeting of the B.A.A. some two years ago, and led to the conclusion that the colour of the greater part of the moon's surface resembles that of a weathered stone wall of a light brown or yellowish tint.

Mr. Hargreaves contributes an article on his photographic methods to the March number of the *Taylor-Hobson Outlook*, illustrated by two photographs; one is of the moon (not coloured) taken with a 6¼-inch mirror and an equivalent focal length of 25 feet; the exposure was 2 seconds; a large amount of detail is visible both in the dark and brighter regions. The other is of the Andromeda nebula, exposure 1½ hours, focal length 20 inches; a good deal of detail is visible, the dark spaces between the whorls of the spiral being plainly discernible. It is noted that the picture of the farther edge of the nebula is some thirty thousand years older than that of the nearer edge.

These pictures are the more creditable in that the mounting of the equatorial is of the simplest character and almost entirely home-made. It will be remembered that the comet Grigg-Skjellerup at its return last year was first detected on Mr. Hargreaves's plates, although the huge instruments at the Yerkes and Bergedorf Observatories were already engaged in the search.

THE DISTANCES OF THE SPIRAL NEBULÆ.—An article by R. Hess in *Astr. Nach.*, 5561, brings out an interesting point regarding Dr. Hubble's estimates of the distances of the spirals. Hubble began by tabulating the apparent and absolute magnitudes of seven objects, including the Andromeda nebula, the two Magellanic clouds, and M 33. He thus deduced the average absolute magnitude of a spiral nebula as −15·0; he used −15·2 in deducing the distances of the fainter spirals from their apparent magnitudes. Mr. Hess points out, however, that in our star system there is a correlation between apparent and absolute magnitude; this feature also appears among the seven objects used for getting the scale; those with fainter apparent magnitude have also fainter absolute magnitude. Thus it is unsafe to use the value −15·2 derived from bright spirals as the correct mean to take for much fainter ones.

Mr. Hess admits that the material is insufficient to obtain the law of correlation, but he has made a preliminary attempt. He gives the following example of its application. Dr. Hubble estimated the distance of spirals of apparent magnitude 16·7 (which need an exposure of an hour with the Mt. Wilson 60-inch reflector) as 80 million light years. Hess's correlation law would reduce this to ten million light years, which would make the distribution of spirals in space some 500 times as dense as Hubble's value. No claim of accuracy is made for the correlation law deduced by Hess, but he seems to be correct in indicating the need for assuming such a law, which would lead to an appreciable diminution of Hubble's estimates for the fainter spirals.

Research Items.

BENGALI MARRIAGE AND COGNATE CUSTOMS.—Mr. M. M. Chatterji has published a number of notes on Bengali customs in the *Journal of the Asiatic Society of Bengal*, vol. 22, N.S., Pt. 6, which for the most part deal with rites and ceremonies connected with marriage. Prostitutes are devoted to their profession by a ceremonial or 'mock' marriage which is intended to preserve the religious purity of the system by an implied consent of the human or inanimate husband. The prostitute bears the mark of vermilion powder on her hair and the iron bangle on her left wrist which distinguish the married woman. The marriage may be with a degraded or pretended Brahman, with an idol, public or private, or with a long-lived shrub such as the tube-rose, of which the preservation becomes an anxious care. Should an idol which has been married be destroyed, as sometimes happens in the case of the private effigy, the surviving wife has to abandon all signs of wifehood. In the initiation into wifehood, on the appearance of the signs of puberty, the woman is segregated, not being allowed to see the sun or a male, in a cell or narrow room formed by a barricade in the corner of a room of two lines of bamboo branches on mud pedestals. She is under the supervision of a board of five women, of whom the chief must be a woman all of whose children are alive or, failing that, whose first-born child is alive. The girl's diet is carefully regulated, consisting mostly of uncooked vegetables and milk and its preparations. An important part of the observance is a bath on the fifth day in the unexcavated tank, which is not a tank but a platform of mud, which also appears in the ante-nuptial bath taken by both bride and bridegroom before marriage, when water is poured over the bathers. In the puberty custom, the girl's companions pelt one another with mud while the girl picks up clams which have been spread out on the bath and water poured over them. This may be regarded as indicating that originally this bath must have taken place in a stream or river.

HOURS OF WORK.—Report No. 47 of the Industrial Fatigue Research Board (London: H.M. Stationery Office), by Dr. Vernon and others, consists of two studies on hours of work, namely, the five-hour spell, and the two-shift system. It is found that the adoption of a rest pause within the 5-hour spell—with opportunity for refreshment—is desirable both for physiological and psychological reasons. The rest pause increases the efficiency of the workers, for, in various occupations the immediate effect of a rest pause was to increase the output. There is, however, a number of semi-continuous occupations where the rest pause is not practicable because the loss of time involved is greater than the nominal rest pause. It is suggested that it might be possible for different groups to take their rest successively. The two-shift system is the centre of much difference of opinion. Contradictory assertions are often made as to the effects of this system, assertions which it is difficult either to prove or disprove. This report is interesting for its negative character. Neither system seemed to show significant differences in any measurable standard, nor was there any difference in sickness. Where either system was in regular operation, workers seemed to adapt their habits and to be satisfied: a change over from one to the other was usually unpopular, and in some cases resulted in a high labour turn-over. The problems involved seemed to be rather of a social character and to be dependent on local conditions.

ANIMAL LIFE IN A PHILIPPINE HOUSE.—The various kinds of animal life that occur in a nipa dwelling-house in the Philippines form the subject of an interesting paper by Dr. F. X. Williams in the *Philippine Journal of Science*, vol. 35, January 1928 (pp. 53-118). During a residence of two and a half years, Dr. Williams has been able to record quite an extensive fauna sharing his dwellings in those islands. Scorpions, spiders, and centipedes are prevalent, and among the latter creatures a large species is recorded which was found in the nest of a sparrow, clinging around the bird's body with its head imbedded in the sparrow's side: the bird, it may be added, died from the attack. Termites are dealt with in some detail, and the author records the behaviour of the predaceous fly *Bengalia*, which he noted seizing these insects and carrying them near by to suck out their body-fluids. An unknown beetle larva living as an ectoparasite of a termite is figured. Wasps, bees, and ants are favourite groups with the author, who records a number of interesting observations on their economy. Among vertebrates, lizards are among the most constant representatives of a tropical house fauna. The so-called 'talking lizard' (*Gecko gecko*) is perhaps more often heard than seen, and is eager to devour such large insects as hawk moths and *Oryctes* beetles, or even small birds and bats. Among birds that live in houses of their own accord, the only truly domiciliary kind is the common sparrow (*Passer montanus*), while bats of several species are more frequent inhabitants.

BRITISH SPECIES OF PROTURA.—The Protura or Myrientomata are very minute, fragile wingless insects which remained unknown to science until the year 1907, when Silvestri erected a separate order for this reception. In the *Entomologist's Monthly Magazine* for May, Mr. H. Womersley describes three new British species of the genus *Acerentomon*, all from the southern counties of England. The descriptions are based upon single examples in each case, and although all three specimens were immature, the characters relied upon are stated to be constant throughout the different instars of any particular species, and are therefore to be considered specific. Mr. Womersley also provides a key to the British members of the order, and enumerates fourteen species up to date, of which eight belong to the genus *Acerentomon* Berl., three to *Acerentulus* Berl., one to *Parentomon* Wom., and two to *Eosentomon* Berl.

OXYGENATION IN RESEARCH.—L. R. Cleveland (*Science*, vol. 63, pp. 168-170; 1928), who by confining termites in oxygen at a pressure of 60 lb. per sq. in. for one hour has removed their protozoa without injuring the termites, suggests that a similar technique may be helpful in other investigations. He points out that it is an important and difficult problem to keep silkworms free from the protozoan *Nosema*, and that possibly by confining the eggs or cocoons of the silkworm in oxygen under pressure, this protozoan menace to the silk industry may be abolished. More than three hundred species of microsporidia, one or more species of the flagellate *Hexamitus*, and two genera of ciliates—*Ichthyophthirius* and *Chilodon*—are parasitic on fishes. It is known that *Hexamitus* can be killed by oxygenation and without the slightest injury to its hosts, and perhaps the other protozoan parasites of fishes as well as the trematode *Gyrodactylus* and the moulds (*Saprolegnia*) may be dealt with in the same way. By confining in oxygen under

pressure insects concerned in the transmission of protozoa, it may be possible to obtain protozoa-free insects required for experimental work, and the method might be helpful in destroying the insects which infest grain and nuts. The fact that different protozoa react differently to oxygen, and that the death points are fairly separated, renders possible the removal of only some of the protozoa while leaving others, and hence observations on how the presence of one protozoan inhibits the multiplication of another. Dr. Cleveland further suggests that many of the examples of symbiosis should be re-investigated, *e.g.* insects with intestinal yeasts, or with intracellular yeasts and bacteria, to ascertain how, if at all, the micro-organisms aid their insect hosts or partners.

SEXUALITY IN THE MYCETOZOA.—The striking differences in structure exhibited by the various stages in the life-history of the slime-fungi have attracted the attention of many investigators, and although sexuality in the group was discovered by Jahn (1911) and recorded for several species, it has been left for Wilson and Cadman to work out a completed sequence of events and publish a detailed description of the whole process (*Trans. R. S. of Edin.*, vol. 55, part 3, No. 24). The complete life-history has been worked out for *Reticularia Lycoperdon* Bull., particular attention being paid to the accompanying cytological changes. This species differs from many others of the group in the absence of myxamœbæ and resting stages such as cysts or sclerotia in the life-history. Spore germination seems to depend on the osmotic pressure exerted by the surrounding liquid, and not on the presence of bacteria. The spores are uninucleate, and on germination give rise to small amœboid masses of protoplasm which pass into the flagellate form. On swarming, these cells withdraw their flagella, and then divide karyokinetically in a transverse plane. After a number of divisions the swarm cells become gametes, which fuse in pairs seemingly accidentally. Before the final fusion of the nuclei of two gametes, other swarm cells, from three to eight in number, are drawn into the fusion cell, the process being regarded by some authorities as 'ingestion,' by others as 'coalescence.' Wilson and Cadman consider the fact that the fusion cell is dominated by a diploid nucleus, and the entering swarm cells by haploid nuclei, constitutes a physiological difference between the two protoplasms sufficient to prevent their coalescing and become one. That this view may be the correct one is suggested by the fact that the nuclei of the entering swarm cells are digested in vacuoles and absorbed.

A BACTERIAL DISEASE OF COTTON.—The bacterial disease of cotton known as Angular Leaf Spot has recently assumed serious proportions in the Sudan. Hitherto, successful methods for its control have not been devised because the conditions for favouring or checking the disease were unknown. It could become prevalent under widely different climatic conditions, varying from desert to wet tropics, and further, its occurrence was independent of air temperature and soil acidity or alkalinity. R. E. Massey, however (*Annals of Botany*, **41**, 497), has demonstrated a close correlation between soil temperature and the incidence of the disease. The experimental work was carried out on seedlings in boxes and also in the field, the temperature readings being taken at a uniform depth of 2 in., namely, that at which the seed is planted. Infection appears to be confined to a definite range of soil temperature. Whereas at 11°·20° C. it is slight, and not usually serious if conditions are favourable for the growth of the seedling, at 21°·26° C. infection is severe. At still higher temperatures, however, the intensity decreases, at 28° C. little or no infection being obtained, and at 30° C. the plant is generally immune. Preliminary experiments were also carried out with artificial inoculation, healthy seedlings being sprayed with water containing a suspension of the bacteria. If a cooling current of air was directed along the spray so that the soil and air temperatures were reduced from 34° to 22° C., marked infection was obtained. This furnished indirect support to Faulwetter's theory that splashing of raindrops was a means of transmission of the disease.

TRIASSIC FAUNA OF NORTH AMERICA.—In a monograph on the Upper Triassic marine invertebrate faunas of North America (*Prof. Paper*, 141, U.S. Geol. Surv.; 1927), J. Perrin Smith gives another instalment of his long-continued researches on the marine Trias. 314 species are described and illustrated by 121 plates. A summary of the geographical relationship of the faunas of the Triassic zones is given, and it is shown that at some periods the American Sea was connected with the Arctic and Oriental, at other times with the Mediterranean Sea. Some of the faunas have a wide distribution; that of the lower Noric coral zone extends from the Mediterranean region to California, and from thence to Alaska and the Himalayas. In all these regions it is characterised by the abundance of reef-building corals related to modern forms, which flourish only where the temperature is not lower than 74° F., and it is probable that this temperature extended up to Alaska. The ammonites form a large part of the Triassic fauna, and according to the author belong to two main stocks only, both descended from Carboniferous goniatites; one from the Gephyroceratidæ, the other from the Gastrioceras branch of the Glyphioceratidæ. In the Upper Trias there are numerous ammonoids showing dwarfed, degenerate, or reversionary characters, suggestive of racial old age.

MAGNETIC DECLINATION TABLES FOR THE MINING INDUSTRY.—For some years past, in response to appeals from mine-surveyors, particulars of the magnetic declination during each week have been supplied to the *Colliery Guardian* for speedy publication. As the usefulness of the data became familiar to surveyors, the need for modifications of the original scheme, and of additions to it, began to be felt. During the past year or more the subject has been much discussed in mining societies and publications, and representative requests for changes in the data supplied have been formulated and communicated to the Government departments concerned. These are the Royal Observatory, Greenwich, which is responsible for what is now the only complete magnetic observatory in southern England, at Abinger; and the Meteorological Office, which is responsible for the magnetic observatory at Eskdalemuir, just north of the Scottish border. Both observatories now provide data for each hour (originally only averages over two hours were published), these being mean values over the interval from one exact Greenwich hour to the next. The declination is given to the nearest half-minute of arc. Moreover, an indication is given, by attached symbols or special type, of the occurrence of unusual variation, within three intervals of range, in the course of any hour. This makes it possible for a surveyor anywhere in England or southern Scotland to form a rather accurate estimate, on any not too disturbed day, of the correction to be applied

to a magnetic bearing for the departure of the declination at that hour from the mean of the day or year. Further, arrangements have been made by which duplicates of the original magnetographs can be purchased from the observatories at a small cost, so that for any special purpose still more accurate knowledge of the changes of declination may be gained than is permitted by the hourly tabulations.

MULLER HOT CATHODE TUBE.—The X-ray tubes made by Messrs. Muller of Hamburg can now be obtained in Great Britain from Messrs. Watson and Sons (Electro-Medical), Ltd., of Sunic House, 43 Parker Street, Kingsway, and are described in a small booklet published by that firm. In these tubes the electrons which constitute the cathode stream are generated by a filament heated by a separate current, as in the more familiar Coolidge tube. The Muller tubes have, however, several distinctive features. The residual gas is helium, which, it is claimed, reduces the chance of molecular collision and also allows of a pure electronic discharge at a higher pressure than is possible with air. In practice, it is found that the helium-filled tube seldom breaks down from perforation. Several of the tubes are constructed on the line-focus principle. The filament of the cathode is so placed that the electrons emitted are projected on to the anode in the form of a line instead of a spot. The anode is made with the surface of the target more nearly at right angles to the incident beam than is usual, so that the line-focus, viewed from the direction of the principal ray of the X-ray beam, appears as a spot. Since X-rays are emitted in uniform intensity over an angle of nearly 180°, this arrangement does not reduce the intensity of the radiation to any extent, whilst the heat of the discharge is distributed over a wider area. Such a line-focus tube can therefore carry a heavier current than the corresponding tube of the ordinary type, without risk of overloading. It is necessary to take particular care in the centring and aligning of tubes of this type, as a loss of detail is noticeable if the tube is rotated to any degree, a loss which may be accompanied by somewhat curious astigmatic effects.

CRYSTAL STRUCTURES OF BENZENE HEXABROMIDE AND HEXACHLORIDE.—Hendricks and Bilicke (1926) showed that benzene hexabromide and hexachloride both have four molecules in the cubic unit of structure. The crystal structure of these compounds is further discussed in the *Journal of the American Chemical Society* for March by R. G. Dickinson and C. Bilicke, who have obtained new X-ray data. The centres of the four molecules in the unit are at points equivalent to either ($\frac{1}{2},\frac{1}{2},\frac{1}{2}$) or (0,0,0), and the six bromine atoms nearest to these points form a regular octahedron or a ring in which the atoms are not coplanar, respectively. Stereochemical considerations favour the latter configuration, since if the cyclohexane ring has its centre at (0,0,0), the halogen atoms fall very nearly in tetrahedral directions from the carbon atoms and at distances of 1.94 A. from them. The configuration of the hexachloride molecule is shown by the experimental data to resemble closely that of the hexabromide.

A QUANTITATIVE STUDY OF THE PHOTOCHEMICAL ACTIVATION OF STEROLS.—Recent discoveries have shown that rickets can be cured by sterols which have previously been exposed to ultra-violet radiation. In the *Journal of the American Chemical Society* for March, R. J. Fosbinder, F. Daniels, and H. Steenbock describe an attempt to determine the amount of energy necessary to secure a definite deposition of calcium in the bones of a rachitic rat. Specially purified cholesterol was used and, after exposure in different parts of the spectrum, was tested physiologically. It was found that only wave-lengths shorter than 313 millimicrons were effective in the process of activation, and with the Hg line at 265 $m\mu$. a minimum energy input of 234 ergs was required to give a positive test. The energy input required increased with the wave-length up to 2730 ergs at 302 $m\mu$. Assuming the Einstein law and the complete utilisation of all the light absorbed for the production of vitamin D, the results indicate that $3\cdot2 \times 10^{13}$ molecules or 2×10^{-8} gm. of vitamin D is sufficient to initiate a cure of rickets. This result may be compared with that of Rosenheim and Webster, who found that 1×10^{-7} gm. of irradiated ergosterol was sufficient to give a positive test. In view of the minuteness of these quantities, it seems impossible to relate the gross chemical or physical properties of the irradiated material with its antirachitic action.

THE ROTATING LOOP WIRELESS BEACON.—The sixth special report of the Radio Research Board, by R. L. Smith-Rose and S. R. Chapman (London: H.M. Stationery Office, 1928. 2*s*. 3*d*. net), describes experiments carried out on a rotating loop beacon transmitter at Fort Monckton, near Gosport. The object of the investigation was to study the performance of the beacon when transmitting over land and sea, and in particular to ascertain the trustworthiness for navigation purposes of radio bearings taken under many different conditions. The experiments were made on board ship at many different distances from the beacon. The inaccuracies were found to be of the same order as those obtained in radio direction finding under the most favourable conditions. Up to distances of 50 miles, both by day and night the readings were sufficiently accurate for navigation purposes. Even at 50 miles the inaccuracy of the great bulk of the observed bearings was less than two degrees. When, however, the waves passed over land, appreciable errors occurred, and so it seems desirable that at least during the night time the path of the transmission should be entirely over the sea. The great advantage of the beacon system is that for reception only an ordinary radio receiving set is required. It is probable, therefore, that the beacon system will prove of great value in marine navigation. Experiments were also made with a closed loop instead of an open aerial, in order to compare the results obtained. The experiments prove that when an aerial is available it is always better to use it. Attempts were also made to improve the sharpness of the signal 'minima' by surrounding the whole of the rotating portion of the beacon by an open wire screen. A slight improvement in the sharpness of the minima was obtained, but it was largely masked by errors due probably to local conditions at Fort Monckton. The screen had certainly no detrimental effect on the radiation. It seems, therefore, that it would be possible to protect a rotating beacon from lightning by enclosing it within a symmetrical screen of vertical wires.

COAL CARBONISATION TESTS.—In amplification of the paragraph on the test of the 'Crozier' retort for low temperature carbonisation in our issue of June 9, p. 921, it may be said that the intermittent operation during the trial was enforced by the lack of electric power supply at Wembley. Although the retort is unsuitable for dealing with caking material, it is designed to deal with shales and lignites, and is claimed to be suitable for some British coals which are not now being carbonised.

Anthropological Research in Australia.

IT was announced in NATURE of Nov. 6, 1926, that the Rockefeller Foundation had made a grant of funds to the Australian National Research Council for anthropological research in Australia and the Pacific. With the help of these funds several important researches have now been carried out.

A systematic attempt is being made to collect as much information as possible about the surviving aborigines of Australia before it is too late. Mr. Wm. Lloyd Warner (University of California) has spent several months amongst the hitherto unknown natives of the north-eastern corner of Arnheim Land, where he has discovered an interesting form of social organisation and a highly elaborate system of totemism. He has now returned to the same region for a second season's work. Miss Ursula McConnel (University of Queensland) has spent some months making investigations amongst the Wikmankan tribe of the Archer River, Gulf of Carpentaria, and she will be continuing her work amongst the same people this year. Dr. A. P. Elkin (Universities of Sydney and London) is studying the natives of the Kimberley District of Western Australia. He has already obtained interesting and important results. His work will be continued for about eighteen months in all. Mr. C. W. M. Hart (University of Sydney) will be at work during 1928 amongst the natives of Melville and Bathurst Islands, North Australia. Mr. Donald F. Thomson (Universities of Melbourne and Sydney) is to spend twelve months amongst the natives of the eastern side of the Cape York Peninsula.

Outside Australia the chief problem that has been taken up has been the investigation of the Polynesian colonies in Melanesia. Mr. H. W. Hogbin (University of Sydney) has paid a short visit to Rennell Island and is now engaged in a systematic study of the people of Ontong Java or Luanuia, an outlying atoll of the Solomon Island group. The inhabitants are Polynesian in language, but have a very distinctive culture of their own, the affinities of which it is not yet possible to determine. Since the group was taken up by Messrs. Lever Bros., the population has decreased with extraordinary rapidity. Of an estimated population of five thousand in 1907, there only survive five hundred and sixty-eight, so that the present study of them is only just in time. Dr. Raymond Firth (Universities of New Zealand and London) left early in May for a year's field work in the outlying island of Tikopia—another of the Polynesian-speaking peoples of Melanesia.

The study of the native peoples of New Guinea is already being carried out by the Government anthropologists of the Territory of Papua and the Mandated Territory of New Guinea, but it is intended to supplement their work with that of special investigators. Mr. R. F. Fortune (Universities of New Zealand and Cambridge) is at present investigating the natives of the D'Entrecasteaux Archipelago.

In all the above-mentioned researches the aim is to study as completely as possible the language and customs of the people investigated. The Australian National Research Council has also provided for certain researches of more limited scope. The University of Adelaide has established a board for anthropological research and has carried out investigations in physical anthropology of the aborigines of South Australia and a study of the aboriginal music of the Arunta tribe. The Department of Physiology of the University of Sydney has initiated a series of investigations, still in progress, which have for their purpose the comparison of the physiology of the Australian aborignes with that of white people in Australia and in Europe. These investigations promise to give interesting results.

Optical Instruments for Research Laboratories and Works.

IT is not given to all men to be able to invent a proverb, but whereas it has been truly said that 'necessity is the mother of invention,' it has been the good fortune of Messrs. Adam Hilger, Ltd., to make invention the mother of necessity. There can be few persons responsible for the equipment of a physical or spectroscopic laboratory who will not realise the necessity of some of the beautiful instruments which have originated in the Hilger workshops.

The last fifteen to twenty years has seen an immense expansion in the range of products of this firm, disregarding the abnormal period of the War, and this growth of activity is reflected in the catalogue recently published.[1] In the early days, however, when the main products were confined to spectroscopic apparatus and optical work, the firm had the wisdom to build on a sound foundation of high quality work, and this reputation of thoroughness and consistency is still deservedly held at the present time. Hilger instruments have been concerned in many of the most important of modern researches, and the firm is entitled to an honourable place in the company of science, for it is true that the design and evolution of an instrument is a matter which often calls for the solution of problems quite as difficult as those in which the use of the finished instrument is employed.

The flattery of imitation cannot make the instrument maker vain; it calls not only for fresh invention but also for a continual improvement of his wares if he is to keep his lead. Of the various instruments wholly or largely originated by Messrs. Hilger, amongst which may be mentioned the group of wave-length spectrometers, the different spectrographs, the 'Twyman' interferometers, and instruments for spectrophotometry, ultra-violet refractometry, and the like, it is of the greatest interest to study the development of some of the leading types. The wave-length spectrometer has not only been greatly improved in convenience and optical performance, particularly in regard to stray light, but also the fundamental ideas in the design have been carried out in monochromators and various specialised forms of spectroscope, and the instruments have been adapted for spectrum photography and physical spectrophotometry.

In the class of spectrographs the new all-metal 'quartz' spectrographs will attract attention. They embody an optical system in which the number of component lenses has been reduced by the employment of aspherical surfaces, and it is claimed that a considerable improvement in the richness of spectrum detail has resulted, together with a possible increase in the range from 2000 A. in the ultra-violet to about 10,000 A. in the infra-red. It has been the general experience that quartz systems made from carefully selected material yield a degree of definition practically unattainable by systems made of glass, so that the performance expected of this instrument will certainly be of a very high order; it should be of great use in trying atmospheric conditions.

The spectrograph of standardised design with inter-

[1] "A General Catalogue of the Manufactures of Adam Hilger, Ltd." Pp. 8+D22+E86+F36+H82+K2+L7+M28+N14+iv. (London: Adam Hilger, Ltd., 1928.)

changeable optical systems is another new venture which should interest those who have no space for a multiplicity of instruments for different purposes, and the possibility of varying the optical and dispersion systems ought to be of the greatest interest to teachers.

Those interested in many recent advances in vacuum spectroscopy, X-ray work, physical photometry, and the like, will find new material of interest. Speaking generally, one great means of securing information about natural objects has been the production of visible pictures due to ordinary light; in this matter the limit of our resources has already been reached in regard to such possibilities as of resolution in microscopy, but when the range of radiation which we can employ for investigation directly or indirectly is extended far beyond the visible limit, our resources are indefinitely increased, and though the difficulties are great they will not be found to be insuperable. Such advances, then, are of fundamental importance.

The extension of so-called 'industrial research' has called for new instrumental developments. The 'Nutting' type of spectrophotometer can now be obtained in the form of a specialised industrial instrument complete in itself; the possibility of maintaining such an equipment in permanent adjustment should be valuable in a laboratory where absorption measurements are becoming of increasing importance in optical methods of control in manufacture. The optical system of the instrument is modified in the latest type by the introduction of a polarising prism into both of the separated beams.

There is still room for a satisfactory spectrophotometer which will produce a matching field of uniform colour without undue loss of light.

Amongst other newcomers to the catalogue we note the 'Mutochrome' and the 'Coverimeter,' names which those unfamiliar with the instruments should find intriguing enough. In the description of the Houston apparatus for investigating colour vision, we are told that a diagram can be produced to describe the colour vision of a subject which states results in 'an absolute manner.' There are not many matters in which Messrs. Hilger need be disillusioned, but this is one of them.

It might almost be considered that such an instrument as a measuring microscope had reached finality in design, but in recent years the present writer has been pointing out in lectures and in a book certain simple principles which should receive attention, although they had evidently been overlooked in many such instruments. It is gratifying to find that these principles have received full attention in a new photo-measuring micrometer of a very attractive design.

The fact that one or more Twyman interferometers will be found in almost every workshop in Messrs. Hilger's factory is a sufficient comment on the value and utility of these instruments. In the production of accurate optical parts for such instruments as these interferometers and the various other forms of interferometer of the Fabry-Perot and Michelson types, optical workmanship must touch the high-water mark of skill.

Work of the types which have been hinted at above means careful individual work. Especially in bringing out a new design for the use of workers in some branch of research, the maker is faced with problems which require time and patience for their solution; perhaps the first models may not meet all practical requirements; development work is essential, and yet in a way it is a 'liability'; it is like the injection of cold feed water into the boiler. The expense of development work must be borne by the better established branches of a business.

Yet there are ways in which such firms as Messrs. Hilger might perhaps make progress. Not for all are the marvels of precision, the charm of all possible refinements of workmanship, materials, and finish. How many of us have not learnt much of our optics with apparatus of the simplest description? On page D.10 we find a student's wave-length spectrometer of a simple type. Is it not possible that with care in design and with suitable choice of materials, a much wider range of apparatus could be made for students' use, which might not satisfy the requirements of research but would prove a godsend to teaching laboratories?

As the makers themselves state, this catalogue contains such instruments as are of most interest to chemists and physicists. The information is clear, precise, and usually sufficient; optical diagrams are given in many instances, and short bibliographies are often included in the descriptions. Special publications deal with particular groups of instruments of more restricted interest. Messrs. Hilger are to be congratulated on this catalogue. L. C. M.

The Etiolation of Shoots for Cuttings.

A RECENT paper by Dr. Edith Smith upon the vegetative propagation of Clematis (*Trans. Roy. Soc. Edinburgh*, **55**, Part 3, 643-664; 1928) again directs attention to the question of the etiolation of shoots used for cuttings. Dr. Smith finds it necessary to modify an earlier statement to the effect that clematis cuttings do not root at the node under ordinary conditions, as in fact many commercial houses still employ nodal cuttings with this plant. Normally, however, cuttings made an inch below a node root more readily. It was found, though, that after previous etiolation the stem rooted readily at the node. In an earlier paper from the Edinburgh Botanic Garden, Reed has described the ready rooting of cuttings of camphor after previous etiolation (*Trans. and Proc. Bot. Soc. Edin.*, **28**, 184-188; 1922-23). Knight and Witt have also rooted shoots of apple and plum more successfully after previous etiolation, and pointed out that in the etiolated shoots the roots did not emerge through the callus as in the normal case, but arose higher up the cutting and emerged through the cortex (*Journal of Pomology*, **6**, 47-60; 1927).

Priestley has described the ready rooting of etiolated shoots of broadbean and pea and correlated this with the development of an endodermis in these shoots upon etiolation (Master's Lectures, *Jour. Roy. Hort. Soc.*, **51**, January 1926). In etiolated apple shoots, however, he found no endodermis, and Knight, Reed, and Smith also do not find an endodermis developed in their etiolation experiments. Smith suggests that etiolation acts in two ways, first by exciting meristematic activity, and secondly by 'softening' the hard tissues of the fibres and the pith.

Probably modern experimental work upon propagation will find this a profitable line of investigation. It is by no means a new one. Goude recently described in the *Gardeners' Chronicle* (Jan. 14, 1928) the method used at the Danish Experiment Station at Blangsted for the successful rooting of scion varieties of apples. The one-year maiden trees are laid down and the lateral shoots earthed up; as these shoots then develop under etiolated conditions a ring of wire is bound tightly around them. Roots later develop above the ring. The same method for preliminary treatment of shoots before they were removed as cuttings was described admirably by Duhamel in "Physique des Arbres" in 1763.

University and Educational Intelligence.

CAMBRIDGE.—Mr. C. Tate Regan, director of the Natural History Museum, and Dr. R. J. Tillyard, chief entomologist to the Commonwealth of Australia, have been elected to honorary fellowships at Queens' College.

Prof. J. B. Buxton has been re-elected into the professorship of animal pathology. Mr. T. G. Room, St. John's College, and Mr. S. W. P. Steer, Christ's College, have been appointed university lecturers in mathematics.

Mr. W. Dawson, Gonville and Caius College, has been appointed to represent the University at the centenary of the College of Forestry, Stockholm, next October.

Mr. C. Forster Cooper has been elected fellow of Trinity Hall; Dr. D. R. Hartree, Christ's College, has been appointed University demonstrator in physics; Dr. F. C. Phillips, Corpus Christi College, has been appointed University demonstrator in mineralogy.

The Tyson Medal in astronomy has been awarded to J. C. P. Miller, Trinity College, and the Mayhew Prize in applied mathematics to M. J. Dean, Trinity College. The Rex Moir Prize in engineering, the John Bernard Seely Prize in aeronautics, and the Ricardo Prize in thermodynamics have all been awarded to H. L. Haslegrave, Trinity Hall.

OXFORD.—In default of other candidates, Viscount Grey of Fallodon, Hon. D.C.L., has been elected Chancellor of the University as from June 16.

The report recently issued of the Delegates of the University Museum directs attention to the completion, during the past year, of the Sir William Dunn School of Pathology, and the new laboratory for teaching and research in biochemistry. Separate reports are included of seventeen scientific departments, in which are given lists of accessions to the various museum collections, and of researches and publications by members of the staff and other workers in each department. The accessions are especially numerous in the collections of the Hope professor of zoology and of the keeper of the Pitt-Rivers Museum.

A proposal has lately been started for the establishment of a club for workers in the departments of the Museum and allied institutions. It is felt that much advantage would result from the provision of more opportunities for intercourse among such workers. The accommodation aimed at is naturally of a kind which it is not within the province of existing college common-rooms to supply.

ON Thursday, June 14, the Duke of Connaught made his first visitation to University College, Southampton, and opened the George Moore Botanical Laboratories. The new buildings have been made possible by a bequest under the will of the late Mr. George Moore, of Southampton, and have been designed by the staff of the College, and particularly Prof. S. Mangham, professor of botany, and Mr. E. E. Mann, lecturer in civil and mechanical engineering. The dimensions of the building are 120 ft. × 30 ft., and it runs east and west, the north side being glazed so far as possible to afford facilities for microscope work. There are two floors. The ground floor provides thirteen rooms, including a theatre, two lecture rooms, library, two laboratories for physiology, and a photographic dark room. The upper floor has seven rooms, including a large elementary laboratory, pathological laboratory, laboratory for advanced work in systematic and structural botany and plant biochemistry, an exhibit room, and the usual preparation rooms. Plant houses, partly glazed with Vita glass, have been built along the south front and western end, and the surrounding grounds will be developed as a botanical garden. In drawing up the plans of the building, full provision has been made for increased accommodation for research work. The Principal of the College stated in his report that the cost of the new building and its equipment was only about £5000. In his address, the Duke of Connaught congratulated the College authorities on their careful management of the College funds, and expressed the hope that further benefactions would be forthcoming to enable the College to develop and to claim full university status.

ABOUT four years ago, Christ's Hospital, Horsham, started training a few of its older boys in practical farming, with the view of their migrating to the Colonies. The scheme is financed by the income of a legacy of about £5000 bequeathed by an old scholar of Christ's Hospital for that purpose. It is now proposed to develop the science teaching at Christ's Hospital by taking in biology, mycology, entomology, and kindred subjects, to help boys to qualify themselves for scientific posts under the Colonial Office. The present accommodation for science teaching at Christ's Hospital is not adequate to modern requirement, and in making the necessary extensions the opportunity is being taken to provide for biological work. The cost of the extensions will exceed £30,000, and since it was felt that the scheme for biological training is of significance far beyond the school itself, an appeal was launched on speech day last year by the then Lord Mayor, Sir Rowland Blades. The Corporation of the City of London responded with a gift of £1050, and other city companies brought the sum up to £6000. The Prince of Wales, who is president of Christ's Hospital, has now given £500. This, with subscriptions from governors and ex-scholars, brings the fund to about £14,200. Extensive additions for science teaching and for practical domestic work, costing about £20,000, are also contemplated at the girls' school of Christ's Hospital at Hertford. The funds at present available will only permit of the commencement of work at the girls' school. We hope that the initiation of the important scheme for biological training at the boys' school will not be long deferred for lack of funds.

THE Educational Colonies and Self-supporting Schools Associations of Great Britain and India are appealing for support in an attempt to embody their ideals in a pioneer colony. The Associations aim at such a reform of existing educational systems as will ensure for each child a thorough training, manual, physical, and scholastic, and maintenance when necessary, to be paid for during or at the completion of the training by a short period of employment that would be profitable both economically and educationally. The plan for the pioneer colony is one which has formed the subject of prolonged inquiry by the "Poverty Problem Study" department of the University of Calcutta and of numerous addresses and brochures by Captain J. W. Petavel, R.E. (retd.), Prof. J. W. Scott, of University College, Cardiff, and others. It combines the principles of the Swiss labour colony of Witzwil with those of the garden city movement and the co-operative movement, and is based largely on the beneficial effects on children of open-air life in rural surroundings with plenty of manual labour under skilful direction, at manifestly productive and therefore interesting tasks. It is described at length in "The Plan of the Educational Colonies Associations" (pp. 288, price 1*s*. 6*d*.). The honorary secretary of the Association in Great Britain is Mr. J. B. Pennington, c/o East India Association, 3 Victoria Street, London, S.W.1.

Calendar of Customs and Festivals.

June 24.

ST. JOHN THE BAPTIST. MIDSUMMER DAY.—A peculiar method of marriage divination recorded for England, in a locality not specified, was that an unmarried woman fasting should set out a table on the eve of St. John with bread, cheese, and ale, and then sit down as if to eat, leaving the street door open. Her future husband would then enter, bow to her, fill a glass of ale, and retire, leaving it on the table.

The sowing of hemp seed to secure the appearance of the lover, which was employed on the eve of St. Agnes, was also used at midsummer. Both processes point to the belief in the activities of spirits at this time, while the former recalls some of the north country wake ceremonies. Similarly, it was possible to foretell death by watching in the churchyard to see at midnight the spirits of those who were to die within the next twelve months. In Wales, if a St. John's wort were named for each person in the house and hung up, the first to wither would indicate who would be the first to die.

Certain herbs, if gathered on midsummer eve, had magical properties, or their magical properties were enhanced; for example, fernseed, which conferred invisibility, the rose, St. John's wort, vervain, trefoil, rue, mugwort, etc. They gave protection against disease or against spirits and witches. Orpine was set in clay on a slate or potsherd, and was called the 'midsummer man.' As the stalk was found next morning to set to right or left, it showed whether the lover would be true or false, a custom suggestive of phallic significance. Many of the customs which are superficially purely divinatory have certainly originated in practices intended to secure the fertility of those taking part. For example, in Greece there was formerly practised a method of divining the name of the future husband with the assistance of apples dropped in a vessel of water fetched by a boy from a spring on St. John's eve.

A closely related custom of Macedonia is called ὁ κλήδονας or κλήδονα, names of which the meaning is connected with 'omen,' but by the peasants, by an association of sound and from a certain feature in the observance, is connected with 'lock.' It, even more than the bonfire, is the most important observance of the feast of St. John. On the eve, plants are marked by the women for gathering next morning, and a brass vessel is prepared with flowers into which each casts a trinket. This is locked with a padlock after it has been filled with water by a boy after due observances at each of three fountains. The vessels are carried in procession through the village on the following day, each being guarded by young men with wooden swords. When the vessel is opened on the following evening, extempore verses prognosticate the fortune of the owners as each trinket is taken out. The frequently ribald character of these verses and the water ceremonial unmistakably point to a fertility rite, while a recent writer has pointed out the significant resemblance of the details to those of Rumanian marriage customs (Beza, "Paganism in Roumanian Folk-lore," p. 54 *sqq.*).

MIDSUMMER FIRES.—The most significant and important observance at midsummer is the survival of the fire festival. The practice of lighting fires on midsummer eve is of wide distribution and great antiquity. As on May Day and other occasions, when similar ceremonial fires are lighted, the people both jump through them themselves and send their cattle through them. King Manasseh, it is recorded in the Old Testament, caused his children to pass through fires in the Valley of Hinnom, and Ovid ("Fasti," iv. 655) refers to the custom of leaping through the fire. Medieval writers speak of the rites of St. John's eve among the Teutonic and Scandinavian peoples, and ascribe to them a pagan origin and a connexion with the sun.

The lighting of midsummer fires, and the practices associated with them more or less common to all, are recorded of the peoples of eastern Europe, of every part of Germany, and Spain, Italy, and Sicily. In France, where in particular pagan customs have lingered side by side with the observances of the Christian Church, they are recorded from many localities, and in Brittany these fires are lit regularly as an accompaniment of the *pardons* which take place around about midsummer. Often the parish priest goes in procession with the crucifix and lights the bonfire with his own hands; otherwise it is usual for them to be lighted after the recital of prayers by an old man. In Upper Brittany the fires were built around a pole which was surmounted by a nosegay or garland supplied by a man named Jean or a woman named Jeanne. Flowers from these garlands were charms against disease, and brands from the fire were a protection against lightning and conflagrations. In some localities in Great Britain the records show that the bonfire was similarly built round a pole surmounted by a garland.

In both Great Britain and Ireland the midsummer fires continued down to recent times. The references of medieval writers show that the fire ritual consisted of three elements—the rolling down a hill of a wheel swathed in straw, to which a light was set; a procession with burning brands around the fields; and the bonfire itself. In the vale of Glamorgan, within living memory, if the wheel burned well until it reached the bottom it was held to foretell a plenteous harvest. In one record quoted by Frazer ("The Golden Bough," x. 103), the wheel was mounted on a pole projecting some three feet on each side, by which it was guided by young men. The aim was to roll the wheel, while it still blazed, into the waters of the Moselle, so as to secure an abundant vintage.

Further examples of the fire festivals in which those elements of the ritual appear have been collected by Frazer in "The Golden Bough," vol. x. From these instances, and more particularly from the form of the belief in the magical efficacy and purificatory powers of the midsummer fires which appears in Morocco, it would seem that the ceremonial is directed towards securing the prosperity of the crops and stock, by protecting them against the evil influences potent at this period. This seems more probable than that it is a survival of sun worship, as was suggested to the older writers by the presence of the wheel, or than that it is an act of worship of Baal, as was indicated by the interpretation of Beltane as Baal or Bel's fire.

June 29.

ST. PETER'S DAY.—Similar observances to those of St. John's eve took place on the eve of St. Peter. In Scotland fires were lighted on the hill-tops, and processions with torches took place. According to an ancient record, the boatmen of Gisborough, in Yorkshire, used to keep festival on this day, decking their boats, painting their masts, and "sprinkling their prows with good liquor." In Wales girls tied a small key on each wrist, and when in bed repeated the sixteenth and seventeenth chapters of Ruth nine times. The future husband would appear to them in a dream, and then the keys fell from their wrists.

Societies and Academies.

LONDON.

Royal Society, June 14.—**A. V. Hill**: (1) Myothermic apparatus. Improvements have made it possible to measure with relative accuracy, in the sartorius of the frog or any similar muscle, not only the heat suddenly produced by a single stimulus, but also that liberated over long intervals at rest or in recovery, or as the result of prolonged discontinuous stimulation. A Zernicke moving-coil galvanometer (Kipp) has been employed. The total heat has been measured from the area of the deflexion-time curve. The temperature of the muscle chamber has been maintained constant within 0·001° C. An 'all-metal' thermopile has been devised which responds quickly and is very completely insulated. A Ringer's solution containing phosphate (7 to 15 mgm. per cent) has led to improved performance in the isolated muscles employed.

(2) The rôle of oxidation in maintaining the dynamic equilibrium of the muscle cell. The resting heat-rate in oxygen of frogs' sartorius muscles agrees with existing determinations of the rate of oxygen consumption. The minimum resting heat-rate in the absence of oxygen is sufficiently accounted for by lactic acid formation. Stimulation produces an immediate increase in the anaerobic resting heat-rate. The total heat in eight hours may be as great as 5 calories per gram of muscle: the maximum rate may be as high as 1·4 calories per gram per hour. Resting anaerobic survival without stimulation leads gradually to the same high heat-rate. The effect of anaerobic stimulation in increasing the resting heat-rate can be reversed, partially or completely, by recovery in oxygen. The possibility of oxidation leads to the inhibition of reactions previously occurring. It is considered that the degenerative changes set up by anaerobic stimulation, or survival, proceed at a rate determined at any moment by the degree of oxygen want. Oxidation at rest is concerned with upholding the integrity of boundaries, or membranes, which are essential if the organised system is not to become a chaos of biochemical processes.

(3) The absolute value of the isometric heat coefficient Tl/H in a muscle twitch and the effect of stimulation and fatigue. Direct observations of T and H give a mean value of the isometric heat coefficient $Tl/H = 6·16$, in close agreement with the value calculated from the lactic acid data of Meyerhof. Previous anaerobic activity, liberating a large fraction of the whole energy available, has little or no effect on the isometric heat coefficient. The effect, if any, is in the direction of a slight reduction; in extreme fatigue, however, the reduction is large. The results, therefore, of chemical studies of muscle (which have necessarily employed a large number of twitches) are applicable directly to a case of a single twitch.

(4) The absence of delayed anaerobic heat in a series of muscle twitches. In a series of muscle twitches, in the absence of oxygen, there is little or no heat production except during the contractions themselves: the 'total' heat is equal to the 'initial' heat. Hence the lactic acid formation—which must be accompanied by heat liberation—occurs entirely during contraction. The contrary conclusion of Embden, Lehnartz, and Hentschel, the experimental base of whose work has been criticised by Meyerhof and Schulz, rests on imperfect reasoning.

(5) The recovery heat-production in oxygen after a series of muscle twitches. The ratio (total heat in oxygen)/(total heat in nitrogen) for the case of a series of twitches, reckoning heat per unit of mechanical response developed, has a mean value of 2·07. This allows us to calculate the 'oxidative quotient for lactic acid,' and the result, 4·81, agrees well with the mean value, 4·7, of Meyerhoff and Schulz, deduced from experiments involving lactic acid and oxygen measurements. The 'isometric heat coefficient' Tl/H is the same in oxygen and in nitrogen, confirming the conclusion of Weizsäcker and others that the initial heat is entirely non-oxidative in nature.

A. V. Hill and **W. Hartree**: (1) The anaerobic delayed heat-production after a tetanus. The supposed long-continued anaerobic delayed heat-production after a tetanus is due to a misinterpretation of the permanent increment in resting heat-rate produced by anaerobic stimulation. Its earlier part is a genuine occurrence, but it is complete within a minute or two. It is very variable in amount, ranging from 5 to 46 per cent of the initial heat. It is probably due to the over-stimulation of some of the fibres of the muscle producing a delayed formation of lactic acid. There is no sign of an endothermic process occurring at any stage in, or after, contraction. A statement by Furusawa and Hartree that in purified nitrogen a muscle becomes gradually inexcitable, as a nerve is known to do, was not confirmed.

(2) Factors determining the maximum work and the mechanical efficiency of muscle. The 'efficiency' of a frog's sartorius muscle has been measured. Its maximum value, as the mean of 56 observations on 21 different animals, is 26 per cent, with an average deviation from the mean of only 2 per cent. This refers to the initial (anaerobic) process only: for the complete cycle (including oxidative recovery) the maximum efficiency is only 12½ per cent. In man the efficiency of muscular movement may be twice as great. In the frog the very low value is due to the extremely expensive nature of the process required per second to maintain a contraction. Contractions of short duration, therefore, are necessary and movement must be rapid. In rapid shortening, however, muscle 'viscosity' plays a very large part in reducing the work done—74 per cent of the mechanical energy of the initial process is degraded into heat. In man the maintenance of a contraction is far less expensive. Consequently, the most efficient contractions are of considerable duration (1·3 seconds) and viscous resistance absorbs a far smaller proportion of the mechanical energy.

C. H. Best and **Ruth Partridge**: The equation of motion of a runner exerting a maximal effort. Experiments in which external resistances of varying magnitude have been applied to a runner show that the maximum speed of the subject is decreased by the amount calculated from the equation of Furusawa, Hill, and Parkinson. This is a satisfactory demonstration that the internal resistance of the muscles is real, in the sense that it has identically the same effect as an external added resistance.

S. Dickinson: Dynamics of bicycle pedalling. The maximum speed of pedalling a bicycle ergometer has been determined as a function of the load applied to the wheel. The relation between maximum speed and load is linear, speed decreasing as load increases, according to equation $P = P_0 (1 - k/t)$, where P is force exerted on pedal crank, P_0, is 'theoretical maximum force' attained only at zero speed, k a 'viscosity' factor, the 'theoretical minimum time,' and t actual time of a single leg movement. The value of k was much the same in all subjects; P_0, the 'strength' factor, varies widely. Bicycle pedalling, like other movements involving external resistance, shows an optimum speed, at which mechanical efficiency is highest.

C. A. Seyler: The Dictyoxylon cortex of Lycopodiales as a constituent of coal. By the metallographic method of polishing and etching, the characters of secondary xylem in transverse, radial, and tangential sections of coal can often be observed. A band of clarain in the Deep Soft seam of the Middle Coal Measures at Grassmoor Colliery, Derbyshire, has been investigated. The band has the structure of a broken network of sclerotic fibres, enclosing in its meshes a thin-walled tissue, and has macroscopic and microscopic characters of a heterogeneous Dictyoxylon periderm.

B. Sahni: On *Clepsydropsis australis*, a Zygopterid tree fern with a *Tempskya*-like false stem, from the Carboniferous Rocks of Australia. Several large specimens of this plant, recently discovered in rocks of the Kuttung Series (Carboniferous) of New South Wales, are described. These specimens reveal an extraordinary type of stem organisation not previously observed in any palæozoic plant. The trunk must have stood upright and attained a considerable height, with a heavy crown of foliage at the top; it was a 'false stem' composed of numerous relatively weak, but erect, repeatedly forked leaf-bearing axes, which were embedded in a dense matrix of adventitious roots and aphlebiæ.

W. O. James: Experimental researches on vegetable assimilation and respiration (19). Carbon dioxide was supplied to *Fontinalis antipyretica*, in solutions with and without bicarbonates. The effect of moving both kinds of solution at different rates past the plant was also observed. Only with relatively rapid movement of the solutions was the assimilation rate independent of the presence of bicarbonate. The results are discussed in relation to the aqueous diffusion of carbon dioxide and its effect on the photosynthetic process.

A. W. Greenwood: Studies on the relation of gonadic structure to plumage characterisation in the domestic fowl (4). In four cases the successful implantation of testicular material from the hen-feathered strain of Campines into castrated Brown Leghorn males produced the normal male head furnishings and behaviour, but did not lead to change in plumage character. These results support Roxas' conclusion that 'hen-feathering' of male in hen-feathered breeds is due to endocrine difference between the two testes. Successful implantation of testis from a Leghorn male into a castrated hen-feathered Campine did not result in change in plumage as would be expected on the basis of the above hypothesis. The failure may have been due to insufficient amount of testis, since it was incapable of inducing normal development of head furnishings.

T. P. Hilditch: Relationships between chemical composition of vegetable seed-fats and their botanical origin. In any one of the four orders, *Palmæ*, *Cruciferæ*, *Umbelliferæ*, and *Myristaceæ*, the composition of the fatty acids of the seed-fats is of the same general type, but each order is marked by definite and specific characteristics in the composition of the fatty acids. Thus the *Palmæ* seed-fats almost always contain 46 to 50 per cent of combined lauric acid, with minor amounts of caprylic, capric, myristic, and palmitic acids and relatively small proportions of oleic acid; in the *Myristaceæ* seed-fats myristic acid predominates; in Cruciferous seeds there is usually 40 to 50 per cent of combined erucic acid, the remainder consisting of oleic and linoleic acids in varying proportions; and finally, Umbelliferous seeds appear to be characterised by the presence of an isomeric form of oleic acid, petroselinic acid (20 to 75 per cent), not yet observed in seed-fats of any other order, except the closely related *Araliaceæ*.

PARIS.

Academy of Sciences, May 21.—Emile Borel: The calculus of probabilities and arithmetic.—**Maurice Hamy**: A comparator, suitable for the measurement of filiform spectra, intended for the determination of the radial velocities of stars. The method is based on the direct comparison of a solar and a stellar spectrogram, both obtained with the same spectrograph and containing the same comparison lines.—**Pierre Termier** and **Eugène Maury**: New geological observations in eastern Corsica: attempt at a tectonic synthesis.—**Louis Roy**: The equations of small movements of elastic surfaces.—**W. A. Tartakowsky**: The determination of the whole of the numbers representable by a positive quadratic form, with more than four variables.—**P. Vincensini**: Certain congruences of normals.—**Calugaréano**: A class of equations of the second order integrable with the aid of polygene functions.—**Vladimir Bernstein**: Some relations between the growth of a holomorph function in a demi-plane and its growth in a series of isolated points.—**Miécislas Biernacki**: The lines of Julia of integral functions.—**J. Delsarte**: A group of functional rotations with one parameter and certain integro-differential equations connected with it.—**Mlle. Nina Bary**: The analytical structure of an arbitrary continuous function.—**D. Pompeiu**: Divergent numerical series.—**Mandelbrojt**: The composition of normal families [of functions].—**J. Haag**: The calculation of certain elastic deformations, with application to the inertia of spirals.—**Benjamin Meisel**: The relative motion of a liquid filling a rotating vessel.—**A. Lambert**: The precision of the measurements and its control in the operation of world longitudes. The differences of longitude adopted for the fundamental stations taken two at a time do not appear to admit of a systematic error of astronomical origin exceeding 0·02 sec., or of radiotelegraphic origin exceeding 0·01 sec.—**A. Danjon**: Polarimetric observations of the Pons-Winnecke comet (1927 *c*). The proportion of light polarised was 0·11. If all the light from the comet had been solar light diffused by a gas, the polarisation would have been 0·8 on June 20 and 0·6 on June 21.—**Henri Mémery**: The low temperatures of the month of May 1928 and diminution of the solar activity. The abnormal cold weather coincided exactly with a marked diminution in the sunspots.—**L. Saint-Antoine**: The dielectric constant of benzil. Fused benzil has a very high dielectric constant (13·04 at 95° C.), which varies rapidly with temperature. This affords an explanation of the exceptional electro-optical properties of benzil.—**Rabinovitch**: Quarter wave-length mica plates.—**Paul Riou** and **P. A. Bérard**: The absorption velocities of sulphur dioxide in alkaline solutions.—**Jean Savard**: The ultra-violet absorption curves of pulegone and isopulegone.—**Mme. Lucie Randoin**: The comparative influence of the lipides and glucides in the food on the evolution of *B*-avitaminosis.—**E. Nicolas** and **J. Lebduska**: The biochemical study of thiourea. Thiourea retards the coagulation of blood *in vitro*; its toxic action is very slight, and less than that of urea.—**Bordier**: Moiré effects are due to the production on the retina of circles of diffusion.—**Marcel Labbé, Floride Nepveux**, and **Hiernaux**: The influence of insulin on the disturbance of lipoid metabolism in severe diabetes.—**L. Mercier**: Three cases of congenital cataract obtained experimentally in the same strain of mice.—**F. Heim de Balsac, E. Agasse-Lafont**, and **A. Feil**: Pneumokoniosis in paving-stone workers.—**C. Kling** and **A. Höjer**: Researches on the mode of propagation of foot-and-mouth disease.—**G. Ramon, R. Martin**, and **A. Laffaille**: Contribution to the study of immunity towards the streptococcus called scarletinous.

Official Publications Received.

BRITISH.

Further Impressions of the Public Library System of the United States of America. By Miss K. E. Overbury and Dr. E. E. Lowe. Pp. 47. (Dunfermline: Carnegie United Kingdom Trust.)

British Research Association for the Woollen and Worsted Industries. Publication No. 94: A Survey of the Production and Utilisation of Wool. By S. G. Barker and Arnold Frobisher. Pp. 10. (Leeds.)

Education, India. Occasional Reports, No. 15: Rural Education in England and the Punjab. By R. Sanderson and J. E. Parkinson. Pp. ii+92. (Calcutta: Government of India Central Publication Branch.) 12 annas; 1s. 3d.

FOREIGN.

Proceedings of the Imperial Academy. Vol. 4, No. 4, April. Pp. xi-xv+187-187. (Tokyo.)

Zoopathologica: Scientific Contributions of the New York Zoological Society on the Diseases of Animals. Vol. 2, No. 1: The Treatment of Fish Diseases. By Ida Mellen. Pp. 31. (New York City.)

The Record of the Celebration of the Two Hundredth Anniversary of the Founding of the American Philosophical Society, held at Philadelphia for Promoting Useful Knowledge, April 27 to April 30, 1927. Proceedings, Vol. 66. Pp. xiii+750. (Philadelphia, Pa.)

CATALOGUES.

Geologie Deutschlands. (Lager-Katalog Nr. 196.) Pp. 290. (Leipzig: Max Weg.)

The Hump Method for the Heat Treatment of Steel. (Catalog No. 90.) Pp. 40. (Philadelphia, Pa.: Leeds and Northrup Co.; Birmingham: The Integra Co., Ltd.)

The Homo Method for the Tempering of Steel. (Catalog No. 93.) Pp. 28. (Philadelphia, Pa.: Leeds and Northrup Co.; Birmingham: The Integra Co., Ltd.)

Diary of Societies.

SATURDAY, JUNE 23.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Newcastle-upon-Tyne), at 2.30.—J. L. Henrard and J. T. Whetton: The Sinking of Londonderry Colliery, Seaham Harbour, Co. Durham, by the Freezing Process.—T. Greenland Davies: Extracts and Recommendations from the Report of the Water Dangers Committee.—Dr. John G. Kellett: The Physical Constitution of Coal and Coal Seams.—Dr. John G. Kellett: The Distribution of Ash in Bituminous Coal Seams.

MINING INSTITUTE OF SCOTLAND (in St. Margaret's Hall, St. Margaret Street, Dunfermline), at 3.—Discussion on David C. Gemmell's Paper on Supporting Underground Roadways with Steel Arches.—Discussion on J. A. Bernard Horsley's Paper on Design and Maintenance of Flame-Proof Enclosures, with Special Reference to Coal Face Machinery.—Discussion on T. A. Southern's Paper on Life Saving in Colliery Explosions and Fires.—John M. Williamson and John Bisland: An Experience of Machine Mining in a Highly Inclined Seam.—George W. Smith: A Trial Bore-Hole for Oil in South Africa and the Results.

PHYSIOLOGICAL SOCIETY (in the Department of Physiology, The University, Sheffield), at 3.—Demonstration by Benedict Finkleman: Preparation for the Measurement of the Excitability of the Cardiac Nerves of the Frog.—Demonstration by M. M. Croll: Specimens Illustrating the Relative Value of Different Methods for Demonstrating Nerve Fibres in the Pituitary.—F. R. Curtis and J. W. Pickering: The Effect of Pituitary Fractions on the Blood.—F. R. Curtis: The Action of Ephedrine and some of its Derivatives.—R. K. Christie and F. R. Curtis: The Effect of Ephedrine and its Derivatives on the Blood-Sugar.—John Freud: Biological Action of Iodides.—K. Furusawa: A Note on the Total Depolarisation of Crustacean Nerve.—M. Rabinovich: A Smooth Muscle Vagus Nerve Preparation.—W. Hartree and A. V. Hill: The Maximum Mechanical Efficiency of Muscles.—H. H. Dunlop: Adrenalin Dilatation.—G. A. Clark: The Action of Pituitrin on the Portal Circulation.—G. A. Clark: The Effect on Blood-Sugar of Interference with the Portal Circulation.—C. G. Imrie: The Action of Pituitrin in a Depancreatised Animal.—C. G. Imrie: Blood-Sugar and Hyperpnœa.—M. Hirst and C. G. Imrie: The Influence of Thyroid in Certain Types of Creatinurea.—G. P. Crowden and M. G. Pearson: The Effect of Morphia on the Adrenaline Content of the Suprarenal Glands.—E. C. Faves: The Pituitary and Nervous System in (*a*) Infantilism with Diabetes Insipidus, (*b*) Post Encephalitis Diabetes Insipidus.—May Mellanby and C. Lee Pattison: The Healing of Dental Caries.—N. G. Green and E. Mellanby: Vitamin A as an Anti-Infective Agent.—E. Mellanby, E. M. Surie, and D. C. Harrison: The Antirachitic Action of Ergot.

MONDAY, JUNE 25.

INSTITUTION OF MECHANICAL ENGINEERS (at Southampton) (continued on June 26, 27, 28 and 29).

TUESDAY, JUNE 26.

ROYAL DUBLIN SOCIETY (in the Science Room, Ball's Bridge), at 4.15.—Report of the Irish Radium Committee for the year 1927.—C. Boyle, M. Murphy, and H. A. Cummins: "Blossom Wilt" of Apple Trees and "Wither Tip" of Plum Trees, with Special Reference to two Biological Forms of *Monilia cinerea* Bon.—T. Dillon and E. F. Lavelle: A Suggested Method for the Utilisation of Seaweed.—A. G. G. Leonard and P. F. Whelan: Spectrographic Analyses of Irish Ring-money and of a Metallic Alloy found in Commercial Calcium Carbide.—L. B. Smyth: *Salpingium salinosum*, a New Carboniferous Coral.—L. P. W. Renouf: A Preliminary Account of Lough Hyne, Co. Cork.

INSTITUTION OF ELECTRICAL ENGINEERS (Summer Meeting at Scottish Centre) (continued on June 27, 28, 29 and 30).

WEDNESDAY, JUNE 27.

ROYAL SOCIETY OF ARTS, at 4.—Annual General Meeting.

BRITISH ASTRONOMICAL ASSOCIATION (at Sion College, Victoria Embankment).

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section).—Mrs. Isaacs and Drs. Hadfield and Potts: Symposium on Mental Hygiene of Pre-School Age.

THURSDAY, JUNE 28.

SOCIETY OF GLASS TECHNOLOGY (at the Applied Science Department of the University, St. George's Square, Sheffield), at 11.15.—General Discussion on Lessons from the Tour in Germany.—A. Cousen, H. W. Howes, and F. Winks: The Control and Distribution of Temperature in Lehrs.

ROYAL SOCIETY, at 4.30.—Prof. J. C. McLennan: The Bakerian Lecture on The Aurora and its Spectrum.—*To be read in title only*:—E. Jones: Photographic Study of Detonation in Solid Explosives.—Prof. E. T. Whittaker: On the Potential of the Electromagnetic Phenomena in a Gravitational Field.—B. Topley and J. Hume: The Kinetics of the Decomposition of Calcium Carbonate Hexahydrate.—L. W. Nordheim: On the Kinetic Method in the New Statistics and its Application in the Electron Theory of Conductivity.—P. K. Kichlu: First Spark Spectrum of Krypton.—Prof. R. W. Wood and V. Voss: The Fluorescence of Mercury Vapour.—E. Rudberg: The Velocity Distribution of Photoelectrons by Soft X-Rays.—I. M. Mathews: The Absorption Spectrum of Cæsium.—D. Jack: The Band Spectrum of Water Vapour. III.—F. W. P. Götz and Dr. G. M. B. Dobson: Observations on the Height of the Ozone in the Upper Atmosphere.—Prof. T. M. Lowry and M. S. Vernon: An Improved Method of Ultra-Violet Polarimetry. Anomalous Rotatory Dispersion of Sodium Tartrate.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Prof. Jurasz: Movable Kidney.

FRIDAY, JUNE 29.

ROYAL SOCIETY OF MEDICINE (Urology Section), 11 to 12.—Short Demonstration of Special Instruments.

SATURDAY, JUNE 30.

GENETICAL SOCIETY (at the John Innes Horticultural Institution, Merton, S.W.19), at 1.—Annual Meeting.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section) (at Leicester).

FRIDAY, JULY 6.

GEOLOGISTS' ASSOCIATION (in the Architectural Theatre, University College, Gower Street), at 7.30.—F. Gossling: The Geology of the Country around Reigate.—H. A. Hayward: The Geology of the Lower Greensand around Dorking, Surrey.

CONGRESSES.

JULY 9–14.

SEVENTH INTERNATIONAL CONGRESS OF PHOTOGRAPHY, 1928 (at the Imperial College of Science and Technology, South Kensington).—Dr. A. Steigmann: Theory of Photographic Sensitivity.—Dr. Luppo-Cramer: The Herschel Effect as a Regression Phenomenon.—L. A. Jones and V. C. Hall: On the Relation between the Time and Intensity in Photographic Exposure.—Dr. S. E. Sheppard and A. P. H. Trivelli: A Comparison of some Developers for Sensitometric Standards.—Dr. S. E. Sheppard and Crouch: A Machine for the Automatic Development of Sensitometric Strips.—L. A. Jones: Systematic Nomenclature in Photographic Sensitometry.—L. A. Jones and Russell: The Expression of Plate Speed in Terms of Minimum Useful Gradient.—O. Sandvik: On the Measurement of Resolving Power of Photographic Materials.—L. A. Jones and Chambers: High-Intensity Time-Scale Sensitometer.—Dr. E. P. Wightman and Quirk: Intensification of the Photographic Latent Image.—Dr. A. Steigmann: Silver Iodide in the Full-Ammonia Emulsion.—Prof. Dr. Emil Baur: Sensitisation and Desensitisation.—Prof. Dr. A. Lottermoser: Observations and Measurements on the Light-Sensitivity of Silver Halide Sols.—Prof. Dr. Fritz Weigert: On the Light-Sensitivity of Photographic Layers.—T. Thorne Baker and Balmain: The Effect of Temperature on the Sensitivity of Selected Photographic Emulsions and the Influence of Wave-length on such Temperature Effect.—O. Bloch: The Interaction of the Silver Halides in Emulsion Form.—Dr. F. C. Toy, and others: On Turbidity.—Prof. Dr. J. Eggert: On Secondary Processes in the Exposure of Silver Halides.—Prof. Dr. R. Luther: Sensitometric Studies.—Dr. F. M. Hamer: A Chemical Study of Desensitisers. Part I. An Account of the known Desensitisers.—Dr. D. A. Spencer: The Ferro-Prussiate Process; The Ferro-Gallic Process; The Diazo-Type Process; A New Application of the Ferro-Gelatine Process; Printing in Colours with Diazo Compounds.—H. W. Lee: The Modern Super-Speed Lens.—S. Jasienski: The Stereoscopic Effect of High-Aperture, Long-Focus Objectives.—N. Fleming: The Photography of Sound Waves.—Dr. Anderson: The Testing of Photographic Shutters; Lens Interferometry.—Prof. Hartridge: The Focal-Plane Shutter.—Capt. C. J. P. Cave: The Photography of Inaccessible Interior Architectural Details with a Spot-Light.—G. Auborne Clarke: The Photography of Clouds.—Prof. E. G. Coker: Photography as an Aid to the Study of Mechanical Stresses.—O. G. S. Crawford: Archæological Photography from the Air.—Capt. M. Hotine: On Photographic Surveying.—Prof. Namias: On Positives by Reversal.—A. R. Hinks: The Work of the Wild Phototheodolite in the Shaksgram—W. M. H. Greaves: Astronomical Spectrophotometry.—Dr. E. Viterbi: The Fine-grained Emulsion and its Application to Spectrography.—Mr. Elwell: Paper on and Demonstration of Talking Film.—A. J. Bull: Tone Rendering by Half-Tone Processes.—H. M. Cartwright: (1) The Progress of Photogravure Etching; (2) A Method of Colour Correction.—A. A. K. Tallent: Latest Applications of Pyro-Tanning Processes.—E. L. Turner: Modern Photo-Engraving Screens.—William Gamble: The Present Position and Future Possibilities of Photo-Engraving.—H. N. Durham: Mercury Printing Processes.—F. J. Tritton: The Uses of Colour Photography in the Printing Trade.—Prof. Dr. E. Lehmann: On his Two-Colour Process.—Dr. R. von Arx: Dye-transfer Process from Dye Mordant Images.—F. G. Tutton: The Value of the Chromoscope in Commercial Colour Photography.—Commander H. E. Rendall: A Paper on Tri-colour

Cameras.—Dr. R. A. Houston: A Paper on the Colour Mechanism of the Eye.—Julius Rheinberg: Demonstration of Micro-Spectra Method of Colour Photography.—F. C. Tilney: Pictorial Photography; the Relation of Technical Advance.—H. Garnet and G. H. Oakden: The Original Binocular Stereoscopic Camera of John Benjamin Dancer.—Dr. E. Kuchinka: W. Fr. Voigtländer's Eight-inch Double-Objective, and other Large Objectives.

JULY 16–20.

BRITISH EMPIRE CANCER CAMPAIGN (at the Royal Society of Medicine).

Monday, July 16.

Reception of Overseas Delegates at Buckingham Palace by H.M. the King.

2 to 5.—Registration of Delegates at the Royal Society of Medicine.

9.30.—Reception of Delegates and Ladies by Sir John and Lady Bland-Sutton, 47 Brook Street, W.

Tuesday, July 17.

10 (Royal Society of Medicine, Barnes Hall).—Discussions on The Relative Values of Surgery and Radiation in the Treatment of Cancer of the Cervix Uteri, Rectum, Breast and Buccal Cavity. Opened by Prof. Regaud.—Cancer of the Cervix. Opened by Dr. M. Donaldson.—Cancer of the Rectum. Opened by Sir Charles Gordon-Watson.

10 (College of Nursing).—The Etiology of Cancer. Opened by Prof. J. Ewing.

2.30 (at Middlesex Hospital).—Bland-Sutton Institute of Pathology.—(1) Demonstration of unusual Tumours. (2) Relation of malignancy to histological appearances in Cancer of the Breast. (3) Studies of the Rous Sarcoma:—(*a*) Immunity. (*b*) Factors which influence the infectivity of the Rous tumour. (*c*) Initial stages of the tumour produced by cell-free filtrates. (*d*) Influence of physical and chemical agents. (4) Some experiments on lead therapy in Cancer. (5) The application of the Cinematograph to the study of tissue culture. Courtauld Institute of Bio-Chemistry.—(*a*) Demonstration of the metabolism of tumours following Prof. Warburg's views. (*b*) A trial of some unsuccessful methods for the sero-diagnosis of Cancer. (*c*) Routine observations performed on patients undergoing radical operations for Cancer. Barnato-Joel Laboratories.—Demonstrations will be given, mainly of a radiological character. These will include:—Effects of X-rays upon Tumour Growth. Effects of Radium rays upon Tumour and Normal Tissues. Experiments upon resistance in animals to human growth. Experiments upon the physiological action of X-rays. (In collaboration with the Physiology Department.) Operating Theatres.—Radical amputation of Breast by Diathermy, by W. Sampson Handley (and demonstration of cases in the Wards). Operations for Buccal and Abdominal Cancer by Gordon Taylor. Wertheim's hysterectomy, by Comyns Berkeley and Victor Bonney. Operations for Pharyngeal or Laryngeal Cancer by Somerville Hastings.

2.30 (at Radium Institute).—Demonstrations by Dr. Philip Gosse, Dr. Roy Ward. Radium and Radium Applicators. Radon "Seeds." Various types of seed introducers. Cases that have been treated with seeds. X-ray photographs, showing seeds in tumours. Operations on patients, introducing seeds. Demonstration of specimens in the Pathological Laboratory. Demonstration of the preparation and filling of Radon Seeds.—(At Royal College of Surgeons.) Lecture and Demonstrations by Dr. Murray.

Wednesday, July 18.

9.30 (Royal Society of Medicine, in the West Hall).—Discussion on The Classification and Treatment of Bone Sarcoma. Opened by Prof. Ewing. Special Demonstration on Bone Sarcoma.

9.30 (Royal Society of Medicine, Barnes Hall).—Discussion on Some Present Day Medical Aspects of Cancer.—Sir Thomas Horder: A Consideration of Cancer Cachexia.—Dr. Robert Hutchison: The Alleged Increased Frequency of Primary Carcinoma of the Lung.

9.30 (Royal Society of Medicine, Committee Room).—Discussion on Biological Effects of Radium and X-rays, with special reference to the Factors of Wave-length, Intensity of Radiation and Duration of Exposure. Opened by Prof. Regaud, Prof. Holthusen, Dr. D. Quick, Dr. Canti, Dr. Finzi, Prof. Lahm.

9.30 (College of Nursing).—Discussion on Occupational Cancer. Pathology, Statistics and Public Health. Opened by Prof. A. Leitch, Dr. T. H. C. Stevenson, Dr. J. C. Bridge, and Dr. S. A. Henry.

2.30 (at St. Bartholomew's Hospital).—Clinical Demonstrations:—Operations—Sir Charles Gordon-Watson: Insertion of Radium for Carcinoma of the Rectum.—Dr. Barris: Insertion of Radium by Vaginal Route for Carcinoma of the Cervix Uteri.—Dr. Donaldson: Insertion of Radium by Abdominal Route for Carcinoma of the Cervix Uteri.—Mr. Keynes: Insertion of Radium for Carcinoma of the Breast.—Demonstration of Cases—Prof. Gask: Cases of Carcinoma of the Tongue and other cases treated by Radium.—Sir Charles Gordon-Watson: Cases of Carcinoma of the Rectum treated by Radium.—Mr. Harmer and Mr. Rose: Cases of Malignant Disease of the Larynx treated by Radium and X-rays.—Dr. Barris and Dr. Donaldson: Gynæcological Cases treated by Radium and X-rays.—Pathological Demonstrations:—T. P. Dunhill: Carcinoma of the Thyroid—Macroscopic and Microscopic.—Dr. E. A. Carmichael: The Relationship of Cerebral Gliomata to Embryonic Glial Tissue.—Dr. Andrewes, Miss Fell: Tissue Culture in its relation to Malignant Disease.—Dr. Canti, Dr. Spear and Miss Cox: Effects of Irradiation on Tissue Culture.—Miss Strangeways: Comparative Demonstration of Leucocytes and Fibroblasts of the Rat cultivated *in vitro*.—Dr. Canti: Histological Demonstration of Carcinoma of the Cervix before and after Treatment by Radium.—Dr. Shore: Demonstration of Museum Specimens.—Prof. Hopwood, Dr. Levitt: Demonstration of Apparatus in connexion with Deep X-ray Therapy and Radium Therapy.

5—Tea in Library.—Dr. Canti: Cinematograph Demonstration of living tissues cultivated *in vitro*, and the action of Radium upon them.

2.30 (at St. Mark's Hospital).—J. P. Lockhart-Mummery, Sir Charles Gordon-Watson, and L. E. C. Norbury: Operations for Cancer of the Rectum (Perineal Excision) and Resection of the Colon. Demonstration of patients illustrating 5 to 10 year cures after Perineal Excision, and Demonstration of the Cancer follow-up System. Demonstration of Diagnosis by Barium, Enemata and X-rays, and by Sigmoidoscopy.—Dr. Cuthbert Dukes: Demonstration in the Cancer Research Department:—(1) Series of specimens showing early stages in the development of Cancer of the Large Intestine. (2) Specimens showing the intramural and extra-rectal spread of Cancer of the Rectum. (3) Specimens illustrating multiple tumours, obstructive tumours and unusual types of malignant tumours of the bowel.

Thursday, July 19.

9.30 (Royal Society of Medicine, Barnes Hall).—Discussions on The Relative Values of Surgery and Radiation in the Treatment of Cancer of the Cervix Uteri, Rectum, Breast and Buccal Cavity, contd.):—Cancer of the Breast. Opened by Prof. Burton Lee.—Cancer of the Buccal Cavity. Opened by Dr. Douglas Quick.—Evaluation of Statistics relating to Effectiveness of Treatment. Opened by Dr. Janet E. Lane-Claypon.

9.30 (College of Nursing).—Discussion on Methods of Treatment by Chemo-therapy, with Special Reference to Lead. Opened by Prof. Blair Bell.

2.30 (at the Cancer Hospital):—

A.—Surgical.

2.30–5.—Operations. Two Theatres. Demonstration of Cases of Cancer of the Buccal Cavity treated by Radium.

B.—Pathological.

(i) Experimental:—(1) Demonstration of animal tumours produced by various carcinogenic agents. (2) Demonstration of carcinogenic agents (shale oil, paraffins, acetylene tar, etc.). (3) Specimens of mule spinner's Cancer. (4) Betel-nut-chewer's Cancer. (5) Specimens of experimentally produced Cancer of gall bladder in animals. (6) Injected specimens showing vascular supply of tumours. (7) Spontaneous rat tumours. (8) Graphs showing incidence of tar tumours and effect of dilution of tar. (9) Charts of blood changes (due to X-rays) and microscopical specimens illustrating such changes in human cases and in the rabbit.

(ii) Clinical:—(1) Sero-diagnosis of tumours by a flocculation method. (2) Specimens of Cancer of Rectum of various types removed by the abdominal-perineal method. (3) Specimens of rare human tumours. (4) Demonstration of histological sections of kidneys from cases treated by colloidal lead.

C.—Radiology.

Deep therapy apparatus with special patient's turn-table. Paintings of cases of malignant disease treated by X-rays and patients showing the results of treatment. Demonstration of special skiagrams of tumours. Ionisation apparatus for the measurement of X-ray doses. Recording spectrophotometer for X-ray and Ultra-violet light spectra. X-ray distribution in irradiated media.

2.30 (at Westminster Hospital).—Stanford Cade and Arthur Evans: (*a*) Clinical demonstration of cases of Cancer of the Tongue and Mouth treated by Radium. (*b*) A case of lingual Cancer will be treated by Radium, to demonstrate the technique. Tudor Edwards—(*a*) Will demonstrate the transpleural approach of the thoracic part of the œsophagus and introduce Radium into the wall of the œsophagus.—(*b*) If available a malignant tumour of the lung will be excised.—Dr. Braxton Hicks and Dr. Hocking—(*a*) Will show specimen of (1) Chloromata. (2) Lung tumours. (3) Myxosarcoma and primary Cancer of the liver. (*b*) Demonstrate the manufacture of Uranium and give an account of its clinical uses in cases of Cancer.—Demonstration in X-Ray Department by Dr. Caldwell, Dr. Allchin, Dr. Kerley.

2.30 (at St. Mark's Hospital).—Repetition of Programme for July 18.

2.30 (at the Lister Institute).—Demonstration by Dr. Thomas Lumsden, assisted by Miss A. C. Kohn-Speyer. (1) Culture of Normal and Malignant cells in pure serum. (2) The Effects of anti-Cancer sera on such cultures, showing the existence of specifically anti-malignant-cell bodies. (3) Treatment of various rat and mouse tumours by injection of antisera into the tumours. Subsequent immunity. (4) Cure of small "metastases" by local vaccine treatment of a co-existing large implanted tumour. (5) Lantern slides illustrating vaccine treatment of implanted tumours and the mechanism of regression. (6) Demonstration of a new Sarcoma of the rat which grows progressively in 100 per cent of rats inoculated and never regresses.

Friday, July 20.

9.30 (Royal Society of Medicine, Barnes Hall).—Discussion on The Early Recognition and Treatment of Cancer of the Stomach. Opened by Sir Berkeley Moynihan.

9.30 (Royal Society of Medicine, West Hall).—Discussion on Diagnostic Methods in Relation to Cancer. Opened by Sir Thomas Horder.

9.30 (Royal Society of Medicine, Committee Room).—Discussion on The Effects of Radium and X-rays on the Blood Vascular and Lymphatic Systems, with Special Reference to Malignant Growths. Opened by Dr. F. Carter Wood, Dr. A. Lacassagne, Prof. Holfelder.

9.30 (College of Nursing).—Discussions on Geographical and Racial Prevalence of Cancer. Opened by Prof. Major Greenwood.—Public Action in Regard to Cancer. Opened by Sir George Buchanan.

Farm Laboratories of the National Institute for Medical Research (Medical Research Council), Mill Hill, N.W.7.—Demonstrations:—By Dr. W. E. Gye: (1) Improved methods of extracting infective material from tumours. (2) The effects of tumour ferments, probably oxidases, in abolishing tumour inducing power; and methods of counteracting the action of these ferments. (3) Destruction of infective power by means of antiseptics, and conditions which influence the result.—By J. E. Barnard: (4) Microscopic demonstration of extracts of tumours. (5) Exhibition of microscopic methods for the study of filter-passing viruses. (6) Demonstration of ultra-filtration methods.

2.30 (at Guy's Hospital).

SATURDAY, JUNE 30, 1928.

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The Application of Scientific Agriculture.

THE title of the annual journal of the Agricultural Education Association, *Agricultural Progress* (London : Ernest Benn, Ltd. 5s.), is ambitious. As an expression of the aims of this useful Association, the designation of its journal is beyond reproach, especially as modified by the expression of modesty implied in the Virgilian couplet (*pater ipse colendi . . . Haud facilem esse viam voluit . . .*) which completes the title-page. But the words inevitably suggest reflections as to the extent to which agricultural education has, so far, been effective in leading to progress in a material sense.

Academically, no one ventures to question the achievements of agricultural science. In the last hundred years the additions to knowledge have been very great, but in the material consequences—the increased production of human food—doubts must arise. Rothamsted itself, by the lips of its director, has been heard modestly to suggest that many of its discoveries have gone to confirm the wisdom of the ages. Even the most progressive country in the world, we are told, feeds itself, in the main, by the exploitation of the fertility locked up in its 'virgin prairies' rather than on the fruits of new knowledge.

Measured in profits, there has been really only one 100 per cent addition to traditional practice in tillage of the soil in the last century, and that is the discovery of chemical fertilisers—that substances extraneous to the soil of definite composition can be used to increase its production. Following this epoch-making discovery there have been many others of supreme scientific importance—the new biological activity of the soil may be instanced—but not one of them has had a material outcome comparable with the first mentioned; for they have all been of the same order of magnitude as the seasonal fluctuations by which *pater ipse* has willed that the husbandman's way should be made difficult.

It is, however, only fair to admit that a particular tiller of the soil, fortified at all points with scientific knowledge and endowed with capital sufficient to tide over hard times, such as the present, has it in his power, by adopting *all* the minor advances which his knowledge suggests, to maintain his average level of profits. Thus he may add one 10 per cent by making use of the improved wheats and barleys with which the scientific plant-breeder has presented him ; and another 10 per cent by feeding his animals according to scientific

principles, and so on. But even the members of the Agricultural Education Association must admit that such men are rare.

The obvious reply is, of course, that the educational standard of husbandmen in general is not high enough. But is not the difficulty really psychological? The adoption of the teachings of education in the everyday affairs of life is dependent on a will to progress, a desire for efficiency. As the late head of the Educational Department of the Ministry of Agriculture once pointed out (to American students of all people!), the pursuit of efficiency is philosophically not always desirable. A marsh starred with Grass of Parnassus is more productive of peace of mind than its efficient substitute a water-cress bed! Rural life is undoubtedly productive of a certain passivity—contentment with things as they are. It is perhaps irreverent to attempt the improvement of Nature's plants. A factory is always crying for improvement, but the lily does not suggest a painter!

Be that as it may, the fact remains that scientific agriculture has not furnished an incitement to the rural worker, unless, possibly, in one direction: the improvement of the animal has always attracted the British farmer, and that as a rule is the chief delight in farming. The animal has proved more plastic than the plant or soil, and it is somewhat unfortunate that the science of animal improvement has scarcely emerged from obscurity. Nevertheless, progress on the practical side is continuous. Such recent triumphs as the 300-egg hen and the 3000-gallon cow offer the husbandman greater rewards than even the largest gift of the chemist, fertilisers from the air, and irradiated foodstuffs.

Physico-Chemical Embryology.

Les bases physiologiques de la fécondation et de la parthénogénèse. Par Albert Dalcq. (*Les problèmes biologiques,* Tome 2.) Pp. viii + 274. (Paris: Les Presses universitaires de France, 1928.) 45 francs.

AMONG all the departments of biology, the study of the developing embryo has probably felt least that powerful tendency towards physico-chemical explanations which has transformed so completely other biological fields. It is possible that this impression may be partly mistaken and due to the fact that no one has yet brought together into a fruitful correlation all the isolated and scattered researches on the chemical phenomena taking place in ontogeny. However that may be, the subject of fertilisation and the earliest happenings in the egg-cell has, as is generally known, given rise to a great many investigations which have been carried on with physico-chemical methods and a full appreciation of the importance of the quantitative. Fertilisation, moreover, forms a convenient subject for a review, in that its boundaries are fairly clear-cut and that for practical purposes it can be discussed in separation from the complicated events which follow it.

It is now thirteen years since Prof. F. R. Lillie published his little book on fertilisation, and the amount of activity which biologists have devoted to fertilisation since that time has made a new survey of the subject very desirable indeed. Such a survey was all the more necessary in that Lillie's book was written to a certain extent in the service of a particular theory, that of 'fertilisins,' a theory which is not now held in the unmodified form of that time. This survey has now been brought to a successful completion by Dr. Albert Dalcq, of the University of Brussels. Although those intimately acquainted with this field of work will not agree with him in all his individual judgments, they will certainly admit the success of his review as a whole, and most biologists can scarcely fail to find it a necessity for their shelf of monographs. The book is divided into seven chapters, which work backwards chronologically; thus the first deals with the physiology of cleavage and segmentation, the second with the time elapsing between the fertilisation act and the first cleavage, and the third chapter with the fertilisation process itself. The exposition is expanded at this point to include chapters on the agents of fertilisation and parthenogenesis, and the cytology of the 'activation' mechanism. The sixth chapter, on the physiological consequences of fertilisation, is practically an extension of the first one, but the seventh and last continues the time sequence by dealing with the period between full maturation and fertilisation. The book concludes with an admirably written summary of the present position.

Speaking generally, we may be said to know far more about fertilisation from the outside, as it were, than from the inside, for although a very great number of influences have been brought to bear on the egg-cell and the spermatozoon, the part played by actual physico-chemical analysis of the material itself has been much smaller. Almost all the factors in the environment of fertilisation which can be varied have been varied, and their effects noted minutely. The weakest part of our knowledge of the subject lies in the direct assess-

ment of the physico-chemical changes going on inside the cell itself during these early hours of development. The strongest part of our knowledge is probably the straightforward cytology of the fertilisation process. All of these aspects are dealt with fully by Dalcq, who is particularly happy in his treatment of parthenogenetic agents, which he lists in convenient tables, and in his discussion of the various theories of cell-division.

A critical consideration of some of the details of his book, of course, brings to light various matters which could be improved in a second edition. No mention, for example, is made of the work of W. J. Crozier and his collaborators on the temperature characteristics of cell-division, although the time has surely now gone by when it can be regarded as useful to reproduce Loeb and Wasteneys' Q_{10} values without comment. Again, the discussion of the respiration of the egg-cell before and after fertilisation is confined unnecessarily to data on echinoderms, and such suggestive work as that of Parnas and Krasinska on one hand, and Bialascewicz and Bledovski on the other, is omitted. Thirdly, the investigations of various French workers, in which the 'energy of segmentation' was calculated from the energy required to stop it, are not treated in a very satisfactory manner. But it is unnecessary to catalogue such imperfections, which are inevitable in a book with any personal flavour at all, and will seem to biologists far more than compensated by the obvious value of the monograph as a whole. It may be noted in parenthesis that the proof-reading has not been too carefully done, so that the text and the bibliography are now and then at vexatious cross-purposes. There is no index.

The union of exact biochemical and biophysical work with the basis of cytological and morphological facts already known must inevitably lead to a new era in the study of the 'coming-into-being' of animals, and of this Dr. Dalcq's book on fertilisation provides a happy augury. J. N.

Timber Trees of Malay.

Malayan Forest Records. No. 3: *Commercial Timber Trees of the Malay Peninsula.* By F. W. Foxworthy. Pp. 195 + 140 plates. (Kuala Lumpur, F.M.S.: Forest Department, 1927.) 5 dollars; 12*s*.

THIS important and useful volume of the *Malayan Forest Records*, issued under the auspices of the Federated Malay States Government, has been prepared by Dr. F. W. Foxworthy, Forest Research Officer. The author states that the aims kept in view in its compilation are primarily those of the forest officer of the Malay States. A study of the volume has shown, however, that it is likely to have a wider range of utility, if alone for the very excellent series of photographs of the trees dealt with, with which the book is profusely illustrated. It is worth recording that, although the book is printed locally by a Singapore press, the plates are the work of Messrs. Lascelles and Co., Ltd., of London. Those who have had anything to do with the reproduction of good photographs to illustrate memoirs and so forth drawn up in many parts of the British Empire are well aware that it is very often difficult to obtain good results with the unavoidably inadequate local resources available. The action taken in this matter in the present volume is well worth following.

The timber trees of the Malay Peninsula are of many kinds and are very imperfectly known, says the author, and the need of a manual as an aid to the identification of the more important ones has been very much felt. He states that there are 2500 known species of trees in the Peninsula. "This is, perhaps, more than are recorded from all British India and Burma." This statement is not quite correct. In Gamble's "Manual of Indian Timbers" (2nd ed., 1922) the following is found: "In his introduction to the 'Flora of British India' Sir Joseph Hooker writes of the Indian region (including Ceylon) as 'perhaps the richest, and certainly the most varied, botanical area on the surface of the globe,' and true as this is of the flora in general, it is no less true for the woody species that constitute the forest vegetation." In a tabular statement appended to this remark, Gamble shows series, natural orders, number of genera, and number of species of the trees, shrubs and climbers of the Indian and Burma forests. The grand total comes to 4749, of which the trees number 2513, exclusive of introduced trees.

In discussing the lines on which his manual is drafted, Dr. Foxworthy states that such a manual should give, as simply as possible, the identification marks for each kind of tree and should also give a concise summary of what is known about each of the commercial trees. Work of this kind had been begun by the late Conservator of the States, A. M. Burn-Murdoch (who was previously in the Indian service). In 1911 and 1912 he published two parts of his "Trees and Timbers of the Malay Peninsula." The work came to an end by his death in 1915 and was discontinued. When the present author took up the work, it was

reorganised so as to condense the material within one handy volume. It was therefore restricted to "those trees which are considered as present-day commercial timber trees with others which, not falling within that category, are so conspicuous in appearance as to commend attention in the forest."

After detailing the lines upon which the field work was carried out, in which he had the assistance of forest officers and others, Dr. Foxworthy gives some general statements on the geography, climate, and soils of the Peninsula, and then deals with the location, extent, natural conditions, and composition of the forests. The area occupied by the commercial forests is estimated to be about 30,000 square miles, although considerable parts of this tract have not yet been fully examined. There are also considerable areas which have been destroyed by the practice of shifting cultivation and are now only covered with inferior growth. As has been said, the species of trees are very numerous and it is not unusual to find single acres of forest which carry more than 100 species of trees.

The forests are roughly classified as littoral, lowland, and mountain or hill forests. The littoral forests are subdivided into the beach forests and the mangrove swamps, the latter forming an important source of firewood. The hill or mountain forests divide themselves into three types. The highest mountains are clothed with a very dense low-growing forest cover containing many species of poor quality, small trees with thick leathery leaves; the forest is at present of little value. Below this comes the mid-mountain forest with better commercial prospects, though at present it is only exploited in the neighbourhood of hill stations. In the mountainous country, high ridges stand out sharply and bear a dense cover of large trees on their crests, amongst which *Shorea Curtisii* is often abundant. The hill forests are roughly taken to be those above 2000 feet elevation.

The third division is the lowland forests. This type starts where the beach forest ends and runs up to the hill type, although, as is usual in such forests, the dividing line is not a sharp one. Briefly, the lowland forests are subdivided into swamp forests, forest which has been subjected to shifting cultivation and is now covered with a poor growth, and high forest. It is calculated that the second type—the aftermath of shifting cultivation—will require 250 years under natural conditions before it again becomes a valuable forest of commercial species. The high forest is what Schimper ("Plant Geography," Chaps. ii. and iv.) terms 'rain forest.' It contains a large number of species and includes most of the present-day commercial timber trees of the Peninsula.

"Our forests," says the author, "are most closely related to those of the Netherlands Indies, Borneo and the Philippines. Detailed studies in the two latter regions have shown that the forests have from 60 per cent. to 90 per cent. of their volume produced by trees of one family, the *Dipterocarpaceæ*. The indications are, from such studies as have been made in the Malay Peninsula, that our forests have about 60 per cent. of their volume of timber in this group."

Dr. Foxworthy has drawn up a key, which is mainly intended for use in the forest by forest officers; it lays most emphasis on those features which are most apparent in the field, more especially the bark, which forms the basis of the key. He has not arranged his material in botanical sequence since he says the book has no pretence at being a botanical flora; for the same reason his descriptions of trees are in simple language. All will not perhaps subscribe to Dr. Foxworthy's arguments or arrangement of his work. It is probable, however, that he will find the average forest officer and others working in the forests in agreement with him; and for the rest, time alone will prove whether the key fulfils the practical objects it aims at. This being said, the author may be congratulated on the compilation of a piece of work which should prove of great utility to all who work amongst or wish to become acquainted with the commercial trees of this region.

Prehistoric Research in France.

(1) *La Grotte de l'Observatoire à Monaco.* Par Marcellin Boule et L. de Villeneuve. (Archives de l'Institut de Paléontologie humaine, Mémoire 1.) Pp. 114+27 planches. 150 francs.

(2) *Les Poissons, les Batraciens et les Reptiles dans l'Art quaternaire.* Par Henri Breuil et R. de Saint-Périer. (Archives de l'Institut de Paléontologie humaine, Mémoire 2.) Pp. 170. 80 francs. (Paris: Masson et Cie, 1927.)

(1) "LA Grotte de l'Observatoire à Monaco" is the first of a series of memoirs to be issued by the Institute of Human Palæontology at Paris, founded some years ago by Prince Albert I. of Monaco.

The late Prince will long be remembered by prehistorians for the active interest he took in all kinds of prehistoric research and for the magnificent series of publications he inaugurated. Not least among these latter were numerous volumes dealing with the results of excavation in

the caves near Mentone. The excavations were under the careful supervision of the Chanoine de Villeneuve, and it is largely due to his scientific precision and careful digging that so much valuable material was obtained.

After the work at Mentone was finished, attention was turned to another cave near Monaco, just below the Observatory and high up on the hillside overlooking the sea. For many years past excavation has been proceeding there, and the work in many ways has been one of peculiar difficulty. In the volume under review we have the results of these years of labour described for us by the Chanoine de Villeneuve and Prof. Marcellin Boule, who has undertaken the detailed study of the objects found, especially of the fauna.

The cave consists of a vestibule, descending rapidly at the back. A large number of archæological layers have been isolated, but these can be grouped into three series, separated by layers of stalagmite; at the bottom were found Lower Palæolithic, in the middle Mousterian, and at the top Aurignacian industries. An interesting find in one of the lower levels was a *coup de poing* made of limestone. This is the first one known in the Riviera district.

The fauna is as might be expected, but the presence of *Cuon alpinus* race *Europæa* is important, although it is not the first example to be found in the district, another having been discovered some years ago in a cave near Vence.

A chapter on the history of the excavations is first given. This is followed by an account of the individual layers and their contents, after which follows a careful description of the fauna and the tools found. The volume concludes with a large number of plates.

The only criticism that can be offered is that the description of the implements is perhaps rather inadequate, and the space allotted for the purpose insufficient. Especially is this the case when we consider the amount of space allowed for the description of the fauna. The plates are good, although perhaps not all quite up to the standard of what we have learned to expect from the Institute. All the same, the volume is a valuable addition to our knowledge of prehistoric times in the district, and Prof. Boule and his collaborator are indeed to be congratulated.

(2) The second of the memoirs published by the Institute deals with certain conventionalisations derived from naturalistic representations of fish, lizards, serpents, etc., that appear in Quaternary art. For many years past M. Breuil has been collecting material and forming series showing how the naturalistic representation of the animal becomes conventionalised. Starting with the original naturalistic representation, a number of diverging lines of development can be determined, there resulting finally totally different conventionalisations. These conventionalisations are of the nature of symbols, having apparently little connexion with the animal they represent; it is only by the finding of all the links in the chain that their meaning has been elucidated.

Collaboration with the Comte de Saint-Périer is indeed happy, and, as M. Breuil himself says, the descriptions are largely due to his colleague, to whom has been given his *dossier* of drawings and his general ideas on the subject. What that *dossier* of drawings is like the reviewer well knows. He spent much time in 1914 in wading through that enormous and precious mass of material.

An added interest is given to the work in that an attempt is made to correlate the various stages of conventionalisation with the actual age of the objects on which they are found. For this purpose the sixfold system of subdivision for the Magdalenian culture, long ago suggested by M. Breuil and now generally accepted in England, is adopted. The results are very interesting, as they show how the conventionalisation altered in the different industries belonging to these various subdivisions.

An important paragraph, which is not further elaborated, deals with the distribution of the industries of the various Magdalenian stages. It is interesting to note at what moments the Magdalenian culture spread its influence far and wide.

M. Breuil and the Comte de Saint-Périer are to be congratulated on their work and on the numerous well-chosen illustrations therein. It is to be hoped that the matter will not be allowed to remain where it is and that further volumes dealing with the conventionalisation of other animal forms, etc., will be issued within the next few years.

M. C. BURKITT.

The Minor Constituents of Coal-Tar.

The Higher Coal-Tar Hydrocarbons. By Dr. A. E. Everest. Pp. xiii + 334. (London: Longmans, Green and Co., Ltd., 1927.) 18*s*. net.

COAL-TAR products may be divided roughly into two groups, the major and minor constituents of tar, this division having relation to the percentage amounts in which these substances appear in the various fractions of tar distillation, but not necessarily to their intrinsic

importance. Among the major constituents are the well-known benzene, naphthalene, and carbolic acid. Of the minor constituents, the most valuable, and historically the most interesting, is anthracene, the yield of which from average high temperature tar is about 0·4 to 0·8 per cent. Until recently anthracene was the only starting-point in the manufacture of anthraquinone colours, although now this important quinone is synthesised industrially from benzene and phthalic anhydride, the latter being derived from naphthalene.

Dr. Everest's book is devoted to a group of higher coal-tar hydrocarbons which are constituents of the less volatile fractions of coal-tar distillation and, like anthracene itself, they form only a very small proportion of the total distillate from tar, but owing to the large scale on which this distillation is conducted, the quantities of these hydrocarbons available would be considerable if they became of value for technical purposes. The subject matter of this book is arranged in three main chapters, dealing respectively with the acenaphthene, fluorene, and phenanthene groups. A concluding chapter is devoted to several hydrocarbons not immediately related to the three foregoing main sections.

Acenaphthene itself is a hydrocarbon which has already been utilised in colour-making. For this purpose it is first oxidised to its quinone, acenaphthenequinone, which is then condensed with hydroxythionaphthene (thioindoxyl) or its derivatives. The resulting colours are vat dyes of the Ciba scarlet series. More recently another oxidation product of acenaphthene, namely, naphthalic acid, has come into prominence as a starting-point in the production of complex vat dyes of the perylene series. The hydrocarbon, perylene, in the volume under review, is considered as a derivative of phenanthrene. It is figuring more and more in modern chemical literature, and is the subject of many current patent specifications.

Dr. Everest's treatise arrives at an opportune time, when fresh interest is being aroused in coal-tar products owing to the circumstance that the attention of chemical investigators is now directed to a new variety of tar produced during the low-temperature carbonisation of coal. This tar also contains its two groups of major and minor constituents, and among the latter are hydrocarbons either identical with or closely related to the hydrocarbons discussed in the present volume, which contains references to coloured hydrocarbons of unknown constitution, such as crackene and chrysogene. Recent investigations have revealed the presence of similar coloured substances in the less volatile fractions of low-temperature tar.

Many interesting research problems are presented by the hydrocarbon, fluorene, and its derivatives. This hydrocarbon has the remarkable property of forming a potassium derivative with heated caustic potash and a sodium derivative with warm sodamide. The latter reaction renders possible the isolation of fluorene on a large scale. The most readily prepared diamine of fluorene possesses certain analogies with benzidine and other colour-producing diamines, but although the disazo dyes from 2 : 7-diaminofluorene are direct dyeing cotton colours, they offer no special advantages over the commercial dyes made from benzidine and dianisidine. The long chapter on phenanthrene contains a comprehensive survey of the large amount of research which has been carried out on this hydrocarbon. Phenanthrene is still the forlorn hope of the colour-maker, although it is of great scientific interest owing to its relationship to the opium alkaloids, morphine, codeine, and thebaine, all of which contain a phenanthrene nucleus.

The phenanthrene structure has also been revealed in several more complex hydrocarbons. Among these are retene, obtained from wood tar, or by the action of sulphur on resin oils ; chrysene and pyrene derived from high-temperature tars ; and picene, a product of the distillation of lignite tar. All these substances are adequately discussed, and throughout the book there are copious references to original literature. The utility of the work as a reference book is further increased by the inclusion of complete author and subject indexes. Within a handy compass, the book contains a considerable store of both scientific and industrial information, and is accordingly a useful addition to the technical literature of coal-tar products.

G. T. M.

Thermionics and Flames.

Handbuch der Radiologie. Herausgegeben von Prof. Dr. Erich Marx. Zweite Auflage. Vierter Band, Dritter Teil: *Glühelektroden*, von Prof. Owen W. Richardson, übersetzt und bearbeitet von Prof. Dr. A. Karolus; *Technische Anwendung der Glühelektroden*, von Prof. H. Rukop; *Flammenleitung*, von Prof. Erich Marx. Pp. xvi + 724. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1927.) 50 gold marks.

THE present rapid rate of progress in physics seems to make it inevitable that parts of a monograph should need revision even in the interval between

preparation of the manuscript and publication of the book, whilst the task of bringing out new editions is at once the more necessary and the more difficult. The three sections of this volume of the "Handbuch der Radiologie" present as many different attempts to cope with the problem. "Glüheelektroden" is essentially Prof. O. W. Richardson's "Emission of Electricity from Hot Bodies," with some additional references, and an appendix by E. Rupp, where the main results obtained in this field between 1921 and 1926 have been summarised. The decision to leave it in this form appears wise, since although there is no immediate prospect of radical alterations in the experimental basis of the subject, Prof. Sommerfeld's very recent application of the Fermi statistics to free electrons has at least shown that its theoretical basis is in too fluid a state to justify more drastic alterations yet.

The second section, Prof. Rukop's account of the technical applications of thermionic phenomena, is, on the contrary, entirely new. In its main features it constitutes another appendix to the preceding part, and deals with the two branches of thermionics which were deliberately omitted from the latter, namely, the construction of valves of various types, and their use as units of conducting networks. It will be of special interest to English readers from the fact that most of the references are to German patent specifications and literature, whilst two pictures of the Königswusterhausen and Langenberg transmitting stations will lend life to two voices which most of us will have heard but few can have seen. The hundred odd figures are good, and go far to contribute to the success of the writer in compressing his subject into as many pages.

The electrical properties of flames have again been treated by Prof. Marx, and his plan has been to retain the bulk of the older historical and descriptive work, but to give some considerable space to more modern theory. Prof. Marx himself has been largely responsible for the application of the Saha theory of thermal ionisation, and his account of it is thus particularly valuable and authoritative. One wishes that the phenomena of glow discharges were equally amenable to analysis. It is to be regretted that no reference has been made to the important researches of the last few years on cold flames, since the presence or absence of ionisation in these, and their peculiar spectroscopic properties, suggest strongly that they represent isolated processes which occur as intermediate reactions at higher temperatures.

K. G. E.

Our Bookshelf.

Radio-Elements as Indicators: and other Selected Topics in Inorganic Chemistry. By Fritz Paneth. (The George Fisher Baker Non-resident Lectureship in Chemistry at Cornell University, Vol. 2.) Pp. vii + 164. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1928.) 12*s.* 6*d.* net.

PROF. PANETH's introductory lecture was partly of a historical character and partly critical of certain well-known claims of more recent years, being a discussion of "ancient and modern alchemy"; in it the author incidentally announced his inability to confirm Collie and Patterson's claim to the synthesis of helium and neon, but remarked that our cautious return to an earlier view of the feasibility of the transmutation of elements—"Alchymia scibilis est, non tamen adhuc scitur"—has greatly stimulated popular interest, unfortunately sometimes ignorant and credulous, in this branch of knowledge and speculation.

Nine following chapters are devoted to a consideration of the use of radio-elements as indicators, whereby, in view of the ease of detection of radioactivity and the known chemical identity of isotopic elements, it is possible to deduce or to follow the course of physical and chemical changes by an indirect process. Thus the method is applicable, for example, to a determination of the solubility of lead chromate, a known quantity of thorium-*B* being first added; to proof of electrolytic dissociation and of the interchange of ions; to a study of the phenomena of adsorption and colloid chemistry, and to technological, physical, and physiological problems. The discovery of the hydride of thorium-*C* was followed by the preparation of bismuth hydride from ordinary inactive bismuth, and lead hydride, first prepared by the radioactivity method, was later obtained from ordinary lead.

Four chapters which are devoted to the group of volatile hydrides are no less valuable than the preceding section. The remainder of the book, constituting a brief study of the natural system of the elements, does not invite particular comment. Name and subject indexes are provided.

A. A. E.

The Earth, the Sun, and the Moon. By Dr. George Forbes. Pp. 80. *The Stars.* By Dr. George Forbes. Pp. 79. (Benn's Sixpenny Library, No. 106 and No. 107.) (London: Ernest Benn, Ltd., 1927.) 6*d.* each.

THE above little books by Dr. George Forbes may be described jointly. They are designed to awaken the interest and enthusiasm of beginners, and deal with the heavenly bodies in large measure from a poetical and romantic view-point. But they embody many of the latest results, including a brief description of Brown's lunar tables, and a note on Einstein's explanation of the motion of the perihelion of Mercury; the author seems to view the latter with disfavour as upsetting Newton's

great law; but it seems more correct to view it as a slight amplification of the law, which Newton himself would have been glad to make if the evidence for it had then been available.

A few points call for comment: in the first book, on p. 59, it should be explained that the lunation is 2·2 days longer than the moon's period of revolution round the earth; the text suggests that they are identical. On p. 62, no extended regions of the moon approach the brilliance of snow as is stated in the text; even Aristarchus, the brightest point on the disc, has a lower albedo than this. In the book on the stars, on p. 60, the sun's motion is only two-thirds of the earth's orbital speed, instead of being "a little quicker"; on p. 68, it is an exaggeration to say that the pitch of a note from a locomotive whistle can be altered as much as an octave by the motion of a train. Even if the listener were in another train travelling in the reverse direction, the speed of each being 60 miles an hour, the change of pitch on passing would be less than this.

A. C. D. C.

Benedetto Croce: an Autobiography. Translated from the Italian by R. G. Collingwood. Pp. 116. (Oxford: Clarendon Press; London: Oxford University Press, 1927.) 5*s.* net.

ALTHOUGH the translation of this autobiography has only recently appeared, the work itself was completed during the War, and in fact before Italy was involved. The writer had reached his fiftieth year, and the value of the book is increased by a suitable prefatory note by J. A. Smith, summing up the importance of the influence of Croce and Gentile during the last twenty years.

The author's object in his work, which was not originally intended for publication, consists neither in confession, nor recollection, nor memoir. He seeks in plain terms to sketch a criticism and therefore a history of the contribution which he has made to the common stock of work done. It is natural that outward events enter into the narrative, which thereby gains in human interest, and one is conscious of the contrast between the political atmosphere of Rome and the academic quiet of Naples. His criticism of Marxism resulted in a deeper interest in philosophy, and in 1902 appeared the "Theory and History of Æsthetic." In the years of activity that followed, Croce found by experience the falsity of that pedagogic theory which restricts education to the first part of life. He also came to possess that toleration which reveres the efforts of past thinkers and recognises that no man can achieve finality in the search for truth.

H. D. A.

Frequency Curves and Correlation. By W. Palin Elderton. Second edition. Pp. viii + 239. (London: Charles and Edwin Layton, 1927.) 15*s.* net.

THIS work deals with the data used by the actuary, for whom it is primarily intended. Nevertheless, the account here given of curve fitting by the method of moments should prove extremely valuable to the non-actuarial reader, who is, however, recommended to begin by reading Appendix VII. An admirable discussion of fitting curves of Pearson's types is fully illustrated with numerical examples and diagrams. A valuable feature is a table of the various types, giving their equations, and a criterion for their applicability. The equations are also given with the origin at the mean, thus allowing a uniform procedure.

The treatment of 'goodness of fit' given in a later chapter could, with advantage, have been fuller. The matter of random sampling is treated in a somewhat summary fashion, the author advancing the opinion that a little thought and common sense are all that are required. The remainder of the book deals with various aspects of correlation. For the benefit of those who are more interested in this part of the subject an abridged course of reading is given in Appendix VIII. A table of the logarithmic gamma function is also given. No great mathematical attainments are demanded of the reader, and the book should continue to prove very useful.

Recent Advances in Ophthalmology. By Dr. W. Stewart Duke-Elder. (The Recent Advances Series.) Pp. xvi + 339 + 4 plates. (London: J. and A. Churchill, 1927.) 12*s.* 6*d.*

THE author of "Recent Advances in Ophthalmology" is careful to point out that this book is in no way to be considered a text-book. His object is to summarise the research work of recent years in association with the subject, to indicate the lines along which ophthalmology is at present developing, and to guide the student seeking what is of value in the accumulation of modern literature. This survey extends over a wide range, from physiological and embryological research to the neuro-psychological foundations of vision, and discusses methods of diagnosis and treatment and morbid processes. From the nature of the eye, it is inevitable that diagnostic methods should attract much attention; of these, the most important is bio-microscopy by means of the slit-lamp, the value and limitations of which are fully considered.

The chapter on neurology includes the observations of neurologists and ophthalmic surgeons on the visual paths and centres and their associated tracts in the nervous system. There is also a brief but well-reasoned section on the psychological aspects of vision and perception. The book is well illustrated and indexed and numerous references are given. Dr. Duke-Elder is to be congratulated on the way he has carried out his task.

Interpreters of Nature. Essays by Sir George Newman. Pp. 296. (London: Faber and Gwyer, Ltd., 1927.) 12*s.* 6*d.* net.

THESE essays, whether relating to explorers in science, great practitioners, or interpreters of human desires (as, for example, Keats), were well worth publication in collected form. They supply excellent reading. Especially interesting are those on the disciples of Boerhaave in Edinburgh, and William Osler as a physician of two continents. A more extended index would have been useful and convenient.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Pressure of Calcium in the Sun's Atmosphere.

IN a recent interesting investigation, A. Unsöld has estimated the total number of atoms of various kinds in the solar atmosphere which give rise to Fraunhofer lines of the observed width and depth (*Zeits. für Phys.*, **46**, 765; 1928). The theoretical curves he has calculated reproduce with remarkable fidelity the contours of such lines as those of sodium, calcium, strontium, and barium. They give, it is true, too small values for the residual intensities in the centres of the lines, but in the wings, where the theory seems unquestionably trustworthy, they agree exceedingly well with observation. With the aid of the Saha theory of ionisation, Unsöld has deduced the total number of atoms of a given species per square centimetre column above the 'photosphere.' The results as regards the relative abundances of atoms of different kinds are in agreement with Miss Payne's estimates of *relative* abundances in stellar atmospheres, but Unsöld's method leads to an *absolute* determination. For example, for calcium he finds $2 \cdot 3 \times 10^{19}$ atoms per cm.^{2}.

The question arises why this constant should have this particular value. Why should there be $2 \cdot 3 \times 10^{19}$ atoms of calcium per cm.^{2} present for absorption purposes in the solar atmosphere? As we penetrate the solar layers from outside, we shall go on encountering calcium atoms in various stages of ionisation, right into the far interior. How comes it that only the uppermost $2 \cdot 3 \times 10^{19}$ atoms per cm.^{2} render themselves apparent in the formation of absorption lines?

The answer must be that below the level corresponding to $2 \cdot 3 \times 10^{19}$ atoms per cm.^{2} complete opacity must have set in. Unsöld himself has calculated the *mean* pressure of these calcium atoms, assuming they extend through the complete chromospheric column of 14,000 km. thickness. He finds thus $1 \cdot 1 \times 10^{-6}$ atmos. But it appears to me, for reasons I have given elsewhere, that the greater part of this column of 14,000 km. is at a much lower pressure, in circumstances of what I have called 'chromospheric equilibrium,' the atoms being almost entirely supported by radiation pressure. This column thus includes only a minority of the calcium atoms, and the bulk of the atoms will accordingly be at a higher pressure, concentrated in a small thickness (some 100 km.) at the base of the column and comparatively unsupported by selective radiation pressure. It therefore seems to me more significant to calculate not the mean pressure but the pressure at the base of the column. For this purpose we may neglect radiation pressure and estimate the pressure by multiplying the value of solar gravity by the mass of calcium atoms per cm.^{2}. The result is a pressure of $4 \cdot 1 \times 10^{-5}$ atmos. This must accordingly be the pressure at which complete opacity sets in. A more refined calculation given in *Mon. Not. R.A.S.* (**88**, 200; 1928) gives 5×10^{-5} atmos.

I wish here to point out that this result is in very fair agreement with an estimate which I made in 1925 (*Mon. Not. R.A.S.*, **85**, 778) by an entirely different method. The method consisted in a crude modification of Kramers' theory of the absorption coefficient in the continuous spectrum formed by the ejection of photo-electrons. Assuming the sun was entirely composed of calcium atoms, I found that at the level from below which only one per cent of the continuous spectrum emerges, *i.e.* roughly at the level at which *almost complete opacity is established, the total* pressure (electrons plus ions) was $1 \cdot 1 \times 10^{-4}$ atmos. The corresponding pressure of calcium atoms (I assumed for simplicity complete first-stage ionisation down to this level) was accordingly $5 \cdot 5 \times 10^{-5}$ atmos. This is to be compared with the above values $4 \cdot 1 \times 10^{-5}$ atmos. and 5×10^{-5} atmos. derived by an entirely different path of reasoning direct from Unsöld's treatment of the observed line-widths of the *H* and *K* lines. The theory I was using is subject to criticism in details, but generally speaking the agreement of the two estimates strongly confirms the suggestion that photo-ejection of electrons is the dominant cause of the sun's continuous spectrum.

In the tentative picture of the sun's calcium atmosphere to which we are led by these and allied calculations, it appears that to a first approximation we may divide the chromospheric layer from the reversing layer and photospheric layers by a certain plane of

CALCIUM ON THE SUN.

Nature of Equilibrium.	Level.	Partial Pressure of Calcium (atmos.).	Ca^{++}.	Ca^{+}. (Fractions).	Ca.
Chromospheric Equilibrium or Monochomatic Radioactive Equilibrium. (Strong selective radiation pressure.)	High Level Chromosphere		0	1·0	0
	⋮ (7000 km.) ⋮	Small pressure gradient.			
	Middle Chromosphere		0	×	×
	⋮ (7000 km.)		(Plane of demarcation)		
Local Thermodynamic Equilibrium. (Selective radiation pressure rapidly decreasing.) (Reversing Layer and Photospheric Layers.)	Base of Chromosphere	10^{-13}	1·0	10^{-2}	0
	⋮ (100 km.) ⋮				
	Level of maximum Ca^{+}	2×10^{-7}	10^{-3}	1·0	10^{-3}
	⋮ (30 km.) ⋮				
	Depth of complete opacity	5×10^{-5}	0	0·85	0·15
	⋮ Interior.		Ca rises to a maximum. Then Ca^{+}, Ca^{++}, Ca^{+++} . . . in turn.		

demarcation. Above this plane the rarity of collisions permits monochromatic radiative equilibrium with strong selective radiation pressure. Below the plane collisions give rise to a state of local thermodynamic equilibrium in which selective radiation pressure decreases inwards exponentially with the optical thickness. In the upper region only those atoms are present which are capable of support by selective pressure. In the lower region the dissociative equilibrium of the different kinds of ions is determined by Saha's theory. The pressure at the interface will be very low, and even Ca^+ atoms will be in a minority compared with Ca^{++} atoms. As we descend, the proportion of Ca^+ atoms increases and rises to a maximum, thereafter decreasing and giving place to Ca atoms. Ultimately, increasing temperature causes ionisation of Ca atoms, and we pass in turn through maxima of Ca, Ca^+, Ca^{++}, etc., as first pointed by Pannekoek some years ago.

The accompanying rough table gives the scheme of pressures and stages of ionisation. Actually, of course, the two layers separated by the plane of demarcation in the scheme must merge into one another continuously, and the scheme does not pretend to treat the transition accurately.

E. A. MILNE.

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The Spectrum of the Hydrogen Molecule.

THE very accurate table of wave-lengths in the secondary spectrum of hydrogen which has recently been published by Gale, Monk, and Lee (*Astrophys. Jour.*, vol. 47, p. 90; 1928), has made possible a great advance in our knowledge of the structure in this spectrum. The very extensive series of band systems described in *Proc. Roy. Soc.* (A, vol. 113, p. 368; 1926) is fully confirmed, and the combinations are found to be exact to the accuracy of the new data. This is true in all essential details for the bands which involve the electron transitions $3 \rightarrow 2$ (α), $4 \rightarrow 2$ (β), and $5 \rightarrow 2$ (γ), but the weak bands involving the $6 \rightarrow 2$ (δ) and higher transitions will require some reconsideration.

As a result of a re-examination of the series of band systems towards the violet end of the spectrum, described in *Proc. Roy. Soc.* (A, vol. 115, p. 528; 1927), we have been led to the discovery of a very large number of bands which have the same final states as these. The bands as there described consisted of 6 progressions with a maximum of 4 members in each. We now have about 40 such progressions, several of them extending to 9 members. Many of the leading lines are very strong, and have been measured with the interferometer as standard lines by Gale, Monk, and Lee. As a result of this and of the large number of systems, we are able to determine the relevant data with very great precision. For example, we believe the following to be the final vibrational differences ($1'' \rightarrow 0''$, $2'' \rightarrow 1''$, etc.) of the lowest rotational levels of these systems: 1312·55 (4), 1276·60 (2), 1242·382, 1209·062, 1176·33 (3), 1144·00, 1112·08, and 1081·29. All these numbers are believed to be sure to within half a unit of the last digit but one. Where the last digit is enclosed in brackets it is less sure than in the other examples. In the one case in which there is a double check involving only standard lines, that is to say, in which all 4 lines have been measured with the interferometer, we find the practically identical values $1242{\cdot}381_1$ and $1242{\cdot}383_5$ cm.$^{-1}$.

The vibrational differences of the B states got by Dieke and Hopfield from measurements of the ultra-violet absorption bands of H_2 are 1313, 1276, 1247, and 1209 in succession. In spite of the apparent discrepancy at the third interval, we think that these B states must be the same as our final states, because the identity is now confirmed by the value of the moment of inertia. For a number of the bands we have been able to identify the $Q(m)$ lines up to $m = 6$. This enables us to obtain the quantity α in $B_n'' = B_0'' - \alpha n''$. From the vibrational data, using Kratzer's formulæ, we then deduce $2B_0'' = uw_0 = 31{\cdot}1$. This is about 12 per cent higher than the value got by Birge (NATURE, Jan. 28, 1928) from the ultra-violet data, and the agreement is as good as the method warrants.

Owing to the very large number of these progressions it will take some time to arrange them. The distribution of intensity among the bands presents different and interesting features in the various progressions, and the initial states evidently exhibit considerable variety. These bands, which extend from the ultra-violet right through the visible into the infra-red, account, together with the α, β, γ bands, for about half the total strength in the secondary hydrogen spectrum.

Many of these bands have an alternation in the intensity of the successive lines with a 3 to 1 ratio, such as was found to be characteristic of the strong bands of the α, β, γ series. These results now rest not only on the data of McLennan, Grayson-Smith, and Collins, but in the case of ${}_1A_2Q(m)$ they are confirmed by the intensity measures of Ornstein, Kapuscinski, and Eymers, and in the case of some of the α-bands by the intensity measures of Goos.

O. W. RICHARDSON.
P. M. DAVIDSON.

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Yield Variability in *Hevea brasiliensis*.

THE most perplexing problem of the rubber-planting industry is the variable yield capacity of different *Hevea* trees. The yields of individual trees range from half a pound to 12 lb. a year, and rare trees are known that have given regularly 30 lb. and more per annum. It is the presence of so many poor yielders (unrecognisable before the tapping age) that keeps down production. Crops per acre on the average estate seldom exceed 350 lb., and numerous tests have shown that most of this rubber is obtained from some 25 per cent of the trees.

Investigations into the causes underlying yield variations have been in progress at the different rubber research stations for many years, and it was thought at one time that the number of rings of latex tubes in the cortex—a factor which is correlated in some measure with yield—would, on closer study, prove to be the determining factor.

With the object of throwing some light on this problem, I commenced in 1922 a detailed study of a group of 250 *Hevea* trees. Anatomical investigations of the cortices of these trees have been made regularly every year, and some of the trees have been studied exhaustively from root tip to leaf tip. Since 1925, when tapping commenced, the yields of all the trees have been measured after each tapping, and attempts have been made to correlate yields with the anatomical characters noted.

The decisive results obtained will be embodied in a forthcoming publication. Meantime it can be stated here that my investigations conclusively show that the number of latex rings is at no stage sufficiently closely related to yield to justify one in regarding this as the chief determining factor. In the early life of the plant, the number of rings present is no guide to

the yield value of the tree, the correlation coefficient even so late as the fourth year being only about + 0·37.

With regard to the disposition of the various rings in the cortex, there appears to be nothing in the arrangements in the successive years from the third to the eighth which is likely to augment materially the value of the ring number factor as a dependable criterion of yield.

The inadequacy of the factor mentioned led me to investigate other characters, and in 1923 I discovered the existence of a relation between the bore of the latex tubes and yield. The great technical difficulties in the way of accurate measurement of average latex tube bore made progress in the study of this character extremely slow, but by the middle of last year I had definite evidence that the bore of the latex tube was the missing factor in the causation of yield variations. High yielders had, I found, large bored tubes, and poor yielders small bored tubes. Of particular importance was the discovery that trees in which the latex tubes have bores below a certain value never become high yielders.

Thanks to improvements made in technique, which enable measurements to be carried out with greater speed and accuracy, I have lately obtained complete confirmation of the previously discovered relation between latex tube bore and yield. Careful duplicated measurements of the latex tubes in the large group of trees mentioned have brought to light a striking correlation. Notwithstanding the disturbing effect of differences in the number of rings in the trees compared, the correlation coefficient of tube diameter with latex yield works out at the high figure of + 0·76 (P.E. ± 0·018). When the aberrations introduced by the variable number of latex rings are discounted by considering only the yield per ring, the correlation coefficient rises to + 0·83 (P.E. ± 0·014). (It may be mentioned here, for comparison, that the correlation coefficient of ring number with yield is only from + 0·3 to + 0·5 according to age of trees.)

It is interesting to find that latex yield increases much more rapidly than the square of the tube diameter. This is no doubt to be attributed to the disproportionate reduction in the internal resistances to flow which a slight increase in the bores of tubes of the order of latex tubes would bring about.

Other anatomical features, such as the density and disposition of the individual latex rings (the latter especially) are occasionally responsible for yield variations. If the disturbing influences of these two factors are taken into account, it will, I think, be evident that we now have, on the anatomical side at any rate, a fairly adequate explanation of the causes of yield variations in *Hevea brasiliensis*.

The practical value of the ascertained correlation between tube bore and yield is that it places at our service a character (defined early in the life of the tree) that can be used to distinguish potentially poor from potentially good yielders, for my observations show that for a rough initial classification, the latex ring factor can be ignored.

As to whether latex tube bore is a hereditary and constant character, there seems little doubt. Numerous one-year-old *Hevea* plants of vegetative origin have been found by me to have latex tubes of the same average bore as those of the 15- to 20-year-old trees from which the plants have been derived. Further confirmatory evidence has been provided by a recent examination of several hundred six-months-old nursery plants. In these, not only is a similar range of differences in latex tube bore observable, but roughly the same proportion of large, medium, and small bored plants occurs as among adult trees. It has, indeed, been found possible to classify *Hevea* plants by the new factor even at this early age, and although such a test bristles with difficulties, I am convinced that the detection of the 50 per cent odd plants found in every nursery that have latex tubes of too small a calibre to enable them to become good yielders can be made a practicable business. The elimination of such plants alone would be the means of doubling the productivity of future planted rubber areas.

It may perhaps be of general interest to botanists to know that I have also found a noteworthy correlation between the average cortex cell diameter and latex yield. This is only traceable in certain tissues, particularly the phloem parenchyma. Here also an agreement in cell size between *Hevea* trees and their budded offspring has been observed. Unfortunately, average cell size is, for many reasons, difficult to measure with certainty, and as a diagnostic character of yield capacity in *Hevea* (for which it was investigated) has too many pitfalls to be depended upon. However, the observation may not be without value also to those concerned with other branches of economic botany in which the vegetative organs are the source of the crop. HERBERT ASHPLANT.

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Diffraction of Cathode Rays by Mica.

A DIFFRACTION pattern was obtained by passing a cathode ray beam through a thin sheet of mica, with an apparatus similar to that used by G. P. Thomson in his interesting experiment on the diffraction of cathode rays by thin films of celluloid and some metals (*Proc. Roy. Soc.*, Ser. A, vol. 117, p. 600 ; 1928).

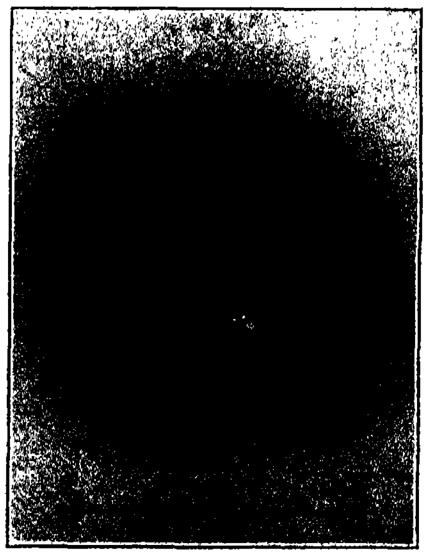


FIG. 1.

The pattern shows in some respect a resemblance to the Laue pattern of X-rays, but the most conspicuous feature of the former is quite different from that of the latter. In Fig. 1 is reproduced one of the photograms obtained, in which the distance between the crystal and the plate was 12 cm., and the voltage applied to the tube was about 50 kilovolts. As will be seen from the photogram, three sets of parallel bands intersecting each other at an angle of 60° form a net of triangular mesh, of which the net points are arranged into an array of spots. Some of the spots are remarkably intensified and somewhat elongated.

The distance between the parallel bands decreases

as the applied voltage is increased. The distribution of the intensified spots is also changed with the applied voltage. When a magnetic field is applied in the path of the rays, the pattern as well as the central spot are shifted. From the magnetic deflexion it is found that the primary rays are more or less heterogeneous, while the transmitted rays seem to be fairly homogeneous. The formation of the net-like pattern may be accounted for as due to the diffraction of short waves by a two-dimensional lattice placed perpendicular to the incident beam, or, in other words, the diffraction of the 'de Broglie waves' by a single layer of net plane parallel to the cleavage face with atoms arranged in a triangular lattice.

This explanation seems to be justified, as the distance of the bands gives a right order of magnitude for the atomic distance. The appearance of the intense spots may be due to the effect of a three-dimensional lattice, and therefore they may correspond to the Laue spots. The elongation of the spots is perhaps due to the distortion of the specimen.

Further experiments are being made.

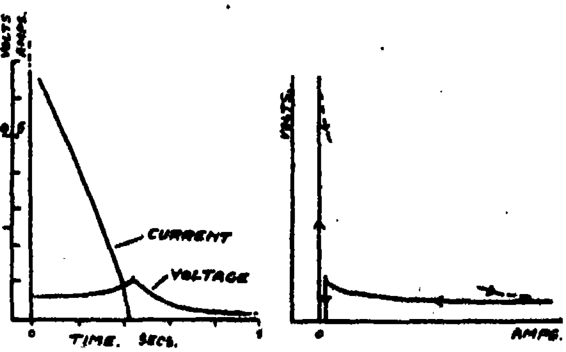
S. Nishikawa.
S. Kikuchi.

Institute of Physical and
Chemical Research,
Tokyo, May 14.

New Type of Discharge in Neon Tubes.

The new type of discharge described in Nature of May 19, p. 794, is evidently the same as that which I have produced when using a neon lamp as a safety device (*Proc. Leeds Phil. Soc.*, 1, 185; Nov. 1927). The method, although different, is similar in principle.

An ordinary 'Osglim' lamp, with the safety resistance removed from the cap, was connected across the coils of an electromagnet excited by 110 volts. This



(a) Fig. 1. (b)

is not large enough to excite the neon lamp, but if the current is suddenly broken a high E.M.F. will, of course, result on account of the self-induction of the coils. The presence of the neon tube, however, limits the rise of voltage, since its resistance falls to a low value when excited in this manner.

The behaviour of the neon tube under these conditions, which, as indicated by the nature of the discharge, was quite different from that when in normal use, was investigated in some detail. The results of these investigations agree in general with those already described in Nature (loc. cit.), and an account of them is to appear in the next issue of the *Proceedings* referred to, but one or two points of interest may be mentioned here.

The 'Osglim' lamp used was of the 'letter' type, as the bee-hive pattern did not stand up to the discharge so well. With the aid of a cathode ray oscillograph, curves giving the relation between current and voltage, current and time, and voltage and time, were obtained and photographed. Several exposures were of course necessary, but with suitable precautions it was possible to repeat any particular curve as often as desired.

The variations of voltage and current with time in a typical case are conveniently shown together in Fig. 1 (*a*); and (*b*) indicates the nature of the current-voltage curve. It may be seen that on breaking the current in the inductive circuit across which the tube is connected, the voltage rises with great rapidity (to 300-400 volts) and drops almost immediately to a low value (about 11 volts in this instance). At the same time the current rises to more than 6 amp., and, as Fig. 1 (*b*) shows, attains its maximum as the voltage reaches its low value. The resistance of the tube at this stage is between 1 and 2 ohms.

The extinction voltage (which varies somewhat as the conditions are altered) is also seen to be quite different from that usually found when the ordinary pink glow is seen. It was thought at first that the second rise in potential (Fig. 1 (*a*)) synchronised with a second increase in brightness which is usually observed, but the current is always zero before the second peak is reached. Sometimes as many as three or four flashes were seen, and there were other divergences from what may be regarded as the normal behaviour under these particular conditions, but it is not possible to discuss them here.

F. A. Long.

Physics Laboratories,
The University,
Leeds, May 26.

The Corpus Luteum and the Cause of Birth.

Recently, Dr. F. H. A. Marshall (*Biol. Rev.*, 2, 129; 1927) has examined the question of the relation of the corpus luteum to the causation of parturition. He has not reached any definite conclusion on the matter, but suggests that the stimulus for parturition may result from an ovarian-pituitary mechanism. Certain investigations which I have been carrying on for some time into the fœtal membranes and placentation of the marsupial *Bettongia cuniculus* have brought in their train observations which appear to show that the ovary has no influence whatever in causing parturition.

Bettongia cuniculus is a small diprotodont marsupial of the family Macropodidæ. A couple of hundred females of this animal have come into my hands in the last few years. *Bettongia* is polycœstrous, its breeding season lasting over seven or eight months of the year. Only one uterus is pregnant at a time, pregnancy being entirely unilateral. There is never more than one produced at a birth, there being only one ovum extruded from the ovary of one side. I have found no exceptions to these rules.

In the early stages of pregnancy the two uteri undergo identical changes, so that by external examination of the uteri alone it is impossible to say which of them is the pregnant one. The sterile uterus is therefore in a condition which is to be regarded as one of 'pseudo-pregnancy.'

It is now well established that uterine development, whether of pregnancy or pseudo-pregnancy, is a result of the stimulating influence of the secretion of the corpus luteum, and Hartmann (*Am. Jour. Phys.*, 71, 2, p. 436) has shown that the Marsupialia, as represented by the opossum, agree with the Monodelphia in this respect. In the case of *Bettongia*, the 'pseudo-pregnancy' of the sterile uterus must be induced by the corpus luteum of the contralateral ovary, seeing that there is no similar body in the

ovary of its own side. This confirms, in the living normal marsupial, observations made by Hartmann (loc. cit. p. 441) on pregnant opossums from which the uterus of one side and the ovary of the other had been removed. This supports, too, Hartmann's contention that operative interference had nothing to do with his results. When the egg in the pregnant uterus has reached the stage where it possesses a well-formed primitive streak, involution of the sterile uterus begins to take place, while the other uterus undergoes the usual enlargement associated with normal development.

Seeing that a single corpus luteum, situated in one ovary, influences, up to this stage, the activities of both uteri, is it not reasonable to suppose that, at the time of involution of the sterile uterus, the secretory activity of the corpus luteum has begun to wane? As such seems to be the case, it is obvious that parturition could scarcely be caused by the action of the corpus luteum.

The only other way of accounting for the regressive changes in the sterile uterus is to suggest that they may be due to some inhibitory influence, but it does not seem that any such influence could exist without involving both uteri.

T. THOMSON FLYNN.
University of Tasmania,
May 4.

Personal and Impersonal Styles in Scientific Communications.

DELIBERATELY encouraged by some editors, though not, I am assured, by the Editor of NATURE, a prejudice is growing against the use of the first person in scientific writings. If it were part of a more general prejudice against the increasing egotism of scientists (manifested, for example, in squabbles over priority and the assignment of credit), it would be admirable, though probably futile. But it is not; it is merely the stylistic fad of the moment, and is wholly contemptible. Truly, it is not well to be always saying 'I'; but there is no virtue, moral or literary, in the mechanical substitution of the third person for the first. The literary vice is not the repetition of pronouns or of any pronoun in particular; it is needless repetition in general; pronouns are mentioned specifically only because it is particularly tempting to repeat them too often. It is very much worse to repeat a cumbrous and artificial phrase than to repeat a pronoun; and when we find our pages, sedulously cleared of 'I's,' besprinkled with 'the present writer' and 'the author of the present paper,' it is surely time to protest against a Pharisaical misinterpretation of the Law.

Pedants are too often ingenious in excusing their sins; and somebody will probably discover literary sanction even for this last abomination, perhaps in the introductions to the Waverley novels. I would therefore insist that, even if Scott's circumstances had been normal, even if he had said 'the present' when he meant 'this,' Scott and his like, for all their excellencies, would still not be fit models for those whose first duty is to be brief and direct. If we must imitate anyone, let it be the masters of our craft; let us try to learn from Faraday, Rayleigh, Huxley, and many others how to say 'I' freely, naturally, with elegance and with dignity.

For there are real difficulties, peculiar to scientific writing, that it would be foolish to ignore. An analysis of about 200 of the worst flounderings in recent journals suggests that they arise in three ways. First, Prof. Smith wants to refer to his own earlier work, but does not like to say 'I found in 1924 . . .' Why should he not denote himself, as he would any other person, by his name, and say, 'Smith found . . .' Second, impersonal narrative becomes tedious; we want to vary 'The next experiment was . . .' with 'Then I tried . . .' Why should we not? The pronoun here is quite unobtrusive; for no emphasis can fall on it, as reading aloud will show. Last, we want to make a personal statement, distinguishing our opinion from facts or from the opinions of others. Here a moral issue is raised. If we are not prepared to make a personal statement in personal form, are we justified in making it at all? Can true modesty, or any other virtue, permit me to occupy valuable space in airing my views and yet forbid me to call them mine?

NORMAN R. CAMPBELL.

The Arc Spectrum of Chlorine.

REGULARITIES in the arc spectrum of Cl were first discovered by Turner (*Phys. Rev.*, **27**, 397; 1926), who found three pairs showing the difference 880 cm.$^{-1}$. A consistent extension of this work into the visible, and theoretical interpretation has, however, never been attempted, especially because the separation of the chlorine lines into arc and spark lines had not been possible. Thus the data given in Kayser's "Handbuch" contain lines of both types.

Recently Mr. K. Asagoe, of this laboratory, has been able to identify 23 arc lines in the region between 4700 A. and 4200 A. The method is similar to that used by Wood and Kimura (*Astrophys. Jour.*, **46**, 181; 1917) in separating the arc and spark lines of iodine. An examination of these Cl lines shows that they form the combination $4s^{4\,2}P - 4p^{4\,2}(S, P, D)$. The frequency differences between the five lower levels are 530·4; 338·7; 1399·1; 640·8 cm.$^{-1}$. Attention has already been directed to the first of those by de Bruin (*Amsterdam Proc.*, **30**, 19; 1927). But these are just the differences which one finds between Turner's lines in the far ultra-violet region. They must consequently be identified as ${}^2P(3p^6) - {}^{4\,2}P(3p^5, 4s)$. In the following table the individual lines, their intensities and levels, are given:

1396·5	3	${}^2P_1 - {}^4P_2$	1351·7	3	${}^2P_2 - {}^2P_1$
1389·9	4	${}^2P_2 - {}^4P_3$	1347·2	5	${}^2P_2 - {}^2P_2$
1379·6	5	${}^2P_2 - {}^4P_2$	1335·8	2	${}^2P_2 - {}^2P_1$
1363·5	5	${}^2P_1 - {}^2P_2$			

All the lines found by Turner are thus accounted for. Although the terms arising from the configurations $(3p^6)$ and $(3p^5, 4s)$ are still approximately 'normal,' that is, the corresponding vector coupling is of Russell-Saunders type, the higher term group arising from $(3p^5, 4p)$, which the visible lines have as initial state, has a decidedly different character; this term group is—as one usually puts it—of 'higher rank.' The situation is quite similar to that in the arc spectrum of argon, where, according to the classification of Meissner (*Zeit f. Phys.*, **39**, 172; 1926), the four $4s$ levels arise from a Russell-Saunders coupling, whereas the ten $4p$ levels which are grouped quite irregularly, are apparently due to some intermediate coupling (Goudsmit-Uhlenbeck). There is consequently a certain ambiguity in assigning l-values to the $(3p^5, 4p)$ group. However, the weakness of intercombinations leads to a distinction between doublet and quartet levels.

Corresponding results in bromine and iodine have been obtained, but the work is still in progress.

My thanks are due to Prof. M. Kimura, through whose kindness my stay in Kyoto has been possible.

OTTO LAPORTE.
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Imperial University,
Kyoto, May 6.

The Influence of Gravitation on Electromagnetic Phenomena.[1]

By Prof. E. T. WHITTAKER, F.R.S.

IN the Bakerian Lecture of 1850, Faraday described a series of experiments which he had made in searching for a connexion between gravity and electricity. "The long and constant persuasion," he said, "that all the forces of Nature are mutually dependent, having one common origin, or rather being different manifestations of one fundamental power, has made me often think upon the possibility of establishing, by experiment, a connexion between gravity and electricity, and so introducing the former into the group, the chain of which, including also magnetism, chemical force, and heat, binds so many and such varied exhibitions of force together by common relations."

The results of Faraday's experiments were negative; but, he said, "they do not shake my strong feeling of the existence of a relation between gravity and electricity, though they give no proof that such a relation exists." The proof was, indeed, not obtained until seventy years afterwards, when the measurements of photographic plates taken at the eclipse of May 1919 showed a deflexion of the rays of light from stars when the rays pass close to the gravitating mass of the sun.

The general theory of relativity, by which this deflexion was predicted, asserts that the presence of matter or energy in any region of space affects the metric in that region; as we may say, it causes a 'curvature' or 'distortion' of space, which not only determines all the gravitational effects in the region, but also has a remarkable influence on any electromagnetic phenomena which may be taking place there. This is the true solution of Faraday's problem.

It is important to notice that gravity and electricity have been brought into connexion in essentially the same way as light and electricity were brought into connexion by the Maxwellian electromagnetic theory of light, namely, by postulating that the same 'ether' transmits both kinds of actions. It is true that we do not speak much of the ether nowadays, and certainly do not regard it as a quasi-material medium filling all space; but when we endow space itself (or, in non-statical problems, space-time) with properties such as curvature, we are making it play the part of an ether. The principle that one and the same ether ought to serve for all purposes was enunciated by Faraday himself: "It is not at all unlikely," he said, "that if there be an ether, it should have other uses than simply the conveyance of radiations."

In what follows I shall make the simplifying assumption that the gravitational field is 'statical,' that is, such as would be produced by gravitating masses which are permanently at rest relative to each other, so that the curvature of space at any point does not vary with the time. In the distorted space of this fixed gravitational field, I suppose an electromagnetic field (either statical, or varying with the time) to exist; strictly speaking, the electromagnetic field has itself a gravitational effect, that is, it changes the metric everywhere; but this effect is, in general, small, and we shall treat the ideal case in which it is ignored, so we shall suppose the metric to be simply that of the gravitational field originally postulated.

The problem before us, therefore, is to study the existence and propagation of electromagnetic fields in a medium whose properties (that is, the distortions of space) vary from point to point, and this naturally suggests a comparison with the Maxwellian theory of electromagnetic fields in a medium the specific inductive capacity and magnetic permeability of which vary from point to point. Do the effects of the distortion of space resemble in any way the effects of a variable dielectric constant and permeability?

The answer is in the affirmative, though the resemblance is not quite perfect. In a gravitational field there are eight partial differential equations which have exactly the same form as the usual Maxwell's equations, but in place of the three simple linear equations which connect the components of the electric displacement of the Maxwellian theory with the components of the electric force, and the three equations which connect the components of the magnetic induction with the components of the magnetic force, we now have six linear equations which express six of the twelve components in terms of all the six others.

Thus, from the mathematical point of view, the problem is similar to that of the Maxwellian electromagnetic field in a medium the dielectric constant and magnetic permeability of which have a kind of six-fold æolotropy. A prophetic adumbration of all this is to be found in a remarkable sentence written by FitzGerald so long ago as 1894: "Gravity is probably due to a change of structure of the ether, produced by the presence of matter."

To learn what happens we must solve these equations, and, as a first and simplest case, let us suppose that the electromagnetic disturbance is a ray of light. In this case it is not necessary to obtain the complete solution of the partial differential equations, since we can make use of the theorem that "a ray of light is a null geodesic of space-time." Let us, then, suppose that the gravitational field is due to a single gravitating mass, which we may call the 'sun,' and let us find the null geodesics of this field, which will be the paths of rays of light in the field of a single gravitating centre. We find that a ray of light which comes from infinity and does not pass too near the 'sun' is simply deflected through a small angle, in the same way as the light from stars was actually found to be deflected in the eclipse photographs. But if it is aimed almost directly at the mass (which, it must be remembered, we are supposing to be collected in a point-centre), much more interesting things may happen. Thus if a certain constant

[1] From a lecture delivered to the London Mathematical Society.

depending on the initial conditions has a particular value, we obtain light-rays which are spirally asymptotic to a certain circle surrounding the 'sun'; one type of ray represents light which, coming from infinity towards the mass, is 'captured' by it, and never gets away again, but circles round it for ever; another type of ray, on the other hand, represents luminous energy which is, and always has been, imprisoned in the immediate neighbourhood of the mass.

These phenomena cannot be observed in the case of our actual sun, because its mass is not sufficiently concentrated: the sun's bulk prevents the light rays from getting close enough to its centre; but it seems conceivable that, at the nucleus of an atom, we may have a concentration of mass into a space so small that the capture of light by an intense gravitational field may be realised.

To pursue this matter somewhat further, let us consider the field round a point-mass. If we draw round this mass a circle, the length of the perimeter of the circle may be denoted by $2\pi R$, a definition which determines the physical meaning of the quantity R. But the normal distance between two adjacent circles, of perimeters $2\pi R$ and $2\pi(R - \delta R)$, is *not* δR, but δR multiplied by a multiplier which increases indefinitely as R approaches a certain value a which depends on the sun's mass: that is to say, as we approach the circle of perimeter $2\pi a$ from outside, we find greater and greater difficulty in making any headway; we have to travel a very great distance in order to pass from one of these circles to another just inside it, the perimeter of which differs from it only very slightly, and we can never actually attain to the circle with perimeter $2\pi a$.

If, then, we consider a ray of light coming from infinity and travelling directly towards the point-mass, the velocity of the light will always be c; but when it begins to approach the circle of perimeter $2\pi a$, this velocity will only be sufficient to carry it onwards very slowly, if we measure its progress by the rate of diminution of perimeter of the circles it cuts through, and it can never, in any time however great, get nearer to the mass than the circle of perimeter $2\pi a$.

Thus, although the light is actually travelling for ever with its usual velocity, it remains permanently in the neighbourhood of the point-mass. The capture and imprisonment of radiation by the intense gravitational field surrounding a point-mass is a remarkable theoretical possibility, markedly different from anything in pre-relativity physics.

Let us now leave the consideration of light rays and pass on to other kinds of electromagnetic phenomena. The mathematical difficulties here are greater, since we now cannot avoid the partial differential equations; but they can be solved in many cases, provided that we take the simplest possible type of gravitational field, which may be arrived at in the following way. Consider the field due to a single gravitating centre, and, fixing our attention on the neighbourhood of a point O, suppose the gravitating centre to be removed to a very great distance from O, while its mass is increased, so that the attractive force at O (to use the language of the older physics) remains finite and equal to g; then we obtain what we may call a *quasi-uniform* gravitational field. In the neighbourhood of O it is essentially the 'uniform gravitational field' of the old physics.

Let us now consider the shape of the equipotential surfaces in a quasi-uniform gravitational field, due to a single electric charge at (say) the origin. We find that these equipotential surfaces are a family of coaxal spheres, having one limiting point at the origin. Thus the difference which a quasi-uniform gravitational field makes to the equipotential surfaces of a single electric charge is that, instead of being concentric spheres, they become coaxal spheres—they become more crowded together on one side of the charge, and less crowded on the other. The effect is exactly the same as if we supposed that, instead of having a gravitational distortion of space, we had the specific inductive capacity and magnetic permeability of the medium each varying as we move in the gravitational field, so that the medium is stratified at right angles to the direction of gravitation.

From these calculations we can deduce a physical result of some interest. Suppose we have an electric charge at rest at the origin, and suppose we have initially a quasi-uniform gravitational field in some particular direction, and that we then reverse this so as to have a quasi-uniform gravitational field in the opposite direction, and then reverse back to the original state of things, and so on. At each reversal the electric equipotential surfaces will change from being a family of coaxal spheres with their second limiting point in one direction, to a family of coaxal spheres having their second limiting point in the opposite direction. But this regular alternation of the electric field must set up radiation, just as the alternation of the electric field in a Hertzian oscillator does: and therefore an electron at rest in a varying gravitational field will, in general, emit radiation.

The knowledge that a motionless electron may radiate, while (as a natural consequence) an accelerated electron does not necessarily radiate, in a gravitational field, may prove useful in accounting for the behaviour of electrons in atoms.

Let us now pass on to the case when the gravitational field is that due to a single gravitating mass at a point, so that we have Schwarzschild's metric. The solution which represents the potential of a single electric charge, and therefore corresponds to the $1/R$ of the ordinary theory, has recently been discovered by Mr. Copson.[2]

The form of the equipotential surfaces is remarkable. Very near the electric charge they are, of course, practically spheres the centre of which is at the charge. But as we get farther from the charge and nearer to the gravitating mass, the equipotentials behave as if they were repelled by the mass, so that eventually they become concave to it (and therefore convex towards the charge!), the mass being in a cup-shaped depression in the

[2] *Proc. Roy. Soc.*, A, 118, 184; 1928.

equipotential surface. Eventually we reach an equipotential which consists of two closed surfaces touching each other, one (the smaller one) enclosing the gravitating mass but not enclosing the charge, while the other (the larger one) encloses this smaller surface and also encloses the charge. Beyond this, again, we have a series of simple closed surfaces, each of which encloses all the earlier members of the family.[3]

The electric field is precisely the same as would be obtained, in the ordinary electrostatics, by supposing that the specific inductive capacity and magnetic permeability of the medium vary in a certain way with the distance from the gravitating mass.

Solutions of the fundamental equations have been found which represent more complex fields than those I have described; but they are perhaps not well suited for description in a lecture,[4] and I will therefore conclude with a remark about energy. In a *statical* gravitational field, electromagnetic energy is a scalar quantity, so we can calculate the 'total electromagnetic energy' contained in a specified region of three-dimensional space by integrating the amounts of energy contained in the sub-regions into which the region may be divided; and the conservation of electromagnetic energy holds. In *non-statical* gravitational fields these theorems are no longer true, since energy is not then a scalar quantity; the energy in one region is different in kind from the energy in another region, just as momenta in different directions are different in kind from each other.

[3] A figure is given in Mr. Copson's paper, loc. cit.

[4] Reference may be made to *Proc. Roy. Soc.*, A, 116, 720; 1927.

Heirlooms of Industry in the Science Museum.[1]

By Col. Sir HENRY G. LYONS, F.R.S.

THE idea of a general museum of science is only seventy-five years old, and was due to the Prince Consort, who, after the Great Exhibition of 1851, urged the formation of an institution which would extend the influence of science and art on productive industry. From this proposal arose the Science and Art Department with, as an essential part of it, the South Kensington Museum, the dual activities of which are now represented by the Science Museum and by the Victoria and Albert Museum respectively.

For a long time previous to this, scientific instruments, pieces of apparatus, mechanical devices, and such like had been preserved in many places, but a museum designed to illustrate the influence of science on technical development did not exist; even the Museum of the Conservatoire national des Arts et Métiers in Paris, which dates from the end of the eighteenth century, was, and still is, primarily the teaching collection of the Conservatoire. Recently technical museums having similar aims have been established at Munich in 1903, and at Vienna in 1919; others illustrating special industries are to be found in many cities.

While no one will dispute the utility of technical museums, it must be admitted that they fall far short of art museums in the attractiveness of the objects which they contain, and this fundamental difference affects every stage of museum arrangement. For the objects in a technical museum to be interesting, something of their history and their purpose, the part which they have played in the age-long development of the branch of industry to which they belong, must be known to the visitor, and to this end carefully edited labels are essential; important objects may be so displayed that the internal working parts can be seen, and their purpose understood; coloured diagrams and specially arranged illumination may be employed; models, etc., may be shown in motion; others may be so arranged that they can be set in motion by the visitor; all this being done with the object of supplying essential information in a form intelligible to the general visitor, with additional technical description for the specialist.

The dominating principle in such a museum must be to illustrate development. Everything, whether it be an industry, or a group of related objects, or a type of tool, is shown so as to emphasise the successive stages of development which have been traversed from early crude forms which sufficed in the days of hand labour through various grades of slow improvement to the rapid advances of modern times so effectively aided by steam and electricity. In some branches of human activity it is instructive to show a few examples from the times of the earliest civilisation, and from the handiwork of primitive races who exist to-day. In this way the story of time measurement, of various hand tools, and of land and water transport for example, can be illustrated far more effectively and attractively than if the exhibits were restricted to those dating from the last few centuries.

To take the case of an industry, aeronautics furnishes a convenient example of rapid development, for air transport has grown from its first experimental stages to an important branch of world communication within the lifetime of many of us. The series exhibited in the Science Museum begins with the first power-driven model aeroplane which John Stringfellow constructed in 1848, and which achieved a free flight of forty yards. Later on experiments in 'gliding flight' were of great importance in providing information on many points in aerodynamics, and Otto Lilienthal was its greatest exponent. One of his gliding machines of 1896 is exhibited. During the next seven years Prof. Samuel P. Langley, of the Smithsonian Institution at Washington, designed and constructed a man-carrying tandem monoplane, of which a model is on exhibition, but it failed to make a successful flight when tried in 1903.

Inspired by the experiments of Lilienthal in

[1] Synopsis of a discourse delivered at the Royal Institution on Friday, April 20.

gliding flight, the brothers Wilbur and Orville Wright, of Dayton, Ohio, carried out a large number of gliding flights during several years after Lilienthal's death, and the success which they achieved encouraged them to construct their first power-driven aeroplane, with which they made their first successful flights on Dec. 17, 1903, the longest being one of fifty-nine seconds, when the distance covered was 852 feet. The aeroplane with which they made their flight is now on exhibition in the Museum, having been lent by Mr. Orville Wright. Another important example is Mr. A. V. Roe's light tractor triplane, which was built and flown by him in 1909, and is remarkable for low power of the engine, a 9 h.p. twin-cylinder J.A.P. engine. Another interesting type is the Antoinette model, of French design, which was flown across the English Channel by H. Latham in July 1909. Mr. S. Cody's machine, which he used in the military manœuvres of 1912, is also preserved in the Museum as an instructive type of pre-War aeroplane. This series is fittingly concluded by the Vickers-Vimy Rolls-Royce aeroplane on which Sir John Alcock and Sir Arthur Whitten Brown made the first direct trans-Atlantic flight in June 1919. The extraordinarily rapid development of this form of transport is strikingly demonstrated by the fortunate juxtaposition in the gallery of the Museum of the Wright Brothers' aeroplane, which flew 284 yards in 59 seconds in December 1903, and the Vickers-Vimy aeroplane, which covered 1890 miles in 15 hours 57 minutes in June 1919, only 15½ years later.

Road transport also provides a series in which the transition from early types to modern practice is strikingly shown—that of the bicycle. Starting from the hobby-horse of 1818, the first practical form of two-wheeled machine was the early bicycle invented by Kirkpatrick MacMillan, a blacksmith, of Dumfriesshire, in which he anticipated the rear-driving safety bicycle of forty years later. Michaux's bicycle of 1865, one of the so-called 'boneshakers,' the Starley Spiderwheel Bicycle, and Lawson's bicyclette of 1879, bring us to the safety bicycles of to-day.

Just as in an industry, so with each tool or machine, the successive stages by which the early form has advanced through others of increased efficiency, or of greater convenience, bear witness to the inventiveness of successive generations, and, wherever possible, this is illustrated. Miners' lamps are represented by a long series, including every type of importance from Sir Humphry Davy's to the latest pattern of the modern lamp. In the same way a most instructive series of radio-valves, beginning with original valves of Prof. Fleming, and continuing through many modern types, illustrates the rapid advances made in a modern instrument of great economic importance.

In machine tools, the primitive form of lathe, in which the work is rotated by means of the forward and backward movement of a bow held in the right hand, was long in use and still exists in some countries, but it was replaced later by the spring beam, or pole drive, and this type is still used by the chair-makers of High Wycombe. About 1800, Henry Maudslay combined the slide rest and the use of a lead screw with change wheels for the production of screw threads, and the first workshop tool in which Maudslay embodied his invention is preserved in the Museum. A further advance is shown by Roberts's back-geared slide lathe of 1817, after which examples of the most modern types of workshop lathe complete the story.

The early history of the hammer is illustrated among the hand tools, where there is one of the diorite hammer stones which were used to hammer out the shafts of granite for the obelisks of ancient Egypt; but when greater power was needed mechanical devices were adopted. A lift hammer of 1556 is shown by a model, and lift and tilt hammers were still in use at the beginning of the nineteenth century; two hammers which were erected in Portsmouth Dockyard in 1804 by Simon Goodrich are shown by a model. In 1839, James Nasmyth invented his steam hammer, which is represented by a working model; and other models show the various improvements which were introduced at later dates. The great power presses of to-day are too large and heavy to be shown, but illuminated photographic transparencies are utilised to show the form and character of those used in modern practice.

The early forms of any machine or tool are now of the greatest interest to us as we compare them with later developments, but only in few cases have they been preserved. The first design is modified and improved: its importance is thereby diminished; and it is not until much later that its historical value is realised. By that time it has usually disappeared. Fortunately, a considerable number of such early types have been acquired from time to time for the nation, among which are:

Arkwright's original 'drawing frame' of 1780, in which the drawing of cotton is effected by successive pairs of rollers revolving at increased rates of speed.

Two of James Watt's double acting rotative beam engines of 1788 and 1797, of which the latter is shown in motion. Among locomotives, the original *Puffing Billy* of 1813 and the *Rocket* of 1829 are the most important of four which are shown.

In marine engineering, among many notable landmarks, are the engine of Bell's *Comet*; also the T.S. *Turbinia*, and the turbine engines with which she steamed thirty-five knots at Spithead in 1897.

The collection of ship models contains a number of early and important contemporary models which furnish details of hull construction and of rigging which are not otherwise obtainable; they include a model of Christopher Columbus's ship, the *Santa Maria*, which was presented by the Spanish Government; the *Prince*, which was built at Chatham by W. Pett in 1669; also a contemporary model of a 64-gun man-o'-war of 1805, which has supplied much information for the recent re-rigging of the *Victory* at Portsmouth. Another very instructive model is that of a yacht

of 1660, built in the style of the Dutch vessels of that period.

The wholesale disappearance of the earliest forms of technical instruments, to which reference has already been made, has often deprived us of all but a single specimen of its type. An accurate copy is then the only way of representing it in a collection, and in recent years a number of reproductions of this kind have been acquired by the Museum. They include an astronomical instrument of Egypt (the 'merkhet') which was used for setting out lines, and for determining the time by observing the passage of selected stars over the meridian, and a shadow clock of the same country, both dating from about the eighth or tenth century B.C.; the 'groma,' as used by the Roman land surveyors, and also one of their 10-foot rods; two telescopes made by Galileo, which are now preserved at Florence; Newton's reflecting telescope, made by himself, and now in the possession of the Royal Society; and a copy of a fourteenth century rain-gauge from Korea.

It only occasionally happens that the life-work of one of the great inventors of the past can be suitably shown in a museum, but in the case of James Watt, the attic workshop in which he worked during the last twenty years of his life has been reproduced, and in it are placed all the machines, tools, and other contents of the original room at Heathfield, near Birmingham.

Obituary.

Prof. Otto Nordenskjöld.

DR. OTTO NORDENSKJÖLD, professor of geography in the University of Göteborg, died on June 2, at the age of fifty-eight, as the result of a street accident sustained two days before. A nephew of the great Swedish explorer and scholar, Baron A. E. Nordenskiöld, his attention was turned to natural science at an early age, and as a student at the University of Upsala he specialised in geology. He was appointed lecturer on mineralogy at Upsala after taking his degree in 1894.

The spirit of Linnæus broods over his old university, and the young Otto Nordenskjöld felt the old urge which for nearly two hundred years has sent out Swedish naturalists as pioneer-explorers to all parts of the earth. In 1895 he organised his first expedition, when he led a party of Swedish men of science for a summer's work in Tierra del Fuego in order to compare the geological formations, the fauna and flora of that southern archipelago, with those of north-western Europe. The glacial deposits attracted his attention in particular, and after the return of his companions he proceeded to the little-known lake-district of southern Patagonia, where the Cordillera of the Andes is interpenetrated by the fjords of the Pacific and where a narrow zone of sharp transition separates the wooded slopes exposed to the wet west winds from the dry gravel plateaux of the pampas. The region, then unexplored and uninhabited, was of special interest at the time, because of the dispute between Chile and the Argentine Republic as to the delimitation of the boundary set out in the treaty as "the highest summits of the Cordillera forming the watershed," and Nordenskjöld's demonstration that the watershed showed no relation to the Cordillera foreshadowed the compromise which Sir Thomas Holdich's subsequent arbitration commission happily settled. In the summer of 1898, Nordenskjöld conducted a small scientific expedition to the Klondyke region of Canada, then at the height of the gold rush.

On returning from this expedition Nordenskjöld found the interest of European geographers concentrated on Antarctic research, to which his own attention had first been directed at the Sixth International Geographical Congress in 1895. The *Belgica* expedition had just returned from its experience of the first Antarctic night, the *Southern Cross* expedition under Borchgrevink was wintering for the first time on the Antarctic continent, and preparations for two great national expeditions, working on a common plan in different regions, were going forward rapidly in Great Britain and Germany. Nordenskjöld determined that Sweden should take its part in Antarctic research; he set himself to the tremendous task of raising funds by private and public appeals to the small circle of scientifically minded Swedes. In order to gain personal experience of polar conditions he went to East Greenland as a member of Amdrup's expedition of 1900. He succeeded in fitting out an expedition in time to take part in the simultaneous series of observations. He was fortunate in securing Capt. C. A. Larsen, a Norwegian who had already had experience in the Weddell Sea, to command his ship the *Antarctic*, and in enlisting a very able body of scientific assistants. Early in the Antarctic summer of 1901–2 he reached his base at the farthest accessible point in the Weddell Sea on the east coast of Graham Land, while the *Gauss* under Prof. E. von Drygalski (now the sole survivor of the Antarctic leaders who started their work with the present century) and the *Discovery* under Capt. Scott took up their stations at two far-distant points on the circumference of the continent. A year later the *Scotia* under Dr. W. S. Bruce completed the first of the great combined international efforts to study the physical conditions of Antarctica.

Nordenskjöld alone of the four decided to send his ship back after landing, in the expectation that she should return the following year to take him off. He passed the winter of 1902 at Snow Hill in 64° 27′ S., carrying on meteorological and magnetic observations, and on the approach of summer making large geological and zoological collections. He found the conditions adverse to any extended sledge journeys from his base, though he discovered King Oscar Land, and followed its coast to 66° S. On returning he eagerly awaited the return of the ship which never came. A second winter had to be spent in the hut, but the observations were

continued steadily until in the summer of 1903–4 an Argentine vessel appeared to bring him back to civilisation. The *Antarctic* had found the ice conditions of the previous year so bad that a party was landed to attempt to reach Snow Hill by sledging over the coastal ice, while the vessel returned northward in the hope of getting in towards the land farther east. The Weddell Sea proved inexorable and the ship was crushed and sank. Larsen and his crew wintered in a hut, Gunnar Andersson and his land-party in another, and by the most dramatic coincidence in the history of exploration, both parties arrived at Snow Hill just in time to return as a united expedi- with Capt. Irizar in the *Uruguay*.

On his return to Europe, Nordenskjöld was appointed professor of geography in the University of Göteborg, where he continued to occupy himself in preparing the full report of the results of his expedition, the publication of which was facilitated by a grant from the Swedish government. The Antarctic gives no rest to a man who has once come within the field of its attraction, and Nordenskjöld, like Scott and Shackleton, set his heart on a second and greater effort to get at the baffling problems of south polar geography, glaciology, and geology. By 1913 he had worked out, in conjunction with Admiral Palander, a scheme for an Anglo-Swedish expedition, and obtained promises of support from his own government and from influential authorities in Great Britain. The outbreak of war in 1914 put an end to the preparations, and he never saw the Antarctic again. In 1909 he had visited West Greenland, and since the War he made frequent visits to Spitsbergen and Iceland, continuing his earlier studies in Arctic geology. In 1920 he revisited Patagonia with a party of Swedish geologists, following the discovery of remarkable fossil reptiles.

During his tenure of the professorship at Göteborg, Nordenskjöld had always inspired his students with the spirit of research and maintained the high traditions of Swedish explorers and students of Nature. He was modest and unobtrusive in his manner, but insistent and persevering in the promotion of exploration and research. As a leader he was less a commander than a trusted comrade and a constant friend. An enthusiast in the search for knowledge, he was indifferent to the spectacular publicity which gratifies small-minded ambition. He always maintained the happiest relations with the geographers and polar explorers of other countries, and he will be greatly missed by many friends in all parts of the world, whose sympathy goes out to his widow and children. HUGH ROBERT MILL.

DR. J. A. THOMSON.

DR. JAMES ALLAN THOMSON, who passed away on May 6, was at the time of his death director of the Dominion Museum in Wellington, New Zealand, and also president of the New Zealand Institute. Notwithstanding ill-health, he had a very distinguished career. He was the first New Zealand Rhodes Scholar, and went to St. John's College, Oxford, in 1906, where he was awarded the Burdett-Coutts Scholarship, and later he was appointed to a lectureship in geology at St. John's.

Leaving Oxford in 1908, Thomson worked on the geology of the Western Australian goldfields, and published several papers relating to them. He was chosen senior geologist for the second Scott Expedition in 1910, and went to Sydney to work with Sir Edgeworth David with the view of preparing himself for his work. Unfortunately, at this point in his career, the first signs of the disease to which he ultimately succumbed began to show, and, greatly to his own disappointment, and that of others, he was not allowed to go with the expedition.

Returning to New Zealand, Thomson joined the Geological Survey as palæontologist, a position which he held until 1914, when he was appointed to succeed the late Mr. A. A. Hamilton as director of the Dominion Museum, and in spite of failing health he continued to occupy this position until the end. Though repeatedly forced to lay aside his work and battle with disease, his scientific activities never ceased for long and his interest in scientific matters was never dulled. He published many papers on geological subjects, and during the last six years of his life he was busily occupied on a monograph on the brachiopods, a work which he lived just long enough to finish and to see in print.

For his geological work, Thomson was awarded the Hutton Medal of the New Zealand Institute, and last January was elected president of the Institute; he was also one of its original fellows. His death removes a scientific worker of the highest ideals and a man of exceptionally attractive personality; in the face of much physical weakness he maintained an unconquerable cheerfulness. He died of tuberculosis at the early age of forty-seven years. C. C. F.

PROF. JOHANNES GADAMER, Director of the Pharmaceutical-Chemical Institute in the University of Marburg, died on April 15 at the age of sixty-one years. A native of Waldenburg, in Silesia, he was appointed professor of pharmaceutical chemistry at the University of Breslau in 1902, and in 1919 he succeeded the late Prof. Ernst Schmidt at Marburg. Gadamer worked upon many alkaloids and glucosides. He also edited the *Archiv der Pharmazie* and published a "Lehrbuch der chemischen Toxikologie." After the death of Prof. E. Schmidt, Gadamer undertook the completion of his book, "Ausführliches Lehrbuch der pharmazeutischen Chemie."

PROF. G. SCHULTZ, Director of the Chemical Technical Laboratory in the Technische Hochschule at Munich, died at the end of April, aged seventy-six years. A native of Finkenstein, in West Prussia, Schultz spent several years in the Berlin laboratories of the aniline dye factories, becoming later factory director at Basel. In 1896 he was appointed to the chair of chemical technology in Munich. He was the author of well-known standard works, including "Die Chemie des Steinkohlenteers" and "Farbstofftabellen."

News and Views.

Apart from the 'news value' of the woman passenger, the latest Atlantic flight is mainly of technical interest. The *Friendship* is a Fokker F VII float monoplane with high-set, deep-section wing, driven by three Wright-Whirlwind engines of 150 kw. each. Taking the empty machine as 3·3 tonnes, crew, etc., as 300 kgm., fuel and oil as 3 tonnes, the total starting weight would be about 6·6 tonnes. The route chosen was a small circle from Newfoundland to Valentia, but in the prevailing fog the seaplane alighted 600 km. farther on, near Llanelly, on the south coast of Wales. A geographical distance of 3300 km. was covered in 21 hours at an air speed of 130 km. per hour, with a following wind of 30 km. per hour according to estimates. Navigation was almost entirely by compass and dead reckoning, and the accuracy with which the course was maintained indicates a fortunate absence of serious changes in the magnitude of the cross wind. The flight may be compared with the distance of 5200 km. from New York to Paris covered, solo, by Lindbergh in an aeroplane of one-third the size and power. The performance, measured in ton-miles in proportion to the total weight, is heavily in favour of the smaller aircraft.

Renewed efforts to reach General Nobile and his companions have met with success. On June 20, Major Maddelena, in an Italian aeroplane, flew over General Nobile's camp on the pack-ice to the north of North East Land. He found it impossible to land, but dropped supplies of food, clothing, guns, and ammunition. General Nobile's party totals seven, including Prof. Behounek. On June 23, a Swedish machine succeeded in landing by General Nobile's camp. General Nobile himself was picked up and brought to Whale Island, and thence to his base ship the *Citta di Milano* on the following day. Swedish aeroplanes have been searching the coast for Prof. Malmgren and his two companions, who left the main camp and travelled westward to find help. Several steamers are at hand waiting in the hope of the ice opening, as is not improbable shortly, and Soviet ice-breakers are in Spitsbergen waters. These should be useful if loose pack or young ice bars the way, but it is unlikely that they could force a way through the heavy ice off North East Land. At the time of writing there is no news of the remainder of the *Italia's* crew who drifted away with the wrecked airship. Capt. R. Amundsen with Com. Guilbaud left Tromsö on June 18 in a French aeroplane to take part in the search. His plans were uncertain, and lack of news of his movements need not be taken to imply disaster. His aeroplane had a cruising radius of nearly 3000 miles, while the distance from Tromsö to General Nobile's camp is about 1000 miles. Norwegian and French warships have been sent north to help in the search.

Physical chemists of all shades of opinion will wish to associate themselves with the two hundred and more colleagues and students of Prof. Sydney Young, who, on June 15, offered, in an address, their congratulations on the occasion, a few months ago, of his seventieth birthday, their high appreciation of his services to the progress of physical chemistry, their regret on learning of his resignation from the chair of chemistry at Trinity College, Dublin, and their cordial good wishes for long and happy—in fact, active—leisure years. Prof. Sydney Young, whose name is associated in the minds of all chemists with investigations of fundamental importance on vapour pressures, boiling points, and specific volumes of liquids and mixtures of liquids, on the efficiency of apparatus for distillation, and on the quantitative aspect of fractional distillation, is a Lancashire man, his birthplace being Farnworth, near Widnes. In 1882 he was appointed lecturer and demonstrator at University College, Bristol, and occupied the chair of chemistry there from 1887 until 1903, when he became professor of chemistry at Trinity College, Dublin. Prof. Young was elected a fellow of the Royal Society in 1893; he was a member of the council of the Chemical Society from 1894 until 1898, and a vice-president from 1917 until 1920; from 1920 until 1925 he was a member of the Advisory Council of the Department of Scientific and Industrial Research, whilst he occupied the presidential chair of the Royal Irish Academy from 1921 until 1926. Two important books bear his name on the title-page: "Stoichiometry" (Sir William Ramsay's series of text-books of physical chemistry, 1907 and 1918) and "Fractional Distillation" (1903), revised and extended in scope, with the assistance of experts in various branches of manufacture, in 1922, under the title "Distillation Principles and Processes." Among Prof. Young's numerous original papers are some devoted to a study of the composition of petroleum.

Since the anthropoid ancestry of man became a subject of scientific discussion and table-talk, the interest aroused in the great apes, the nearest living relatives of humanity, has had an unfortunate repercussion upon the very creatures which a fellow-feeling should have spared and guarded. Only a few years ago a general outcry arose against the inordinate slaughter of gorillas in Africa, where large numbers were killed, sometimes for scientific purposes, more often in the name of sport! Now another of the great apes, the orang-utan, more restricted in distribution than its African relative, is threatened with rapid extermination in Sumatra, one of its two strongholds. The natives have discovered an easy method of catching orangs alive, and since there is a steady demand for living specimens for zoological gardens, they find the labour lucrative, and large numbers have been exported during recent months. In ordinary cases the market would become sated and decreasing demand would check the supply at its source, but there is a heavy mortality amongst captured orangs, so that one cannot look to economic laws to check the disastrous trade. In view of recent events, it would seem that nothing but drastic restriction of the capture and

export of the orang can prevent its speedy extinction, and much support will be given to the Society for the Preservation of the Fauna of the Empire in its efforts to induce the Dutch Government to impose the necessary restrictions at the earliest possible moment.

THE annual report of the executive committee of the British Science Guild, presented at the annual meeting on June 21, comments on a variety of important problems associated with applied science. Attention is directed to some anomalies in Patent law, in particular the insecurity of British as compared with German and American patents. This insecurity arises largely through the fact that invalid patents are freely granted in Great Britain. There are also 'paper' patents—obtained merely with the view of extracting undeserved royalties from manufacturers who shrink from patent litigation, the cost of which is frequently enormous. Another subject that receives attention in the report is the position of science teaching in the public elementary schools. At present the selection of subjects is left to the local education authorities. Instruction in elementary science may be inadequate or even omitted entirely. A letter has been circulated amongst leading local authorities asking for the names of elementary schools in which adequate teaching of elementary science is being carried on. This inquiry should elicit some useful information regarding the nature of courses and the methods of instruction followed. The position of the technical expert in the public service and in industry is now being studied by a special committee appointed by the Guild. Since the War, administrative and clerical branches of the public services have been reorganised and a material improvement in the prospects of officers in these classes has been effected. There has been no similar reorganisation of the technical and scientific branches; new measures are necessary to afford such professional officers a status corresponding to modern conditions.

THE report also presents a series of six memoranda of considerable interest, illustrating recent developments in the application of science—mainly in the fields of agriculture and food products. In connexion with animal nutrition, great importance attaches to recent investigations of the part played by vitamins. The discovery that ergosterol, when submitted to ultra-violet irradiation, acquires very powerful anti-rachitic properties, is an example. Attention is also being paid by the National Institute of Industrial Psychology to the problem of eliminating needless human effort and waste of time in agricultural processes. In such matters as the destruction of injurious fungi and insect pests and the elimination of animal diseases distinct advances have recently been made. Consideration of these problems leads to a reference to the recent Imperial Conference on Agricultural Research. At this conference several useful proposals were made, including the establishment of three new bureaux devoted respectively to soil science, animal nutrition and animal health, and the formation of 'correspondence centres' to act as clearing houses for information. Other notes deal with the Empire Timber Exhibition (held in London last year), the formation of Imperial Chemical Industries, Ltd., and "Scientific Method in Conference Procedure."

THE results of archæological investigation in Egypt during the past winter seem to be in a fair way to establish beyond question the early dating of the prehistoric cultures of the Fayum and at Badari, for which Sir Flinders Petrie has urged a Solutrean origin and a dating directly related to the occurrence of that period in the European area. The excavations which Miss Caton-Thompson has carried out under the auspices of the Royal Anthropological Institute in the Fayum were mainly directed towards finding material to date the culture as it is found in that area. Although the much-desired cemetery which might produce dateable relics did not come to light, one site afforded evidence which, while without prejudging its Badarian affinities, may be regarded as directly determining the relation of the Fayum culture to predynastic. A preliminary report of Miss Caton-Thompson's expedition is being published in the July issue of *Man*. Miss Caton-Thompson's report also clears up a situation of some ambiguity which has arisen from accounts of the discovery of an alabaster factory which did not make it clear that two different sites were involved. An exhibition of such material as has been allowed to leave Egypt will be held at the Royal Anthropological Institute on July 9-21; admission free to non-fellows on presentation of a visiting card.

WHILE Miss Caton-Thompson was excavating in the Fayum, Mr. Guy Brunton was engaged on a similar problem at Badari, continuing under the auspices of the British Museum the work begun by the British School in Egypt. Here the evidence was complicated by the occurrence of copper beads from settlements and cemeteries apparently of an earlier date than any previously known. These had produced objects similar to those from the Fayum, pottery ware, some finer in ware and finish than any other known, a delicately worked flint dagger, and the oldest known stone vase. During the past season, on which Mr. Brunton has reported in the *Times* of May 26, further support of the view that the Badarians were older than the predynastic peoples has come to light in the discovery of the undisturbed graves of the latter superimposed on those of the Badarians. A second phase of Badarian culture has also been discovered with pottery of different forms and eye paint palettes of alabaster instead of the usual slate.

A PAPER on talking and synchronised motion pictures, by W. H. Bristol, the president of a company well known for its recording instruments for industrial applications, is published in the *Journal of the Franklin Institute* for February. The de Forrest and Case-Fox systems, where the sound is photographed on the edge of the film, have already been successfully used in picture theatres for short sketches and news films. Complete talking motion picture dramas, however,

have not yet been presented to the public. It seems probable that very shortly the author's method will enable this to be done commercially. Many so-called educational films are used primarily for indirect advertising, but there are some truly educational films the value of which will be considerably enhanced by synchronised sound. In the Bristol system the turntable for the phonograph and the projector for the film are kept exactly in step by two synchronous electric motors operated by alternating current. Each of them is capable of transmitting about a quarter of a horse power. The sound-reproducing system consists of three parts, the electrical 'pick-up,' an amplifier, and a loud speaker. The quality of the reproduction depends on each of these three elements. The electrical device converts the mechanical undulations of the phonograph recorder into corresponding electrical oscillations. A long horn and a special amplifier are used for theatres. When taking a picture it is of the greatest importance that no extraneous noises be recorded. Hence the camera is placed in a booth, the only sounds reaching it being those which are intended to be recorded. In perfecting the 'talking motion picture' two main difficulties had to be overcome. The first was to get a simultaneous record of the sound and motion, and the second was the loss resulting when a film was broken and a piece of it lost. In the latter event both the sound and photographic records were spoilt.

THE government of Greenland has recently presented to the Department of Zoology of the British Museum (Natural History) a white whale or Beluga from Greenland, with the heads and flippers of three other individuals. This extremely valuable material was collected specially for the Museum by the Danish administration, preserved in salt, shipped to Copenhagen, and thence to London. On arrival in the Museum the whale was found to be in perfect condition. A plaster cast of the entire animal, a male measuring 12 feet 6 inches in length and weighing about 1 ton, has been made, and this will in due course be exhibited. Dissections of the whale are in progress, and the skeleton when cleaned will form an important addition to the collection. The Beluga is hunted in the Greenland seas for the sake of its blubber and for its remarkably tough hide, which is used in the manufacture of boot-laces. The Department has also received the skin and skull of a Swedish wolf in exchange from the Stockholm Museum; this animal is now nearly extinct in Sweden. Mr. D. Holderness, engineer to the Harbour Board, Auckland, New Zealand, has presented seven specimens of the Giant Ship Worm (*Kuphus arenarius*) from the Solomon Islands. They were obtained for the Museum by Capt. Burgess of the Mission steamer *Southern Cross*, after several years of search and inquiry among the natives, and are the first specimens of the soft parts of the animal that have been seen by any naturalist since the time of Rumphius, more than two centuries ago. The Mineral Collection of the Museum has recently acquired a set of minerals from the pegmatite quarries at Newry, Maine, U.S.A., which are now being worked for pollucite; this mineral contains 34 per cent of cæsium oxide and is the richest known source of this alkali metal, which now finds an application in the construction of thermionic valves.

AN offer of considerable interest to anthropologists and statisticians is made by the Eugenics Research Association, which announces a competition with prizes of £200 and £40 for the best two essays by American authors on "A comparison of both the crude birth-rate per 1000 females 15 to 45 years of age and the 'vital index' (or 100 births/deaths ratio) of the Nordic and non-Nordic peoples in the Americas." Data are to be considered in different periods from 1850 to the present time or last available census. Nordic peoples are considered to be those whose ancestors came mainly from Nordic countries. Such countries are defined as including the Scandinavian countries south of lat. 63° N., the Netherlands, England, Scotland, North Ireland, and certain German States, non-Nordic being regarded as the rest of Europe, Asia, and Africa north of the Zambesi. Essays must reach the Association at Cold Spring Harbor by Feb. 1, 1929. Prizes of the same amount are offered to European authors for essays on the same subject and under similar conditions.

THE Right Hon. Viscount Astor will deliver the inaugural address to the congress at Plymouth of the Royal Sanitary Institute on Monday, July 16. The popular lecture by Prof. W. E. Dixon on "Poisoning in Daily Life" will be delivered on July 20. The subjects for discussion cover a wide field, and include the tuberculosis problem, immunity in scarlet fever and measles, puerperal fever research and fœtal deaths and injuries, juvenile rheumatism, ultra-violet therapy treatment, health conditions in factories and industrial rheumatism, smoke abatement, refrigeration, contamination of foods exposed for sale, milk, refuse and sewage disposal, and water supply. More than eight hundred delegates have been appointed to take part in the congress by government departments in the British Empire and foreign countries. Visits to institutions dealing with child welfare work, and municipal undertakings of professional interest to medical men, engineers, and others, are being arranged, as well as excursions of more general interest. The Health Exhibition, which is an important part of the congress, will include exhibits on water softeners, refrigerators, electric appliances, soaps and disinfectants, sanitary appliances, etc., and will be opened by the Mayor of Plymouth on July 16.

A PRELIMINARY announcement has been issued giving information about the Fuel Conference, 1928, organised as a sectional meeting of the World Power Conference. It has the support of forty-five countries, many government departments, universities, societies, important industrial corporations in Great Britain, and will be held at the Imperial Institute, London, on Sept. 24–Oct. 6. Application for membership should be addressed to the Secretaries, Fuel Conference, 1928, World Power Conference, 36 Kingsway, London, W.C.2, the fee for membership being 30*s*., or 20*s*. for members of participating institutions and

associations. The Conference will be divided into Sections A-X, covering every aspect of the fuel industries, and advance copies of the papers to be presented are to be available to members of the sections in which they are interested. Reduced fares will be available on the railways under conditions to be announced later. Messrs. T. Cook and Sons, Ltd., have been appointed official travel agents and will assist members in obtaining hotel accommodation, Arrangements are being made for official receptions, entertainments, and excursions.

THE radio photogram service which has been conducted by the Marconi Company since May 1926 for the transmission of photographs, drawings, signatures, and facsimiles of all kinds by radio between London and New York, has now been extended so that photograms received in New York by radio may be transmitted to other important commercial centres in the United States of America. A photogram sent from London by radio addressed to these cities is transferred in New York to the telephone-wire picture service of the American Telegraph and Telephone Company. The cities included in the radio-and-wire photogram service are Boston, Cleveland, Atlanta, Chicago, St. Louis, Los Angeles, and San Francisco. The service between London and New York has been widely used since its inception for the transmission across the Atlantic of news pictures, facsimile signatures, and even Christmas cards.

IT is announced in *Science* that the Willard Gibbs gold medal, given annually by the Chicago section of the American Chemical Society, has been awarded to Prof. William D. Harkins, of the University of Chicago. The medal is awarded for work in either pure or applied chemistry of wide importance.

AN earthquake of moderate intensity was recorded at Kew Observatory on June 21 at 16 hr. 37 min. 58 sec. G.M.T. The epicentral distance is estimated to be 4600 miles, and the shock probably occurred near Alaska. A smaller disturbance was recorded earlier at 10 hr. 59 min. 54 sec. G.M.T., the epicentre being nearly 10,000 miles away.

THE Institution of Naval Architects has acquired the freehold of two houses in Adam Street, thus securing for the Institution a permanent home in the same neighbourhood as before. On and after July 1 the address of the Institution will be 2 Adam Street, Adelphi Terrace, London, W.C.2.

'COMMEMORATION DAY' was held at Livingstone College, Leyton, on June 15. Dr. Carmichael Low was in the chair and gave an address on the advances that have been made in tropical medicine during the last forty years. The Principal reported that 1020 students had passed through the College, and appealed for £400 to close the financial year without deficit on the year's working.

REFERRING to Sir Herbert Maxwell's letter in NATURE of June 9, Miss E. Armitage, Dadnor, Ross, Herefordshire, writes recording two similar events of death due to voraciousness. In a pond in her garden, a dead perch was found with a smaller perch fixed firmly in its mouth, while on another occasion, and on the bank of the pond, a dead kingfisher was discovered with a perch fixed in its mouth.

THE fourteenth lecture in the series arranged by the Institute of Physics on "Physics in Industry" will be given, with the co-operation of the seventh International Congress of Photography, by Dr. C. E. Kenneth Mees, Director of the Research Laboratory, Eastman Kodak Co., Rochester, N.Y., at 8 P.M. on July 12. Dr. Mees will take as his subject "Physics in Photography," and his lecture will be delivered at the Institution of Electrical Engineers.

THE annual report of the School of Tropical Medicine, Institute of Hygiene, and Carmichael Hospital for Tropical Diseases, Calcutta, for 1927, has recently been issued. A memorable event during the year was the unveiling, by Lord Lytton, Governor of Bengal, of a "Gate of Remembrance," which commemorates the great discovery of the mosquito transmission of malaria by Surgeon-Major Ronald Ross, I.M.S., in 1898, in the presence of Sir Ronald Ross himself, who made a suitable reply. Teaching and research occupy the time of the staff of the school, and much valuable research work has emanated from it. The Director makes the interesting statement that "all our research workers agree that light teaching duties are useful rather than otherwise, as they compel the worker to keep in touch with the broader aspects of his subjects and to cultivate the art of lucid exposition."

THE following books are announced for early publication by the Cambridge University Press: "Great Britain: Essays in Regional Geography," by twenty-six authors, with an introduction by Sir John Russell and edited by A. G. Ogilvie; "The Symmetrical Optical System," Dr. G. C. Steward ("Tracts in Mathematics and Mathematical Physics").

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A lecturer in physics at the Borough Road Training College, Isleworth—The Principal, Borough Road Training College, Isleworth (July 7). The headship of the geography department in the University of Leeds—The Registrar, The University, Leeds (July 8). Two junior assistants at the Fuel Research Station, East Greenwich, S.E.10—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (July 9). A public analyst for the Administrative Counties of Cambridge, Huntingdon, and Isle of Ely, and for the Municipal Boroughs of Cambridge and King's Lynn—The Clerk to the Cambridgeshire County Council, The County Hall, Cambridge (July 11). A demonstrator in the physics laboratory of the Royal Naval Engineering College, Keyham (Plymouth)—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (July 12). A full-time lecturer in the mathematics and physics department of the Polytechnic, Regent Street—The Director of Education, The Polytechnic, 309 Regent Street, W.1 (July 13). A whole-time research student in

the department of helminthology in the London School of Hygiene and Tropical Medicine—The Secretary, London School of Hygiene and Tropical Medicine, 25 Gordon Street, W.C.1 (July 14). An assistant on the higher technical staff of the science division in the Science Museum—The Director and Secretary, Science Museum, South Kensington, S.W.7 (July 16). An assistant lecturer and demonstrator in engineering in the University College of South Wales and Monmouthshire—The Registrar, University College, Cardiff (July 16). An assistant inspector under the Ministry of Agriculture and Fisheries in connexion with agricultural and horticultural education and research—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (July 16). A reader in biology, a lecturer in physics, and a lecturer in chemistry in the University of Hong Kong —C.A. [N], The Secretary, Board of Education, Whitehall, S.W.1. Scottish candidates should apply to [N], The Secretary, Scottish Education Department, Whitehall, S.W.1 (July 30). Temporary assistant chemists in the Government Laboratory—The Government Chemist, Clement's Inn Passage, W.C.2 (Aug. 4). A professor of mathematics in the University of Melbourne—The Agent-General for Victoria, Victoria House, Melbourne Place, Strand, W.C.2 (Sept. 3). A full-time graduate assistant with works' experience to teach engineering subjects up to Higher National Certificate mechanical engineering standard at the Darlington Technical College—The Chief Education Officer, Education Office, Darlington. A full-time lecturer in mining subjects at the Mansfield Technical College—The Principal, Technical College, Mansfield. A lecturer in geography, botany, and zoology at the Bedford Training College—The Principal, Training College, 14 The Crescent, Bedford. A senior lecturer in the chemistry department of Battersea Polytechnic—The Principal, Battersea Polytechnic, Battersea, S.W.11. A head of the physics department of Huddersfield Technical College—The Director of Education, Education Offices, Peel Street, Huddersfield. A lecturer in the physics department of Woolwich Polytechnic—The Principal, Woolwich Polytechnic, Woolwich, S.E.18. An experienced graduate agriculturist, to initiate scientific pedigree breeding in selected indigenous breeds in Nigeria —The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, Whitehall, S.W.1.

Our Astronomical Column.

Conjunction of Mars and Jupiter.—Mars and Jupiter are now 'morning stars,' rising nearly half an hour after midnight and approaching each other to a very interesting and close conjunction on July 3 at about 9^h P.M. They are situated among the southwesterly stars of Aries and both are moving eastwards, but the greater speed of Mars enables this object to overtake Jupiter on the evening of July 3 about three hours before they come above the horizon on July 4 at about 0^h 22^m A.M. Mars will be 0·3° south at the time of conjunction, and when both planets become visible, Mars will be a little to the south-east of Jupiter and very much fainter. Its ruddy light will contrast strongly with the pale yellow tint of Jupiter. Mars will appear faint, being only of 0·8 mag., while Jupiter will be of 1·8 mag., but neither planet will be near maximum brilliancy, being at considerable distances from the earth. Diameter of Mars, 6·6″, Jupiter, 34·8″. Maximum diameters:

Mars, opposition Dec. 21, diameter, 16″·0.
Jupiter, opposition Oct. 29, diameter, 46·3″ (Polar).

The Fixing of Easter.—The passage of the measure for a fixed Easter through the House of Commons advances the solution of this matter by an important stage. It was wisely decided that the measure should not come into operation until the assent of the leading religious bodies had been obtained; but the indication of the desire of the representatives of the British nation is likely to bring this assent nearer. The Bill adopts the same rule for finding Easter that was adopted by the League of Nations Committee; namely, the first Sunday after the second Saturday in April.

Variation in the Earth's Rotation.—It seems only a short time since this idea was put forward with hesitation as a possible explanation of the mysterious fluctuations that are found unmistakably in the motion of the moon, and to a smaller extent in the more rapidly moving planets. Prof. de Sitter, the president of the International Astronomical Union, has included proposals on this subject in the agenda for the coming meeting of the Union at Leyden. He divides the action into two parts, and gives formulæ for each in terms of the time and its square. The first part is taken to be discontinuous, and subject to abrupt changes at irregular intervals, varying from twelve to ninety years; the other is tidal friction; he suspects that the coefficient of T^2 is not constant, giving 1742 and 1869 as the dates of changes of rate. These dates do not coincide with any in the former list. He proposes that corrections based on his formulæ should be applied to astronomical time as now observed, thus reducing it to 'Newtonian' or uniform time. It will probably be difficult to secure unanimity in this matter, but it promises to give rise to an interesting discussion.

Astronomical Discovery.—Mr. W. F. Denning contributes a paper with this title to the *Nineteenth Century and After* for June. He gives an interesting review of many of the advances in astronomical knowledge that have been accomplished in recent years; but as he has himself been a successful cometary discoverer, it is natural to dwell more particularly on this section of his article. He notes that the record perihelion distance of a comet, which had been held for two centuries by the comet of 1729, has been broken twice in succession by the discovery of comet Schajn-Comas Sola in 1925, and again by the discovery of comet Schwassmann-Wachmann in 1927. The latter has an orbit that lies entirely between those of Jupiter and Saturn, and that deviates so slightly from a circle that it may be possible to follow it round the whole course of its orbit. Allusion is also made to other additions to Jupiter's comet family, the latest being Reinmuth's comet discovered last January.

Mr. Denning notes that 115 comets were detected between 1900 and 1925, of which 70 were new comets. The rate of discovery of the latter is therefore three per annum, very close to the figure derived from the statistics of the nineteenth century. It may be noted (though not included in Mr. Denning's paper) that we have to deplore the death of the most active and successful comet hunter of recent years—Mr. William Reid—which occurred in Capetown on June 8.

Research Items.

CONCEPTIONS OF GOD IN WEST AFRICA.—In No. 2 of *Africa*, the journal of the International Institute of African Languages and Cultures, Prof. D. Westerman analyses the religious beliefs of West Africa. Three groups of beings are conceived as more or less imbued with personality and worthy of veneration: (1) individual tutelary spirits, (2) local deities, (3) the God of Heaven. The individual tutelary spirit enters a man at birth and determines his character and destiny, and protects, advises, and helps him. As the *okra* or spirit had been married in the spirit world before entering upon its human tenement, among the Ewe it is necessary that at marriage the spirit wife should be propitiated by placing in a small hut dedicated to her a small part of each present destined for the earthly betrothed or wife. Local deities are the chief object of worship. Most are the incorporation of natural objects or phenomena, mountains, rocks, springs, thunder, rarely animals. There are also gods of war, peace, of the year, harvest, etc. Idols are often set up in their honour at which they can be worshipped. As a rule a priest is set apart for each deity. He is often selected by the deity, *i.e.* a state of ecstasy is induced in him. The local deity receives its power from the God of Heaven, by whom the administration of a definite sphere of living beings is delegated to him. The God of Heaven is also connected with a natural body, namely, the visible heavens; but he is unique in that he is above everything and is everywhere. Everything owes its existence to him. He is the creator and the preserver of all that is in the world. His characteristic qualities are power, justice, and goodness; but his remoteness, his universality, and his goodness have made the conceptions of him vague and shadowy.

MAGIC AND TABOO IN BENGAL.—In the *Indian Antiquary* for June, Dr. Biren Bonnerjea notes examples of magic and taboo in Bengal as positive and negative elements in an identical attitude of mind towards physical and spiritual phenomena. The use of a clay image is prevalent both as a love charm, when the heart is pierced with a thorn-tipped arrow, and a means of injuring an enemy, when a knife or pin is stuck into the heart. Night blindness is cured by the internal use of a firefly, which is eaten inside a banana. A still-born child is buried inside the house instead of cremated, in order that the mother may bear another child. Examples of contagious magic are the concealment of the name by the use of nicknames, while a woman is known as the daughter, wife, or mother of such and such a person. The placenta is taken away in an earthenware pot in order that no animal may devour it; nor should it be destroyed before the *annanprâśan* ceremony, 'the taking of the rice,' which is the naming ceremony, otherwise the child will die. A charm to stop rain is for a child to burn a candle of cloth. Much virtue is attributed to abuse as a protective or propitiatory rite. Hence in the month of Bhâdra (July–August) practical jokes are played with the object of provoking abuse, as a protection against ill luck; and with the same object those who have inadvertently looked at the moon in this month, throw stones and brickbats into their neighbours' houses. Among the taboos, excessive praise must be avoided. The names of scavengers and water carriers are taboo, and euphemisms are employed, nor must the names of snakes, robbers, tigers, and so on, be used after nightfall. Food taboos include not merely beef to all Hindus, but also many vegetables such as onions, garlic, palms, and lentils.

A TRANSATLANTIC FLIGHT.—Records of the passage of birds across the Atlantic from east to west are much less frequent than those of the contrary journey, and the experience of human aviators also suggests that, in general, weather conditions do not favour the Europe to America crossing. The more to be wondered at is the extraordinary migration of lapwings—by no means strong fliers—recorded by H. F. Witherby (*British Birds*, vol. 22, 1928, p. 6). On Dec. 20 and 21, 1927, flocks of lapwings, one of which was estimated to number 500 individuals and another 1000, arrived in Newfoundland. The lapwing is not an American bird, but the source of the migration was definitely indicated by the presence on one of the birds of a *British Birds* ring, which showed that it was a native of Cumberland. It is certain, therefore, that large numbers of lapwings crossed the Atlantic from Britain to Newfoundland—a distance of about 2200 miles—in a single flight. The author shows that the weather conditions were extremely favourable for such a journey. A spell of frosty weather in Britain made it imperative for the birds to seek new feeding grounds; they moved westwards and became involved in a wind blowing almost due west at a velocity of about fifty-five miles an hour. This, added to the lapwing's normal speed of some forty-five miles an hour, would permit of the total journey being accomplished in about twenty-two hours. Lapwings have been recorded from America only on eight previous occasions, and these were generally solitary birds.

SOME TROPICAL CRUSTACEA.—In the *Bulletin of the Bingham Oceanographic Collection*, vol. 1, Art. 2, Mr. Lee Boone describes several rare and new Crustacea ("Scientific Results of the First Oceanographic Expedition of the *Pawnee*, 1925." Crustacea from Tropical East American Seas. 1927). This expedition was founded for the purpose of oceanographical research, undertaken and directed by Mr. Harry Payne Bingham in his yacht *Pawnee I.*, for exploration in the West Indian Caribbean regions, fishes being the chief object, but incidentally the crustaceans have proved of remarkable value. The range of depth explored was from littoral regions to nearly 500 fathoms, and it is the deep-sea forms which are of peculiar interest. In order to realise the richness of the crustacean fauna, one has only to glance at the records of the contents of two dredge hauls made consecutively north of Glover Reef, in which twenty species of deep-sea Crustacea were captured, nine of which (seven decapods and two isopods) are new, and two rediscovered forms, a brachyuran and a macruran, not seen since the type specimens were captured by the *Blake*; besides other rare finds. Perhaps the most interesting of all is a new isopod named *Arcturus pawneeanus*, which was found intertwined in the branches of a comatulid, living as a semi-parasitic commensal. Its six posterior legs are hooked for clinging and are entwined round one of the radials, whilst three anterior pairs of legs are feathery and floating, thus bearing a striking resemblance to the host so that it is difficult to distinguish between them, the segmentation also closely resembling the pattern of the radial. An anamouran *Uroptychus rugosus* Milne Edwards, previously taken by the *Blake*, occurred symbiotically on the same crinoid, intertwined in its arms, the legs resembling the cirrhi, the chelipeds resembling the radials, and the carapace being very like the central disc. Here again the commensal is difficult to distinguish from its host.

Yet another 'guest' inhabits the crinoid, a small stalked barnacle named by Boone *Scalpellum rodstromi*.

EFFECT OF POTASSIUM ON INVERTEBRATE MUSCLE. —In an article entitled "The Action of Potassium on Muscle-Preparations from Invertebrates (*Brit. Jour. Exp. Biology, vol. 5, No. 3; 1928*), Mr. George P. Wells makes an important contribution to the comparative study of various invertebrate muscles (*Aplysia, Helix, Maia*). Hitherto many contradictions have appeared in the action of potassium not only in different species but even in the same tissue from the same species in the hands of different workers. By studying very wide ranges of potassium concentration, the author has been successful in showing that these discrepancies originate chiefly in the great dependence of the action of potassium upon its concentration. There is, in fact, a remarkable similarity of behaviour in the invertebrate muscle studied and in vertebrate muscle. In all cases examined it was found that muscle is normally relaxed at a certain definite potassium concentration (which has a different absolute value in different species). At this concentration removal or addition of potassium causes contraction, the degree depending upon the concentration. Rubidium, cæsium, and also ammonium are shown to possess closely similar action to potassium; lithium has a different action. It is pointed out that the similarity of action of potassium and ammonium contradicts Zwaardemaker's hypothesis that the former acts by virtue of its radioactivity. A very plausible hypothesis of the action of potassium and its allies is put forward based on that of Mines. The very different physiological effects of potassium, rubidium, cæsium, and ammonium on one hand, and of lithium and sodium on the other, bear a very suggestive resemblance to the relative abilities of these ions to penetrate the highly impermeable membranes studied by Michaelis: the potassium group may well act by producing changes of potential difference across certain membranes in the cell which the sodium group is unable to effect.

ENCYSTMENT OF *PARAMECIUM*.—L. R. Cleveland (*Science*, vol. 66, p. 221; 1927) points out that *Paramecium* has not been definitely shown to encyst in Nature or in laboratory cultures, and that some investigators have doubted its ability to encyst. He therefore records his observations, though they are incomplete. Two or three cubic centimetres of a rich culture of *Paramecium* (species not determined) were injected into the recta of frogs, with the result that encystment of the *Paramecia* occurred in about two per cent of the frogs, namely, in three frogs. In one frog, examined five and a half hours after injection, only encysted *Paramecia* were present. Some of these were placed in depression slides and frequently observed, and on the fourth day fission was observed to be beginning, and on the fifth day two *Paramecia* were seen in the cyst and some of them excysted, especially when abundant tap-water was added to the preparations. A high percentage of the *Paramecia* were killed and disintegrated within one or two hours after injection into the frog's rectum. All attempts to bring about encystment in removed recta, or in rectal contents, failed.

LETHAL FACTORS IN A GRASS.—In a genetic study of the grass, *Lolium perenne*, Mr. T. J. Jenkin (*Jour. of Genetics*, vol. 19, No. 3) finds that many of the plants are highly self-sterile and that several types of chlorophyll-deficient seedlings occur, including complete albinos, variegated and various grades of green, as well as extreme dwarfs and a full green type which dies back for no apparent reason about the time the second leaf appears. Of these lethal types, yellow-tipped albino was the most studied. Selfing a vigorous green plant gave rise to normal green, non-surviving green, and this albino type. The latter may survive for several months, but they never become full green or strong plants. When the parent plant was crossed with unrelated green plants, lethals did not appear in F_1, but when the F_1 was back-crossed to the original parent, the offspring indicated that the latter was heterozygous for two lethal factors. Another plant was highly self-fertile, and produced green, variegated, and albino seedlings. Of these, 1770 were green. They were of two types, surviving and dying *at the second-leaf stage, in the ratio 3 : 1*. The non-surviving green was indistinguishable from that type derived from the other plant. But when these two plants were crossed they gave for the most part in F_2 and F_3 9 : 7 ratios. Hence the factor producing the non-surviving green type occupied a different position in the germplasm of the two species.

THE MORPHOLOGY OF BUD-SCALES.—The somewhat conventional treatment which the morphology of bud-scales receives in many botanical text-books gives an air of finality to the subject which it does not seem to possess. In a recent paper (*Biological Reviews*, vol. 3, No. 2), A. S. Foster makes a re-examination of the whole problem based on a very comprehensive survey of the most important literature on the subject. Morphological interpretations of the scales from the viewpoint of formal and idealistic morphology are considered, and their effects on recent theories indicated. The major emphasis, however, is placed upon the more dynamic aspects of the problem, and the nature of the bud-scale is examined in the light of developmental, experimental, anatomical, and causal investigations. The author thinks that Goebel's well-known interpretation of bud-scales as arrested growths of foliage leaf primordia fails to account satisfactorily for unsegmented bud-scales, and entirely leaves out of consideration the multipotent nature of foliar *Anlagen*. More recent work, especially on the anatomy of cataphylls, suggests that structurally they are divergent foliar organs, which in many instances develop unlike the foliage leaves from the beginning, and any attempt to recover the formal elements of the foliage leaf in every bud-scale is considered futile. Attention is then directed to the fact that in spite of the numerous morphological and phylogenetic interpretations of cataphylls, some of which rest almost entirely on theoretical considerations, almost no information is available as to the mode of internal development in scales, and the physiological factors which in part determine their divergent growth. It is suggested that further experimental and developmental research will show the important relation of the nutrition and metabolism of the developing bud to the periodic alternation of scale leaves and foliage leaves; and then the problem of bud-scale morphology will properly become an important phase of the wider question of organ differentiation at the growing point. Foster's paper, to which is appended a bibliography of 196 references, is a mine of detailed information regarding the subject of bud-scales.

THE ROCKS OF AFRICA.—The attention of geologists and explorers is directed to the "Catalogue of the Rock Collections in the Mineral Department of the British Museum (Natural History)," by W. Campbell Smith, of which Part I., dealing with Africa, has just appeared (British Museum, 1928. Price 2*s*.). Other parts, dealing in turn with each of

the continental and oceanic areas, will be issued in alphabetical order. The very carefully documented rock-specimens in the Mineral Department (numbering more than 50,000) form a most valuable reference collection for research and comparison, and it is of the greatest importance for the progress of petrology that workers in this branch of science should realise the wealth of material that is here available for their use. Moreover, the catalogue shows what regions of the world are at present poorly represented, and so encourage collectors of every description to fill up the gaps with contributions that will be especially welcome. The present part begins with an interesting historical introduction, and the rocks of Africa follow. Mr. Campbell Smith is to be congratulated on a compilation of the utmost value. Not only do the notes on each group of specimens indicate where, when, and by whom it was collected, but copious references to literature in which any of them have been described are added, together with a record of such analyses as have been made. Indexes follow of persons (donors, collectors, and authors); of localities; and of rock-names and geological formations. As it is issued, the growing catalogue will undoubtedly become for petrologists, and indeed for geologists in general, one of their most valued and stimulating books of reference.

THERMOGRAPHS AND HYGROGRAPHS.—We have received a copy of a recent catalogue issued by Messrs. Pastorelli and Rapkin, 46 Hatton Garden, London, E.C.1, showing Edney thermographs, hygrographs, and hair hygrometers. For amateur meteorologists, instrument No. 10, which records pressure, temperature, and humidity of the atmosphere on a single chart, will appeal on the grounds of economy and convenience. The price is sixteen guineas, which, is far less than the combined prices of separate self-recording instruments for the three quantities measured. Fewer charts are required, and a smaller screen will house the single instrument. There is the added advantage that errors in the time scale due to swelling or contraction of the paper, or to gaining or losing of the clock, do not prevent simultaneity of occurrence of changes of the three quantities from being detected—an important point in studying 'fronts.' For official use these advantages may be counterbalanced to some extent by the drawback that in tabulating hourly values, time may be lost because three workers cannot use the same chart at the same time. No. 18 is a 'distance' recording hygrograph costing £24, designed for use in timber-drying kilns, etc. Such instruments — in which mercury in steel bulbs is used for the thermometers, with flexible steel capillary tubing connexions to a Bourdon tube and recording, mechanism, enable the latter to be placed conveniently far from the kiln.

RESEARCH ON GLASS.—Vol. 10 of *Experimental Researches and Reports* has recently been published by the Department of Glass Technology of the University of Sheffield. It consists of a collection of papers published in other journals during 1927, giving an account of the work carried out in the Department. Some of this work is concerned with the properties of special glasses, but much of it is more technical in character. A useful contribution is entitled "Notes on Some Methods used in the Analysis of Glasses."

A MICRO-CALORIMETER.—In the *Journal of the American Chemical Society* for April, S. Lipsett, F. Johnson, and O. Maass describe a calorimeter which can be employed for the determination of heats of solution using only 4 c.c. of solvent and has an approximate heat content of 1 calorie. This calorimeter was made from a platinum crucible, and is arranged so that it can be rotated about a horizontal axis. The solute is placed in an inner vessel and is brought into contact with the surrounding solvent by rotation of the calorimeter, which is jacketed and submerged in a water bath. The temperature is measured with a platinum resistance thermometer. A series of determinations of the heat of solution of sodium chloride at constant concentration gave results differing by less than 0·26 per cent from a mean value.

APPARATUS FOR ARTIFICIAL SUNLIGHT.—Messrs. Watson and Sons (Electro-Medical), Ltd., of Sunic House, Kingsway, have published, under the title "Artificial Sunlight Apparatus," a catalogue of ultraviolet apparatus which includes some standard instruments of other leading makers in addition to their own. The instruments are classified under their different types, *i.e.* mercury arc, carbon arc, etc., and the list, though not large, is quite representative. The introduction to the publication deals briefly with the history of actinotherapy and with the physics of the absorption of radiation by matter. This latter section appears of somewhat doubtful value, for there is still a big gap between the knowledge of the reaction of the atom to radiation and the observed data of the biological effects on living tissue. The characteristics, advantages, and disadvantages of each type of lamp are dealt with in considerable detail, and summarised again at the beginning of the section dealing with that type. Such points as the cost of running, repairs, and the necessity for the use of goggles are treated very fully, and it is exactly this practical information which is required by the doctor who is compelled to select his apparatus from a catalogue. It should be noted that the cored carbons are here included under the section devoted to carbon arcs, though in many cases the radiation produced by the former is nearer to that of the typical metallic arc in quality.

DIESEL - ELECTRIC LOCOMOTIVES. — High - speed Diesel engines which run on crude residual oil are highly efficient from the commercial point of view and can now be made with a total weight of about 20 pounds per horse-power. In conjunction with a suitable direct current generator and two motors, they can be used advantageously in a locomotive for ordinary railway traction. In the *English Electric Journal* for April there is an interesting account of a Diesel-electric locomotive which has been made for the London, Midland and Scottish Railway. It will be used on the Manchester-Bury line. The power equipment consists of a 500-h.p. Beardmore engine coupled to a 340-kilowatt 600-volt generator. The generator supplies power to two traction motors, each of 280 h.p., mounted on one of the motor coach bogies. The engine has four running speeds, an 'idling' speed of 350 revolutions per minute, intermediate speeds of 600 and 750 r.p.m., and a full load speed of 900 r.p.m. The control is purely electric, the master controller being provided with 'deadman's' handles. A battery of accumulators is provided for starting the engine. Self-propelled vehicles of this type do not affect the question of electrifying a railway system. If complete electrification of a system is commercially justifiable, it would probably be better and cheaper than using Diesel-electric units. But the latter units should prove very useful in those districts where the traffic density is not great enough to justify electrification. It provides a motive power considerably cheaper than that of steam-propelled vehicles.

Elections to the Royal Society.

AT the weekly meeting of the Royal Society on Thursday, June 21, Lord Melchett of Landford (formerly Sir Alfred Mond) and Sir William S. McCormick were elected into the Society under the statutory provision whereby two persons may be recommended at stated intervals who either have rendered conspicuous service to the cause of science, or are such that their election would be of signal benefit to the Society. Lord Melchett, chairman of Imperial Chemical Industries, Ltd., was born at Farnworth, Lancashire, in 1868; he has brought a ripe experience and much earnest thought and judgment to the national and Imperial aspects of science and industry. His powers and his interests are in keeping with the family traditions. His father, Sir Ludwig Mond, was a chemist and inventor of high standing, and, moreover, a munificent benefactor to the Royal Society. Sir William McCormick, who was born at Dumfries in 1859, is administrative chairman of the Advisory Council on Scientific and Industrial Research, as well as chairman of the University Grants Committee.

The following were elected foreign members of the Society;

PROF. ALBERT T. J. BRACHET, rector of the University of Brussels, who holds the chair of anatomy and embryology in the Faculty of Medicine in that University. He is already a *correspondant* of the Paris Academy of Sciences.

PROF. DAVID HILBERT (born in 1862 at Königsberg) occupies the chair of mathematics in the University of Göttingen. He was educated there, and at Heidelberg, Leipzig, and Paris. Prof. Hilbert is the author of numerous memoirs and treatises in pure mathematics, published in continental journals.

DR. PAUL LANGEVIN is professor of experimental physics at the École Normale Supérieure, Paris. He is the enunciator of a theory of diamagnetism and paramagnetism, familiarly referred to under his name. He is already a foreign member of the Reale Accademia Nazionale dei Lincei, Rome.

DR. RICHARD PFEIFFER (who was born in 1858) is professor of hygiene and bacteriology in the University of Breslau; formerly he occupied a similar chair in the University of Königsberg. He is distinguished for his researches on the bacilli of cholera, typhus, and influenza, and on outstanding problems of protective inoculation.

PROF. LUDWIG PRANDTL (born in 1875 at Freising) holds the chair of applied physics, mechanics, and thermodynamics in the University of Göttingen. He received his technical training at various institutions in Munich, and filled important posts in that city. Before transferring (1907) to Göttingen, he was professor at the Technical High School, Hanover. He is a distinguished pioneer in the study of aerodynamics.

PROF. RICHARD WILLSTÄTTER, of Munich, who was awarded the Nobel prize for chemistry in 1915, was born at Carlsruhe (Baden) in 1872. Entering the University of Munich, he studied under Adolf von Baeyer, and ultimately succeeded the master in the chair of chemistry. He is the author (with A. Stoll) of the classic treatise, "Untersuchungen über Chlorophyll: Methoden und Ergebnisse" (Berlin, 1913). We may recall that on July 2, 1927, Prof. Willstätter was included in the Scientific Worthies series of NATURE.

Herring Investigations at Plymouth.

MR. E. FORD has published a report on his herring investigations in the *Journal of the Marine Biological Association* (vol. 15, No. 1, Feb. 1928, pp. 267-319). The report is in four parts, dealing in turn with the methods used in the treatment of the data, the average number of vertebræ in the herrings of the English Channel and the south-east of Ireland, the Plymouth winter fishery of 1924–25 to 1926–27, and the growth of young herrings in the area under discussion.

The first part is important, for in it the author gives a concise account of his methods of age estimation and growth calculation from the scales of the herring. In making comparisons between two lots of fish by means of growth calculation, difficulty is often experienced by the fact that very often one cannot be certain whether or not the calculated lengths, l_1, say, are bimodal. It was found that a fish with a small l_1 had a larger second-year growth than a fish with a large l_1, a fish with a small l_2 grew more than one with a large l_2, and so on, and equations have been deduced from which the length of a fish in any given year can be calculated from its length in the previous year.

The usual method of examining herrings for their 'racial' characteristics is to ascertain the statistical difference between the means of variable characters of samples of fish from different areas, but often these differences are so great even on one ground that the definition of a 'race' is impossible. If this mixture occurs on spawning grounds—and there is no doubt that it does—what is the chance of racial characters being passed on to the next generation? Mr. Ford defines the present limits of 'race' investigation, and confines himself to the study of morphological characters of temporary populations, which, along with the study of age and growth from the scales, should at least help in the solution of the problem of migration.

In the Plymouth winter fishery the 1920 year-class constituted a large proportion of the samples for three seasons, but it is not to be assumed that the same fish returned to the spawning grounds each year, because this was a widely spread rich year-class, and the return of fish to a ground cannot be proved without detailed examination of growth and other characters each year. There are large variations in the length of fish of the same age in this area, and the author names the following as causes for this: (*a*) Some fish were spawned earlier than others; (*b*) some had experienced better conditions for growth than others.

Added to these, however, is the effect of the mesh of commercial drift nets on the length of herrings in the samples. There is a difference in growth between the fish of the western end and those of the eastern end of the English Channel, the larger growth taking place in the more open waters of the west.

Observations on the growth of the young (whitebait) herrings taken in the rivers flowing into Plymouth Sound, show that there is a considerable variation in the length of the fish, but there seems to be a general agreement between the mean length of these herrings and the calculated length l_1 of the adult herrings of the Plymouth winter fishery.

Herring investigations in general present many obstacles to the observer, and in this paper the author has clearly defined the probabilities and difficulties of the work, while the concise accounts of his method of treatment of the data will no doubt be of great assistance to others engaged in marine biology.

Annual Congress of the South-Eastern Union of Scientific Societies.

THE thirty-third congress of the South-Eastern Union of Scientific Societies took place at Rochester on June 6–9, with Sir Martin Conway, M.P., in the presidential chair. The congress was well attended, and delegates were sent from most of the seventy-four societies comprised in the Union.

Sir Martin Conway's address was on "Mountain Exploration." The Matterhorn, Sir Martin said, was once thought to be the abode of evil spirits, and even now we find little chapels at the base of mountains, the object being to dam back the evil spirits from descending into the valleys. In the Andes of Bolivia the mountains were held to be the abode of gods. Indeed, almost all over the world the mountains were held to be the abode of either devils or gods. In the Chinese mind there is a great love for the mountains, and many poems have been dedicated to them; this affection is exceptional amongst the peoples of the world.

Sir Martin said that, geologically, mountains are quite modern, some of the youngest being found in the Himalayas, and the hundreds of peaks there have not yet been worn down as in the case of other ranges, as, for example, the Scottish mountains, where denudation has gone on for a much longer period. Mountains are continually being broken down by the forces of Nature, and at periods in geological history fresh mountains have been reared up from the crust, making up for the denudation of other ranges. In Great Britain, as in other countries, it was only during the course of the last century that people began to see beauty in great heights, and poetry and art have done much since to beget a love for mountain climbing.

Respecting the breaking down of mountains, Sir Martin said he has seen as many as eighteen avalanches in one hour in the Himalayas. In the same range there are great glaciers and great precipitation of snow. The South American Andes are in the main poorly supplied with snow, and the glaciers are as a rule eaten up by evaporation before they reach a low level. On the other hand, in Spitsbergen, although the highest of the mountains is but 7000 feet high, they are the grandest of all, as they are clothed with snow to their base.

In Dr. William Martin's address to the archæologists, he emphasised the necessity of organised work on proper lines, and showed how such work can be prevented from being but desultory and unscientific. He showed what powers exist under the Ancient Monuments Act to prevent destruction of objects of interest, and emphasised the fact that such powers are very limited, and that but little can be done where there is a determined effort to do away with monuments that are in the way of modern so-called improvement. In speaking of the archæological remains in the Medway Valley, Mr. A. E. Hurse stated that he considers that the ancient highway, sometimes known as the Pilgrims' Way, which may have really dated from neolithic times, crossed the Medway somewhere near Snodland. Another ancient highway, sometimes called the Old Road, is remarkable as being in the line of many megalithic remains, such as the circles at Addington, its dolmens, and Kits Coty House. The fact that neither road was much utilised to serve as parish boundaries seems to show that they were to a great extent lost before Saxon and Norman times, when boundaries began to be defined.

Mr. G. E. Hutchings in his paper on the vegetation of the district showed that the area comprises wide chalk areas and salt marshes, and forms an admirable one for the study of plant ecology; little work has yet been done in this direction. Papers of a botanical nature were read by Mr. C. E. Salmon, on fruits and seeds of allied plants, and by the Rev. L. Denton Sayers, on gall-formation in plants.

In the geological section Mr. H. B. Milner gave an illustrated paper on "Geology from the Air," and by the aid of numerous aerial photographs showed how the aeroplane can be utilised for geological study. During flights that he has made in Iraq and Palestine he has taken photographs which give an added interest to the geology of these districts. In thickly wooded country air pictures are particularly valuable, as they can form the basis of maps which can afterwards be more closely filled in by ordinary field work. 'Cut-offs' or ox-bow lakes can thus be identified which may be overlooked by ordinary means in such a country. The meanders of the Jordan were vividly portrayed in one of the pictures shown. English coast-line scenery takes on a new aspect from the air, whilst inaccessible regions in all mountainous parts of the earth can be studied in air pictures. Aerial geology is in its infancy, and much may be expected from it.

Dr. S. W. Wooldridge gave a characteristic paper on the geomorphology of the North Downs, and Mr. G. Dines a paper on the Bapchild palæolithic site. Prof. E. W. MacBride read a paper on the conditions of progressive evolution.

A public lecture was given by Mr. Aymer Vallance on old timber houses, introducing many pictures to illustrate the evolution of the half-timbered houses from what is considered the neolithic plan of drawing branches of trees so as to form an arched roof, to the curved 'ships' timbers' which in early houses supported the roof. Then followed the upright timbers to support a second floor, and finally the curved timbers were used only for walls of that floor, seen outside such a house as part of the half-timbering. The houses at first had a long room or hall where the household met for meals, and many of these were later cut up so as to form a number of rooms, or even separate cottages. When rooms were added on the upper floor the heads of the family would retire to one of these, which came to be known as the 'solar,' a name that gave rise to some discussion. It was suggested that the name arose from the room being in a position exposed to the sun, but it may have been the room where the family could be alone or *solus*.

In the Regional Survey Section, Mr. C. C. Fagg gave a history of the movement, in the development of which he has for many years taken an active part.

Many excursions were made during the congress, some of a strictly scientific nature, those devoted to archæology being well attended. Not the least interesting was that to Gads Hill Place, which was thrown open by the kindness of the occupiers, who showed the visitors may items of interest to lovers of Dickens. A reception by the Mayor in the Guildhall was followed by a lecture by Dr. Mortimer Wheeler on Roman Rochester. The remains of the old Roman walls, the Cathedral and the Castle, the House for Six Poor Travellers, and other places in the town, were visited under local guides during a comprehensive perambulation. At the delegates' meeting the honorary secretary announced that the congress for 1929 would be held at Brighton, under the presidency of Sir Arthur Keith.

University and Educational Intelligence.

BIRMINGHAM.—Considerable increases in the contributions of various authorities in the Midland district to the University of Birmingham have been announced recently. The County Council of Staffordshire has increased its grant from £1000 to £1250 per annum; Worcestershire C.C. from £750 to £1000; Warwickshire C.C. from £500 to £1000 (on the condition that two scholarships are provided); Smethwick from £250 to £350; Dudley from £100 to £200; West Bromwich £260 to £520; Shropshire C.C. £150 to £250. New grants have been made by Walsall (£250) and the City of Worcester (£250). The City of Birmingham has now decided to increase its contribution from £15,000 per annum to the proceeds of a penny rate (equivalent at the present time to about £26,000 per annum).

The degree Congregation which is to be held on June 30 is to be marked by the conferment of honorary degrees on distinguished members of the legal profession to signalise the inauguration of the Faculty of Law in the University.

CAMBRIDGE.—The George Henry Lewes studentship of the annual value of about £250 is being offered for research work. Candidates should send a statement of their qualifications, the subject of their proposed research, and the name of one referee, to Prof. Barcroft, Physiology School, Cambridge, by July 10.

LONDON.—Sir Gregory Foster, Provost of University College, has been elected Vice-Chancellor for 1928–29 in succession to Sir William Beveridge.

Prof. E. N. da Costa Andrade has been appointed as from Aug. 1 to the Quain chair of physics tenable at University College. Prof. Andrade was educated at St. Dunstan's College, University College, the University of Heidelberg, where he obtained the Ph.D. Degree in 1911 (*summa cum laude*), the Cavendish Laboratory (1911–12), and the University of Manchester (1913–14). Since 1920 he has been professor of physics at the Royal Military College, Woolwich. His published work includes: "The Structure of the Atom" (3rd edition, 1927); "Airs"; "The Atom"; "Engines"; and various papers on physical and mathematical subjects in *Proc. Roy. Soc.*, *Phil. Mag.*, *Annalen der Physik*, and other technical journals.

The following doctorates have been conferred: D.Sc. in Anatomy on Miss I. C. Mann (St. Mary's Hospital Medical School), for a thesis entitled "The Development of the Human Eye." D.Sc. in chemistry on Prof. E. C. Williams, until recently Ramsay professor of chemical engineering, for a thesis entitled "(1) The Use of Highly Porous Bodies in the Recovery of Benzole from Coal or Coke Oven Gas. (2) The Purification of Benzole by means other than Sulphuric Acid Washing." D.Sc. in Physiology on Dr. C. H. Best (University College and the National Institute for Medical Research), for a thesis entitled "The Effect of Insulin on the Dextrose Consumption of Perfused Skeletal Muscle." D.Sc. in mathematics on Mr. Charles Fox (University College), for a thesis entitled "I. Null Series and Integrals; II. Generalisation of the Fourier-Bessel Integral Transform."

The degree of M.Sc. in the principles, history, and method of science for internal and for external students will in future be termed the "M.Sc. Degree in History, Methods, and Principles of Science."

A University post-graduate travelling studentship has been awarded to Mr. H. I. Andrews. Mr. Andrews (Imperial College—City and Guilds (Engineering) College) proposes to undertake research work in locomotive engineering upon the locomotive test plant at the University of Illinois. A University post-graduate studentship in engineering has been awarded to Mr. D. M. Robinson (King's College), who was awarded in 1927 the Siemens' Prize in electrical engineering and a £50 research scholarship from the Institute of Electrical Engineers.

NEWCASTLE-UPON-TYNE.—The special committee appointed by the Council of Armstrong College has unanimously agreed to recommend the appointment of Sir Westcott Stile Abell as professor of naval architecture in succession to Dr. J. J. Welch, who retires on Sept. 30. Sir Westcott Abell was professor of naval architecture in the University of Liverpool from 1910 until 1914, and since then he has been Chief Ship Surveyor of Lloyd's Register of Shipping. Sir Westcott was president in 1924–25 of the Institution of Marine Engineers.

Mr. H. P. Mulholland, of Queens' College, Cambridge, has been appointed lecturer in mathematics as from Oct. 1.

OXFORD.—On June 18 the Halley Lecture was delivered by Dr. Harlow Shapley, Director of the Harvard College Observatory, on "A Search for the Centre of the Milky Way." Dr. Shapley, who illustrated his discourse by an ample supply of excellent lantern slides, succeeded in arousing and sustaining the interest of a large and appreciative audience. The lecture fell into three main divisions, namely, the search for the direction and distance of the centre; its surroundings; and the veil of cosmic material behind which it is hidden. Photographic views show that of equal areas of the heavens, one might contain 600 times as many stars as another. The stellar material may be either organised or nebular. Our galaxy has been shown to be a 'bun-shaped' system rotating round a centre. It is possible to see through the galaxy, and so to become aware of the existence of other 'supergalactic' systems. The dark obscuring veil is due to the presence of an enormous amount of meteoritic material. The dark structures observable in certain nebular regions are due not to gas, but to vast quantities of cosmic dust.

DR. JAMES DAVIDSON, chief assistant entomologist at Rothamsted Experimental Station, Harpenden, Herts, has been appointed head of the Department of Entomology at the Waite Agricultural Research Institute, University of Adelaide.

THE governing body of the Chelsea Polytechnic, London, S.W.3, has appointed Mr. F. J. Harlow, Principal of the Wigan and District Mining and Technical College, to be Principal of the Polytechnic in succession to Mr. Sidney Skinner, who retires on Aug. 31 next. Mr. Harlow will take up his duties at Chelsea on Sept. 1 next.

THE London School of Hygiene and Tropical Medicine has made arrangements for courses of lectures and practical demonstrations for the guidance of employees of business firms and other bodies who are about to proceed to tropical and sub-tropical countries or are home on leave. In addition to providing guidance for life in the tropics and personal hygiene, they will also include a short account of some of the more common diseases; with advice in regard to measures of protection against such diseases, and some guidance in simple methods of self-treatment. The first course of nine lectures is being given by Col. G. E. F. Stammers, on July 16–26, from 11.30 A.M. to 1 P.M. each day. A synopsis of the lectures can be obtained from the Secretary, London School of Hygiene and Tropical Medicine, 23 Endsleigh Gardens, Euston Road, W.C.1.

Calendar of Customs and Festivals.

MIDSUMMER PROCESSIONS AND FAIRS.—At about midsummer and the beginning of July, processions take place in many localities, sometimes as an observance of a forgotten local cult. More frequently, especially in connexion with fairs, they mark the close or beginning of an annual or semi-annual period. Such was the ceremony observed at Alnwick when, before the proclamation of the fair, representatives of the townships owing service to the Duke of Northumberland attended at Alnwick Castle. In London, up to Tudor times, the setting of the watch for the coming year was accompanied by processions on Midsummer Eve and St. Peter's night in which the Lord Mayor and Sheriffs took part, attended by cresset bearers, the city giants, minstrels, etc. A similar procession took place at Chester, where the pageant included a dragon, hobby horses, and other beasts of medieval fancy. At Burford a dragon was paraded around the town annually in memory, it was alleged, of a battle of Saxon times. The procession, which in the Isle of Man paid the rent of Mannan-beg-mac-y-heir, the eponymous deity of Manx mythology, by carrying green grass to the top of Barule, was rather in the nature of a first-fruit ceremony, of which similar traces remain in England in the dedication of cuttings of hay or rushes to the use of the church at midsummer.

June 30.

ST. PAUL THE APOSTLE.—Traditional accounts of the martyrdom of St. Paul preserve some particulars which are of interest, especially in connexion with the preternatural origin of springs. On decapitation, the head of the martyr gave three leaps, and at each of these there sprang up a fountain where the head fell, "which fountains remain to this day and are reverenced with singular devotion by all Christian Catholics."

July.

BOUPHONIA.—'The Slaying of the Bull' in Athens took place at the end of June or beginning of July. Barley and wheat were laid on the altar of Zeus Polieus. Oxen were then driven round the altar, and the one which ate the corn was sacrificed after being wetted with water brought by maidens. The ox was felled with an axe and its throat cut with a knife, both men who performed these operations throwing away the weapon and flying immediately. The beast was then skinned. All present partook of its flesh, and the skin was stuffed and yoked to a plough.

A trial for the murder of the ox followed. After each one officiating in the sacrifice had been accused and passed on the blame to the next grade of operators, the murder was finally brought home to the axe and the knife, which were condemned to be cast into the sea. The sacrifice was a crime demanding the extreme penalty. Frazer suggests that the victim, by partaking of the corn, showed himself to be the corn spirit, an aspect of Dionysus personified in the bull. The wetting of the bull is a rain charm analogous to customs of the harvest in many countries.

July 2.

ST. OTTO. A.D. 1139.—In the course of his missionary journeys among the Slavs, St. Otto necessarily came into antagonism with pagan beliefs. At Stettin a sacred oak, at the foot of which was a spring, was allowed to remain standing at the entreaty of the people on the condition that they ceased to perform their superstitious practices there; but an attempt to cut down a sacred nut tree nearly led to the death of the saint at the hands of the owner in whose field it stood. A peculiar form of divination in war at Stettin is recorded. Nine arrows were laid on the ground and a sacred black horse was led up and down among them by its attendant priest. If the arrows remained undisturbed by the horse's hoofs the result of the war would be favourable.

July 2-4.

PROCESSUS AND MARTINIAN.—If it rains on July 2 heavy showers will follow and the corn be spoiled. Rain on the day of the translation of St. Martin (July 4) will be followed by rain for forty days.

July 3.

A solemn celebration in the church of St. Leu and St. Gilles, Paris, commemorated the miracle of the bleeding of a statue of the Virgin in *la rue aux Ours* when it was struck with a knife by a drunken soldier in the year 1513. The image was transported to Rome; but the memory of the event was perpetuated by an annual ceremony performed by the inhabitants of the street, who used to throw a figure of the soldier, fashioned in faggots, into the fire. An elaboration of the ceremony was checked by the magistrates in 1744, whereupon it took the form of a three days' parade of Paris before the destruction of the figure, which was now made of osier, clothed and armed with a knife.

July 6.

OLD MIDSUMMER DAY.—This day was still reserved as the proper occasion for midsummer observances in remote localities in Britain so late as the early part of the nineteenth century.

At Puxton, Somersetshire, on the Saturday before Midsummer day O.S., used to take place the division of certain common lands for the ensuing twelve months. The rights were confined to certain estates and their tenants. They were summoned to the church for the ceremony of measuring the chain by the ringing of the bell. This chain was eighteen yards long, *i.e.* four yards short of the common chain. The party then repaired to the common. Twenty-four apples had been previously prepared with marks, each distinct and each having a distinctive name. As each acre was measured an apple was taken from the bag and a mark to correspond cut in the turf with a special knife kept for the purpose. A certain number of acres, called the 'outlet' or 'out-drift,' were set aside for expenses and let by an inch of candle, burnt in silence except for the bids.

July 7.

ST. THOMAS À BECKET'S DAY.—In Cornwall a festival called 'Bodmin Riding' was kept up on the Sunday and Monday after St. Thomas à Becket's day. A company on horseback with musicians, and a puncheon of ale brewed for the purpose in the preceding October, rode around the town, the crier saluting each house and wishing the inhabitants 'a prosperous morning, long life, and a prosperous riding.' The riding tune was then played and the householder invited to drink the riding ale. On the next day a procession went to the Priory, where they received two garlands on staves and then proceeded to Town End, where the games, lasting two days, were formally opened. A mock trial was also held, presided over by a lord of misrule. Pretended offences, such as peculiarity or irregularity in dress, were punished by a "summons to Halgraver," a place of which the name "signifieth goat's moor . . . a little without the town and very full of quagmires."

Societies and Academies.

LONDON.

Royal Society, June 21.—**C. V. Boys**: Solid dipleidoscope prisms. Bloxam's hollow prism, known as Dent's dipleidoscope, is described. The instrument affords the best practical means of comparing the intensity of illumination of two images, and can be used to check the accuracy of Fresnel's equations for the intensity of light reflected from and traversing refracting surfaces. The solid dipleidoscope prism might be used with advantage to increase the precision of good astronomical instruments.

G. I. Taylor: The forces on a body placed in a curved or converging stream of fluid. The particular case of straight converging flow is of special interest in aeronautics; the resistance is $-(1+\alpha)\ V\partial p/\partial x$, where V is the volume, $\partial p/\partial x$ the gradient of pressure in the fluid, and the 'virtual mass' of the body for accelerated motion in the direction of the stream is α times the mass of fluid displaced. The equations are applied to find the couples exerted on bodies of various shapes. The couple about the direction of the stream-lines is the most interesting, because in a uniform stream of perfect fluid this couple is zero, and even in a real fluid it is zero for all bodies which possess a plane of symmetry containing the direction of the stream. When the stream is curved or converging the asymmetry of the stream reacts with certain elements of asymmetry in the body, causing it to take up certain definite positions. Thus an elongated body with a curved centre line rotates in a curved stream until the plane of the centre line coincides with the plane of curvature of the streamlines, but the direction of curvature of the body is opposite to that of the stream-lines.

G. I. Taylor: The energy of a body moving in an infinite fluid, with an application to airships. The energy in the fluid surrounding a body which moves without rotation in an infinite fluid depends only on the terms of the first degree in the spherical harmonic series for the velocity potential. Conversely, these terms are completely determined when the expression is known which represents the energy of the flow in terms of the components of velocity of the body. As an application of these results a simple formula is developed giving the virtual addition to mass associated with a body moving with a uniform acceleration through a fluid in terms of the equivalent distribution of sources and sinks which give rise to the same external flow.

S. S. Cook: Erosion by water-hammer. The pressure generated at the first moment of impingement of a column of water against a fixed surface is independent both of the length and of the sectional area of the column, and therefore it may be inferred that the same pressure will arise from the impact of a drop of water, being in this case, however, confined to the point of impingement. In the case of vacuous cavities collapsing in an incompressible fluid, the work done by the surrounding fluid closing in is converted into velocity energy, concentrated, when collapse is nearly complete, at the reduced surface of the cavity; and, if further collapse is prevented by the interposition of a fixed surface, high water-hammer pressure will be produced. The erosion of steam turbine blades is attributed to the impact of drops of water struck by the rotating blades, and it may be aggravated by irregularity of shape of the drops, causing a cavity to be entrapped at the surface of impact.

Sir Robert Robertson and J. J. Fox: Studies in the infra-red region of the spectrum. Part I.—Description of prism spectrometer and apparatus. A description is given of the prism spectrometer and apparatus used to explore the infra-red absorption spectrum of ammonia, phosphine, and arsine. Attention had to be paid to the necessity for keeping the source of energy constant, for calibrating mechanism for reading wave-lengths, for shielding the thermopile from variations of air pressure, for keeping close watch on the temperature of the prism, especially when made of rock-salt, on account of the high temperature coefficient of its index of refraction; for accurate alinement of observation tubes, and for obtaining a galvanometer of great sensitiveness and freedom from external perturbations.

Sir Robert Robertson, J. J. Fox, and E. S. Hiscocks: Studies in the infra-red region of the spectrum. Part 2.—Calibration of prism spectrometer; general procedure; preparation of pure ammonia, phosphine, and arsine. The 'wave-length drum' was first calibrated in terms of angle of rotation of the prism table. Large-scale dispersion curves were constructed from Paschen's determinations of refractive indices of the three dispersing media, rock-salt, quartz, fluorite. For the region of the spectrum $0{\cdot}5\mu$ to $16{\cdot}5\mu$, a curve showing the correction, in μ, to be applied to any place on the drum graduation was drawn, and for regions $0{\cdot}5\mu$ to $3{\cdot}5\mu$ and $0{\cdot}5\mu$ to $9{\cdot}5\mu$ curves were drawn connecting drum graduation and wave-length for quartz and fluorite prisms respectively. The gases were purified by fractional distillation.

Sir Robert Robertson and J. J. Fox: Studies in the infra-red region of the spectrum. Part 3.—Infra-red absorption spectra of ammonia, phosphine, and arsine. Tables and graphs are given of oscillation and rotation-oscillation bands, together with a general description of the bands observed. With the prism instrument used partial resolution was obtained beyond $2{\cdot}2\ \mu$ with quartz, $4\ \mu$ with fluorite, and $5\ \mu$ with rock-salt, and fine structure obtained beyond 3μ with quartz, 6μ with fluorite, and 8μ with rock-salt.

Sir Robert Robertson and J. J. Fox: Studies in the infra-red region of the spectrum. Part 4.—Discussion of absorption bands of ammonia, phosphine, and arsine. In certain sequences of bands the members preserve a constant ratio of wave-numbers to one another: $0{\cdot}68$ for PH_3/NH_3 and $0{\cdot}91$ for AsH_3/PH_3. Several harmonic sequences of oscillation bands are found in each gas, but a main sequence is common to all three gases, and a sequence common to ammonia and arsine alone. From the bands resolved, the fine structure has been evaluated, and wave-number differences obtained indicating rotation bands. Oscillation frequencies become slower in the order ammonia, phosphine, arsine, and wave-number differences in rotation bands show that the molecules rotate more slowly in the same order. Support for Hund's view that ammonia has a tetrahedral structure is adduced from bands observed for the three gases.

J. Hollingworth: The polarisation of radio waves. With the recently constructed apparatus the radio waves received can be split up into their physical components, which can thus be studied separately. In particular the form and extent of the abnormal polarisation of the wave returned from the upper layer can be defined quantitatively. Owing to the annual variations involved, observations must be continued for some time.

A. C. Menzies: The spark spectrum of copper. Instantaneous photographs of the copper spectrum in the Schumann region are obtained by fusing copper wires in a small chamber attached to a vacuum

grating spectrograph. The method allows of the use of small capacity pumps, since a low pressure is only required preliminarily. Owing to the high velocity of light the evolution of gases in the fuse is too slow to cause appreciable absorption before the light has reached the plate. Also the lines are very sharp, since 'wandering' of the source is reduced. The spectrograms are not rich in lines, but this is not a disadvantage when one is seeking the lines due to low-level terms. The lowest term of the copper spark spectrum $1\,{}^1S_0$ has been identified with the term-value $-21929 \cdot 4$, and is in accordance with the Heisenberg-Hund scheme.

W. H. Taylor and **W. W. Jackson**: The structure of cyanite, Al_2SiO_5. A qualitative investigation has been made. Data were obtained from X-ray rotation photographs taken under conditions such that an estimate of the density of the photographic image yields reliable information concerning the relative strengths of reflection by different crystal planes. The fundamental assumptions are that the oxygen atoms are arranged in cubic close packing, with the silicon and aluminium atoms distributed among the interstices so that they lie at the centres of groups of four and six oxygen atoms respectively. The main features of the structure are described. Explanations are suggested of the highly perfect cleavage parallel to the *a*-face, and also of the striking difference in hardness exhibited in different directions on this face.

F. H. Constable: A new interference method of measuring the surface area of film catalysts. (1) The theory. The meaning to be assigned to the surface area of a catalyst is discussed. The area will necessarily vary with the means of measurement adopted. In view of the urgent need for a standard method of measuring the area of film catalysts, and the uncertainty attached to adsorption methods, a chemical method has been adopted. The surface is covered with a very thin film of a compound the specific volume of which is considerably greater than that of the metal. The thickness of the film is known from the colour, and the mass of the film is determined independently, hence the area is known. (2) Nickel: a method of preparation of the film, an apparatus for activation and study of the surface area. Metallic films made by the oleic acid method, applying the finely powdered oxide to china clay rods, failed to conduct electricity, so that it was necessary to introduce a new method. Graphite-coated china clay rods were used as the foundation for an electrolytic deposit. The small masses of nickel used could be measured by the quantity of electricity passed. The method of the paper above was used in a special apparatus of quartz. The maximum increase in area on activation was about five times, while reduction at 563° produced a surface only 1·3 times the support area.

S. J. Davies and **C. M. White**: An experimental study of the flow of water in pipes of rectangular section. A built-up pipe was used which permitted variation in the controlling dimension of the section without change of the boundary surfaces. In all, 400 tests have been made on pipes, varying in section from 2·54 cm. broad by 0·0154 cm. deep to 2·54 cm. broad by 0·0681 cm. deep. A range of $\rho vd/\mu$ from 60 to 4600 has been investigated. Employing progressively shorter 'entrant lengths' gives evidence of a third or 'lower' critical point, in the neighbourhood of $\rho vd/\mu = 140$, below which eddies are not transmitted along a pipe. For turbulent flow the values of the resistance coefficient are the same as those obtained from tests of smooth circular pipes, provided that the comparison be made on the basis of the hydraulic mean depth. The latter is thus the controlling dimension in channels with a width-breadth ratio as great as 100 to 1, and hydraulic mean depth as small as 0·01 cm. (equivalent to a round pipe 0·04 cm. in diameter). Roughness, constituted by irregularities some 2 per cent of the distance between the surfaces, has no measurable effect upon the resistance to viscous flow or the turbulent resistance.

J. M. Walter and **S. Barrat**: The existence of volatile intermetallic compounds. The band spectra of the alkali metals and of their alloys with each other. The power of forming volatile binary compounds with each other is general among the alkali metals. Probably 1·5 per cent of the vapours of mixed alkali metals at their boiling point are in the form of these diatomic molecules. Each compound possesses a characteristic band spectrum. Many of the spectra show, in addition, a narrow region of continuous absorption, which, it is suggested, corresponds to the continuous absorption of the halogen molecules. The vapour density of potassium, redetermined by the Victor Meyer method, indicates that the proportion of the diatomic molecules cannot exceed 5 per cent in the vapour at 935° C.

G. Temple: The theory of Rayleigh's principle as applied to continuous systems. This paper deals primarily with continuous one-dimensional oscillating systems, such as a metal bar. If we consider the system to be vibrating in its gravest mode, we may use Picard's method to construct a sequence of functions which form successive approximations to the amplitude. Rayleigh's principle can be applied to each member of the sequence to yield an approximation to the fundamental frequency. The approximations thus obtained steadily decrease to the true value. An upper limit to the difference between the true fundamental frequency and any approximation belonging to the sequence is obtained. Rayleigh's principle is extended to the calculation of the frequency of the first overtone.

R. Schlapp: The Stark effect of the fine-structure of hydrogen. The influence of an electric field on the fine-structure of the energy levels of the hydrogen atom in the Stark effect is investigated by means of the wave-equations of Darwin and Dirac. In weak fields each level splits up into several, the electric separations being, in general, proportional to the field-strength. In the highest fine-structure level of any state, however, the separations are proportional to the square of the field. On Kramers' theory the separation due to a weak field is always proportional to the square of the field. In strong fields each of the Stark levels of the Schwarzschild-Epstein theory is found to have a modified fine-structure. The case of $H\alpha$ is worked out in detail.

Dudley M. Newitt: Gaseous combustion at high pressures (Part 10). The co-volume corrections, maximum temperatures, and dissociations of steam and carbon dioxide in explosions. After applying all necessary corrections, it is shown that in explosions of a theoretical hydrogen-air mixture the mean maximum temperature actually attained rises from about 2585° to between 2660° and 2715° (absolute) as the initial pressure is increased from 3 to 175 atmospheres, the degree of steam dissociation steadily diminishing from 2·2 to about 1 per cent. In a theoretical carbon monoxide-air mixture the mean maximum temperature actually attained gradually rises from 2385° up to between 2700° and 2760° (absolute) as the initial pressure is increased from 3 to 175 atmospheres, the degree of dissociation of carbon dioxide at the maximum temperature remaining fairly constant at 5 per cent throughout. In

the explosion of a $2CO + O_2 + 4CO$ mixture where carbon dioxide dissociation at the maximum temperature is entirely suppressed, the mean maximum temperature gradually rises from 2710° up to between 3020° and 3100° (absolute), as the initial pressure is increased from 3 to 150 atmospheres.

Lord Rayleigh: Observations on the band spectra of mercury. A mercury band spectrum is described which is excited by fluorescence, with the continuous hydrogen spectrum as a source. This spectrum is remarkable as showing in emission the band 2540 near the resonance line 2537 without the resonance line itself. It is observed also that the continuous spectrum on the short wave side of the bands 2345, 2338, etc., extends as far as 2150 and thus much beyond the position of the forbidden line $1\,{}^1S_0 - 1\,{}^3P_2$, 2270, which was found under other conditions to limit this continuous spectrum. The series of bands 2345, 2338, etc., examined in emission with large resolving power, is free from the complications of a finer underlying structure which appear in absorption. The structure in the band 2482 to 2476, described by earlier writers as continuous, is enigmatic in terms of the quantum theory. The band does not appear in absorption.

L. P. Davies: The photo-electric properties of some metals in the soft X-ray region. A photo-electric detector is fitted with iron, cobalt, copper, and nickel photo-electric plates in turn, and these four metals also form the anti-cathode. The ratios of the soft X-ray efficiencies are not affected by changing the photo-electric plate, but their absolute values are. Approximately, iron and nickel are 10 per cent more efficient than cobalt and copper as soft X-ray emitters, and 20 per cent more efficient than cobalt and copper as photo-electric detectors.

C. F. Powell: Condensation phenomena at different temperatures. An apparatus is described whereby the supersaturation required to produce condensation on ions and on associated molecules in the presence of dust-free air, over a range of temperature from −25° to 50° C., has been measured. The effect of the air is of importance not only by determining the amount of water vapour condensed per unit volume for a given degree of supersaturation, but also by preventing the evaporation of water from the walls of the expansion chamber. Apart from the experimental difficulties to be met in working at higher temperatures, atmospheric temperature gives the best conditions for the cloud method of investigating atomic phenomena.

(*To be continued.*)

Physical Society, May 25.—**W. H. Eccles and Miss W. A. Leyshon**: Some new methods of linking mechanical and electrical vibrations. Methods whereby the frequency of an electric oscillatory circuit can be brought under the control of a tuning-fork are described. The electrical circuit may include a crystal contact, piezo-electric resonator, neon lamp, or pointolite lamp. The latitude of working conditions is narrow, but the difference in natural frequency between the fork and the controlled circuit may be very considerable.

DUBLIN.

Royal Dublin Society, May 22.—**S. Leonard**: The waste land of North County, Wicklow. A survey has been made to ascertain what areas of no agricultural value are suitable for afforestation. Owing to the need of shelter from the prevailing south-westerly winds, suitable areas are confined to the northern and eastern slopes of the hills. They amount to about 11 per cent of the waste land, or 6 per cent of the total surveyed.—**H. Ryan and J. J. Lennon**: The action of alcoholic hydrochloric acid on methyldiphenyltetrahydropyrone. It has been shown previously that γ-benzylidine-methylethylketone reacts with benzaldehyde to form isomethyldiphenylcyclopentenone. The latter body was converted by acid into methyldiphenycyclopentenone, and this in turn reacted with benzaldehyde forming benzylidinemethyldiphenylcyclopentenone. The same ultimate product can be got from α-benzylidine-methylethylketone, which in the presence of alkali is converted by benzaldehyde into methyldiphenyltetrahydropyrone. From the latter, by means of concentrated hydrochloric acid in absolute alcohol, the same methyl-diphenylcyclopentenone was obtained as that previously got from γ-benzylidine-methylethylketone. In this way the α- and γ-benzylidine-methylethylketones by interaction with two molecular amounts of benzaldehyde formed the same ultimate condensation.—**H. Ryan and M. T. Casey**: The action of aromatic amines on nitric esters. The reactions between primary aromatic amines and nitric esters appear to be indirectly hydrolytic; for example, aniline and butyl nitrate gave aniline nitrate and butyl-aniline. In the case of secondary and tertiary amines the action of nitric esters seems to be chiefly one of oxidation. A slight degree of nitration also occurs. The reactions between dimethyl-aniline and the nitric esters of the polyhydric alcohols were found to be much more rapid than in the case of monohydric alcohols. The relative rates of decomposition of various nitric esters in the presence of dimethylaniline were measured by the intensity of coloration produced after a given interval.—**H. Ryan, J. Keane, and J. Dunne**: The estimation of diphenylamine and diphenylnitrosamine in the presence of their derivatives. Another method has been suggested by Ryan and Dunne which consists in extracting the powder with alcohol and reducing the extractive in alcoholic solution with stannous chloride and hydrochloric acid. The alcohol is removed from the mixture, which is then distilled in a current of steam. The diphenylamine is extracted with chloroform and estimated volumetrically with bromide water. A modification to this method is recommended by Ryan and Keane by the use of a chloroform instead of an aqueous solution of bromine, in which case the degree of bromination is less dependent on light conditions.—**N. Cullinane, J. Algar, and H. Ryan**: A synthesis of lotoflavin (5-7-2′-4′-tetrahydroxyflavone) and of 7-2′-4′-6′-tetrahydroxyflavone. Phloracetophenone-4-6-dimethylether interacted with methyl 2-4-dimethoxybenzoate forming 2-hydroxy-4-6-2′-4′-tetramethoxybenzoylacetophenone. The latter body on warming with hydriodic acid gave 5-7-2′-4′-tetramethoxyflavone, from which by further action of hydriodic acid 5-7-2′-4′-tetrahydroxyflavone was obtained. This flavone is similar in properties to, and probably identical with, lotoflavin obtained from *Lotus arabicus* by Dunstan and Henry in 1901. By a similar method the isomeric 7-2′-4′-6′-tetramethoxy and tetrahydroxy flavones were obtained from phloracetophenonetrimethylether.—**B. O'Donoghue, J. J. Drumm, and H. Ryan**: The commercial utilisation of Java citronella oil. In an attempt to determine whether it would be possible to produce high-class perfumes from the crude Java citronella oil which is imported for use in household soaps, it was found that citronellal can be readily separated from the crude Java oil by means of sodium bisulphite, and from the residual oil the geranial can be obtained with the aid of its double compound with calcium chloride. No economical process for separating citronellol was devised, but this

perfume can be readily got by electrolytic reduction of the citronellal separated from the oil.

PARIS.

Academy of Sciences, May 30.—**A. Lacroix**: A new region of intrusive nepheline rocks in Madagascar.—**Belzecki**: The equilibrium of elasticity of a rectangular prism.—**Albert Portevin**: The influence of various factors on the internal tensions in wire drawing.—**Paul Piou** and **A. P. Bérard**: The velocity of absorption of sulphur dioxide by magnesium hydroxide.

ROME.

Royal National Academy of the Lincei, Feb. 19.—**U. Cisotti**: The conception of constant tensors in Euclidean varieties.—**G. A. Crocco**: The weight of the aeronautic structure. The design of aeronautic structures is dominated by the criterion of minimum weight, and it becomes necessary to carry out a preliminary approximate calculation without defining exactly the design or developing all the calculations demanded by the science of construction. With the principal factors governing the weight of a structure as starting point, an approximate relationship is deduced which is valid for any structure statically defined, and is to be considered later in its application to aeronautic structures.—**A. Lo Surdo**: Characteristics of triodes with saturating grid tensions.—**F. Zambonini** and **A. Ferrari**: Investigations on lead phosphate and chlorophosphate (pyromorphite). The results of X-ray analysis by the rotating crystal method demonstrate the almost fundamental identity in crystalline structure of lead orthophosphate and pyromorphite, in contradiction to the formula proposed for the apatites by Abegg and Bodländer and by Werner, who regarded these minerals as halides of a complex cation. The mean value of the lattice constant, calculated from the position of the lines due to the radiation $K\alpha_{Fe}$ is 9·65 A. for lead orthophosphate and 9·91 A. for pyromorphite; the Debye method gives 9·67 A. and 10·135 A. respectively. From the mean values the densities are calculated to be 7·03 and 7·06, which are in good agreement with the experimental values.—**S. Minetti**: The necessary and sufficient conditions for an entire function to be of a certain genus and a certain order (3).—**A. Masotti**: The equivalence of tensors.—**L. Berwald**: A normal invariant form of the second variation.—**A. J. M'Connel**: The parallel transport of a vector along a finite circuit: Case of a Riemannian space (2). Results previously obtained are applied to the case of a Riemannian space.—**G. Ascoli**: Laplace's equation of hyperbolic space.—**Gina Burani**: Quadrics of Riemannian space of three dimensions. Slebodzinski has recently defined, as quadric of a Riemannian space $\surd_3$, a surface Q the lines of which are asymptotic to the geodetics of Q and consequently of $\surd_3$. It is now shown that, for quadrics so defined, Bonnet's theorem, according to which the quadrics (of S_3) are characterised by the property that along each line of curvature the principal relative radius of curvature is proportional to the cube of the other, is, in general, not valid.—**G. Palozzi**: The projective invariants of contact between oblique curves.—**G. Scorza-Dragoni**: The quasi-continuity of compound functions. If $f(y)$ is a continuous function in y, and $y(x)$ is a quasi-continuous function in x, the compound function $f(y(x))$ is also quasi-continuous, but if $y(x)$ satisfies a certain condition, the hypothesis of the continuity of $f(y)$ in this theorem may be replaced by that of its quasi-continuity.—**E. Bortolotti**: Local co-ordinates in the projective-differential geometry of a surface: the unit elements.—**P. Nalli**: Integral equation of the third species and applications to differential equations (2).—**C. Cannata**: Contribution to the ballistic theory of variable stars (2). Consideration of the essential features of the ballistic theory of variable stars for elliptic orbits shows that only two cases present themselves, dt/dT either remaining positive for any value of E or changing its sign; constantly negative values are excluded. These results are applied to various examples of each of the two cases.—**E. Fermi**: Statistical deduction of certain properties of the atom. Application to the theory of the periodic system of the elements (2). It has been shown that mean results concerning the distribution of the electrons about the nucleus of a heavy atom may be obtained by assuming that the electrons form round the nucleus a kind of gaseous atmosphere, to the calculation of which statistical considerations may be applied. Given the pronounced density of this electron atmosphere, it will be in a condition of complete degeneration at ordinary temperatures. Application of the statistical method to the theory of the periodic system of the elements renders it possible to predict exactly the atomic numbers at which the various anomalies of the periodic system commence.—**G. Gentile**: Rutherford's theory of the satellites. Calculation by means of classical electrodynamics gives results which throw doubt on the stability of the nuclear systems described by Rutherford in his paper on the structure of the radioactive atom and origin of α-rays, since values are obtained for the mean life which are incompatible with experimental results.—**G. R. Levi** and **A. Celeri**: Pyrophoric lead. This substance has the same face-centred, cubic crystalline structure as ordinary lead and is composed of granules sufficiently large to give sharp, thin lines in photograms obtained by the Debye method. Pyrophoric lead, sometimes slightly contaminated by the oxide, may be prepared by heating the citrate, tartrate, or formate. When slowly oxidised, it yields the oxide directly, but its more or less profound oxidation is a function of the time and of the dimensions of the metallic granules and does not stop at any definite compound.

SYDNEY.

Linnean Society of New South Wales, Mar. 28 (Annual General Meeting).—Late **Prof. L. Harrison**: Host and parasite. For many groups of parasites, host and parasite have come down the ages together. Parasites in general live under conditions which afford little stimulus to evolutionary change, and so tend to differentiate at a slower rate than their hosts, suffering what has elsewhere been called a retarded evolution. The relation between host and parasite may serve several useful purposes: a phylogenetic relationship may be established, or a supposed relationship may be refuted; suggestion of convergent resemblance may be refuted; support may be forthcoming for the common origin of groups now occurring on separated land masses, and thus for the existence of former land connexions. Little use appears to have been made of the host-parasite relation until comparatively recent years, but the degree of unanimity reached by workers on different groups of parasites indicates that the host–parasite relation is a general principle and is capable of wide application. It is concluded that there is a general specificity underlying obligate host–parasite relations, however much this may be obscured, in some groups, by the interposition of other factors.—**Charles G. Oke**: Notes on Australian Coleoptera, with descriptions of new species, Part 1. Notes on species belonging to the families Staphylinidæ, Pselaphidæ, Buprestidæ, Ptinidæ, Cerambycidæ, and Chrysomelidæ. Five genera and forty-four

species are described as new, fifteen species being noted as inquilines living with ants and one with termites.—W. F. Blakely: The Loranthaceæ of Australia, Part 7. This part deals with *Korthalsella*, *Notothixos*, and *Viscum*. Three species of *Korthalsella* are segregated from *Viscum*, and in the latter genus, two species are offered as new.—W. D. Francis: The growth rings in the wood of Australian Araucarian conifers. The degree of distinction and regularity in the growth rings which characterises the wood of many European and North American trees is not shown by the wood of the subtropical Australian Araucarian conifers.

Official Publications Received.

BRITISH.

Jamaica. Annual Report of the Department of Agriculture for the Year ended 31st December 1927. Pp. 30+2 plates. (Jamaica: Government Printing Office, Kingston.)

South Western Naturalists' Union. Annual Report and Proceedings to December 31st, 1927. Pp. 44. (Bristol.)

Air Ministry. Aeronautical Research Committee: Reports and Memoranda. No. 1126 (M. 52): The Distribution of Stress and Strain in the Wöhler Rotating Cantilever Fatigue Test. By Dr. W. Mason and Dr. N. P. Inglis. Work performed for the Engineering Research Board of the Department of Scientific and Industrial Research. (E.F. 201.) Pp. 40+8 plates. 1s. 6d. net. No. 1129 (E. 28): Heat Transfer in Internal Combustion Engines. By Dr. H. Moss. (I.C.E. 618.) Pp. 30+6 plates. 1s. 3d. net. (London: H.M. Stationery Office.)

Medical Research Council. Eighth Annual Report of the Industrial Fatigue Research Board to 31st December 1927. Pp. 36. (London: H.M. Stationery Office.) 9d. net.

Royal Commission on Agriculture in India. Report. Pp. 100+755. (Calcutta: Government of India Central Publication Branch.)

Nature and Archaeology Circle, Littlehampton. Reports of Proceedings, 1926–1927. Pp. 30. (Littlehampton.)

Geophysical Surveying: showing the Practical Value of Geophysics in Mining, and in Prospecting for Minerals (including Petroleum) without Boring. Pp. 28. (London: The British Geophysical Survey, Ltd.) Free.

The Ross Institute and Hospital for Tropical Diseases (Incorporated), Putney Heath, London, S.W.15. Annual Report and Accounts for 1927. Pp. 48. (London.)

Transactions of the Royal Society of Edinburgh. Vol. 55, Part 3, No. 33: The Blood Vascular System of the Spiny Dogfish, *Squalus acanthias* Linné, and *Squalus sucklii* Gill. By Dr. Charles H. O'Donoghue and Eileen (Bulman) Abbott. Pp. 823-890. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 8s. 6d.

Committee on Education and Industry in Scotland. Second Report. Pp. 40. (London: H.M. Stationery Office.) 9d. net.

Report of the Committee on Education and Industry (England and Wales). Second Part. Pp. 79. (London: H.M. Stationery Office.) 9d. net.

Wessex: an Annual Record of the Movement for a University of Wessex based on University College, Southampton. No. 1, 1928. Pp. 111. (Southampton: University College.)

Uganda Protectorate. Annual Report of the Geological Survey Department for the Year ended 31st December 1927. Pp. 44. (Entebbe.) 3s.

The Carnegie United Kingdom Trust. Fourteenth Annual Report (for the Year ending December 31st, 1927) submitted by the Executive Committee to the Trustees on Friday, March 9th, 1928. Pp. ii+114. (Dunfermline.)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 66, No. 378, June. Pp. 569-668+xxxii. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

Proceedings of the Royal Society of Edinburgh, Session 1927-1928. Vol. 48, Part 1, No. 9: Generalised Derivatives and Integrals. By W. L. Ferrar. Pp. 92-105. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 1s. 3d.

H.M. Treasury: Committee on Civil Research. Report of the Research Co-ordination Sub-Committee. Pp. 76. (London: H.M. Stationery Office.) 2s. 6d. net.

Aeronautics. Technical Report of the Aeronautical Research Committee for the year 1926-27 (with Appendices). Pp. viii+878+361 plates. (London: H.M. Stationery Office.) 35s. net.

British Science Guild. The Annual Report of the Executive Committee, 1927-8, presented at the General Meeting of Members, held at the Royal Society of Arts, London, 21st June 1928. Pp. 28. (London.) 1s.

FOREIGN.

Field Museum of Natural History. Botanical Series, Vol. 6, No. 2: Citrus Products, Part 2. By James B. McNair. (Publication 245.) Pp. ix+213-392+plates 7-22. Zoological Series, Vol. 14, No. 4: Contents to Vol. 14, Nos. 1-3. (Publication 246.) Pp. vii+283-285. Zoological Series, Vol. 12, No. 14: A new Crocodile from New Guinea. By Karl P. Schmidt. (Publication 247.) Pp. ii+177-181+plates 13-14. (Chicago.)

Field Museum of Natural History. Botany Leaflet 13: Sugar and Sugar-Making. By James B. McNair. Pp. 34. 50 cents. Anthropology Leaflet 22: Insect-Musicians and Cricket Champions of China. By Berthold Laufer. Pp. 27+12 plates. 50 cents. Anthropology Leaflet 25: The Civilization of the Mayas. By J. Eric Thompson. Pp. 110+14 plates. 75 cents. Geology Leaflet 8: Agate—Physical Properties and Origin, by Oliver C. Farrington; Archaeology and Folk-lore, by Berthold Laufer. Pp. 36+14 plates. 50 cents. (Chicago.)

Bulletin of the National Research Council. No. 62: Algebraic Numbers, II. Report of the Committee on Algebraic Numbers. Pp. 111. (Washington, D.C.: National Academy of Sciences.) 1.50 dollars.

Smithsonian Miscellaneous Collections. Vol. 80, No. 10: Drawings by John Webber of Natives of the Northwest Coast of America, 1778. By David I. Bushnell, Jr. (Publication 2961.) Pp. 12+12 plates. (Washington, D.C.: Smithsonian Institution.)

Smithsonian Institution: Freer Gallery of Art. List of Paintings, Pastels, Drawings, Prints and Copper Plates by and attributed to American and European Artists, together with a List of Original Whistleriana in the Freer Gallery of Art. (Publication 2903.) Pp. 51. (Washington, D.C.: Smithsonian Institution.)

Cornell University Agricultural Experiment Station. Memoir 101: A List of the Insects of New York, with a List of the Spiders and certain other allied Groups. Mortimer Demarest Leonard, Editor-in-Chief. Pp. 1121. Memoir 109: Studies of the Life History of *Ustilago avenae* (Pers.) Jensen and of *Ustilago levis* (Kell. and Swing.) Magn. By George Raymond Gage. Pp. 35. Bulletin 459: The Demand Side of the New York Milk Market. By H. A. Ross. Pp. 86. (Ithaca, N.Y.)

Department of the Interior: U.S. Geological Survey. Bulletin 797-A: Mineral Industry of Alaska in 1926, and Administrative Report. By Philip S. Smith. (Mineral Resources of Alaska, 1926-A.) Pp. ii+66+xii. Professional Paper 152: Geography, Geology and Mineral Resources of Part of Southeastern Idaho. By George Rogers Mansfield. With Descriptions of Carboniferous and Triassic Fossils, by G. H. Girty. Pp. xiii+453+70 plates. 2.40 dollars. (Washington, D.C.: Government Printing Office.)

Spisy Vydávané Přírodovědeckou Fakultou Masarykovy University. (Publications de la Faculté des Sciences de l'Université Masaryk.) Čís. 90: Některé pokusy o geometrických pravděpodobnostech (Quelques expériences sur les probabilités géométriques). Napsal Jos. Bata. Pp. 22. Čís. 91: Propriétés projectives du contact, I. Par Édouard Čech. Pp. 36. Čís. 92: Výklad vzniku krátkých elektromagnetických vln v elektronových lampách, 2 část (An Explanation of the Origin of Short Electromagnetic Waves in Valves, Part 2). Napsal Dr. Josef Šahánek. Pp. 24. Čís. 93: Sur les transformations itérées des variables aléatoires. Par B. Hostinský. Pp. 24. Čís. 94: Klimatická proměnlivost atmosférickych srážek a její vztah k Brücknerově theorii (Les variations climatériques des précipitations atmosphériques et leurs rapports à la théorie de Brückner). Napsal Fr. Říkovský. Pp. 60. Čís. 95: Měření termomagnetického longitudinálního efektu potenciálového (De l'effet thermomagnétique longitudinal). Napsal Josef Zahradníček. Pp. 19. (Brno: A. Píša.)

Diary of Societies.

SATURDAY, JUNE 30.

GENETICAL SOCIETY (at the John Innes Horticultural Institution, Merton, S.W.19), at 1.—Annual Meeting.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section) (at Leicester). At 2.—Dr. H. Stanley Banks: On the Treatment of Toxic Diphtheria by Large Intravenous Doses of Antitoxin.

At 2.30.—C. H. Bond: On the Effect of Certain Radiated Sterols on the Cellular Constituents of the Blood.

At 3.15.—Dr. G. Brittain Gill: On Calcium Deficiency and its Treatment.

At 5.—Discussion.

MONDAY, JULY 2.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Presentation of Prizes:—Keith Prize—Joint Award—to Prof. T. J. Jehu and R. M. Craig. Neill Prize to Prof. A. Robinson.—Prof. J. R. Wilton: The Lattice Points of a Circle. (*To be read by title*.)—Prof. H. W. Turnbull and J. Williamson: The Invariant Theory of the Quaternary Quadratic Complex. II. The Complete System. (*To be read by title*.)

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

TUESDAY, JULY 3.

ROYAL SOCIETY OF MEDICINE, at 4.—Annual General Meeting.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Dr. E. H. Hunt: The Rock-hewn Temples of Ajanta and Ellora.

FRIDAY, JULY 6.

GEOLOGISTS' ASSOCIATION (in Architectural Theatre, University College), at 7.30.—F. Gossling: The Geology of the Country around Reigate.—H. A. Hayward: The Geology of the Lower Greensand around Dorking, Surrey.

PUBLIC LECTURE.

THURSDAY, JULY 12.

INSTITUTE OF PHYSICS (in Rooms of the Institution of Electrical Engineers), at 8.—Dr. C. E. Kenneth Mees: Physics in Photography.

CONGRESSES.

JULY 5, 6 AND 7.

OXFORD OPHTHALMOLOGICAL CONGRESS (at Keble College).

July 5.

Prof. Leonard Hill, W. S. Duke-Elder and others: Symposium on The Ultra-violet Ray.

July 6.

Prof. Arthur Thomson: Observations on the Eyes of Birds (Doyne Memorial Lecture).

The various Supplements should be collated and bound with the numbers with which they were issued.

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